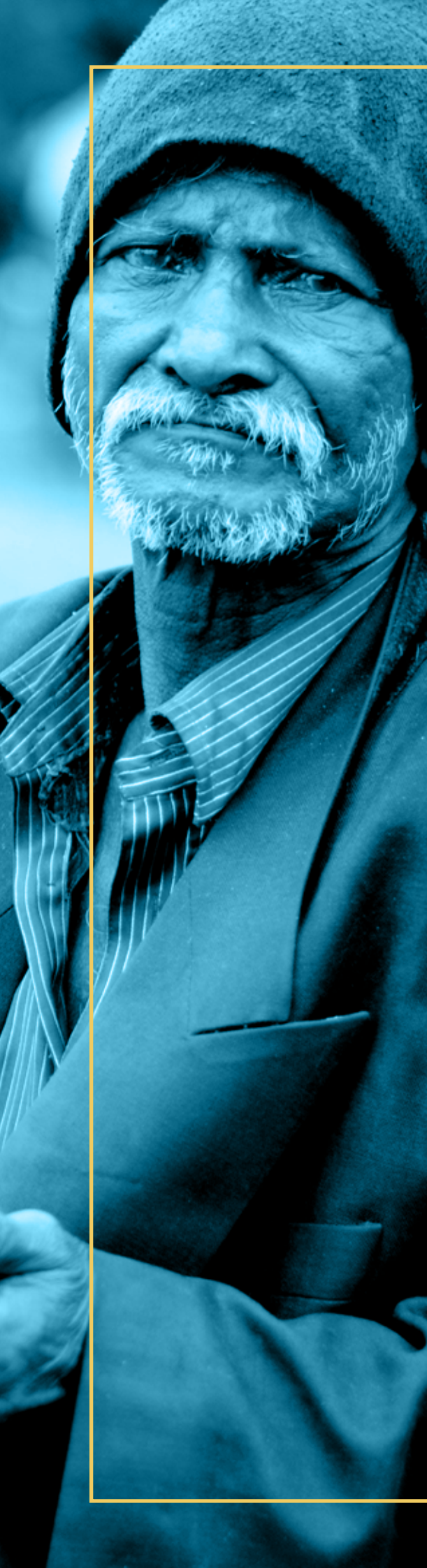




The impact of economic sanctions on health and health systems in low- and middle-income countries

Matteo Pinna Pintor
Christoph Hamelmann
Marc Suhrcke



**World Health
Organization**

Eastern Mediterranean Region



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WHO Library Cataloguing in Publication Data

Names: World Health Organization. Eastern Mediterranean Region; Pinna Pintor, Matteo; Hamelmann, Christoph; Suhrcke, Marc

Title: The impact of economic sanctions on health and health systems in low- and middle-income countries / World Health Organization. Eastern Mediterranean Region

Description: Cairo: World Health Organization. Regional Office for the Eastern Mediterranean, 2023

Identifier: ISBN 978-92-9274-177-8 (pbk.) | ISBN 978-92-9274-178-5 (online)

Subjects: Delivery of Health Care - economics | Health Disparities, Minority and Vulnerable Populations | Data Accuracy | Health Policy | Developing Countries

Classification: NLM W 84

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Acknowledgements

This report was developed and written by: Matteo Pinna Pintor, Luxembourg Institute of Socio-economic Research (LISER), Luxembourg (corresponding author, Matteo.Pinnapintor@liser.lu); Christoph Hamelmann, WHO Regional Office for the Eastern Mediterranean, Cairo, Egypt; and Marc Suhrcke, Centre for Health Economics, University of York, United Kingdom of Great Britain and Northern Ireland.

Work for the review benefited from funding from the World Health Organization (WHO) (2019/884281-0). The funder did not play any role in study design, data collection, data analysis and interpretation, and writing of the report. All data relevant to the report are included. The authors declared no competing interests.

The authors would like to thank Richard Garfield (Centers for Disease Control and Prevention, Atlanta, United States of America), David Ogilvie (University of Cambridge, Cambridge, United Kingdom of Great Britain and Northern Ireland) and Till Seuring (Observatoire National de la Santé, Luxembourg) for helpful comments. Thanks are also extended to Arash Rashidian (WHO Regional Office for the Eastern Mediterranean, Cairo, Egypt) and Shadrokh Sirous (WHO Country Office, Tehran, Islamic Republic of Iran) for logistic and organizational support. We would also like to thank the many authors of studies included in the review for kindly providing additional information.

A shorter version of this report was published in Pinna Pintor, Suhrcke & Hamelmann (2023), and an early version was presented at the 16th World Congress on Public Health, 12–17 October 2020, Rome, Italy.

List of acronyms and abbreviations

CDA	Cuban Democracy Act
ICMMS	Iraq Child and Maternal Mortality Survey
IMR	infant mortality rate
LMIC	low- and middle-income country
MeSH	Medical Subject Headings
MMR	maternal mortality ratio
OFFP	Oil-for-Food Programme
TB	tuberculosis
U5MR	under-five mortality rate

Abstract

Background: Economic sanctions, understood as restrictions to customary commercial and financial ties imposed by a state or group of states on a target, usually a state, to induce change in its political constitution or conduct, pursue a variety of foreign policy goals, including humanitarian objectives. Nevertheless, risk-assessment procedures are not customarily incorporated in the administrative machinery of sanctions, and experience of past episodes suggests that there may be adverse consequences for health and health systems in targeted countries that governments and societies ought to consider when facing international disputes. In this report, we review the evidence to date in terms of whether – and if so, how – economic sanctions influence health and health systems in low- and middle-income countries (LMICs).

Methods: Broad systematic searches of PubMed and Google Scholar, complemented with snowballing approaches, were used to retrieve English-language, peer-reviewed and grey literature published from 1970 to 2021. We identified studies providing quantitative impact estimates, approached them by conceptualizing sanctions as natural experiments, assessed their quality according to a semi-structured risk-of-bias procedure based on the ROBINS-I bias domains, and synthesized them by vote counting to test for the existence of adverse effects of sanctions on all health and health system outcomes. We then contextualized our core findings by integrating quantitative and qualitative information in a thematic narrative.

Results: We find a considerable amount of literature covering the topic in question (185 sources), but only a comparatively small share of studies that provide quantitative analysis. Within the pool of quantitative studies, 31 met our definition of supplying an impact estimate. Within the pool of these core studies, only a minority explicitly address extant methodological challenges, including control for relevant confounding and selection bias. Most of these studies (28) focus on health outcomes, from common indicators of early-age mortality to a diverse range of diseases and sequelae. Fewer studies (10) examined health system indicators, mostly in relation to access to pharmaceuticals. Excluding those with data integrity issues, a significant proportion of studies (21/27) reported consistently adverse effects of sanctions across examined outcomes, with no apparent association to quality, focus on early (as opposed to more recent) sanction episodes or publication period. Contextualizing this evidence base in the broader literature provides important insights on the possible dimensions and mechanics of exposure producing these impacts.

Conclusions: Estimating the impact of economic sanctions on health or health systems is a challenging task, as effects can be confounded by correlated shocks and impaired and selective reporting and collection of data. A full elucidation of the impact is precluded by a lack of information about important impact components such as the legal and operational characteristics of sanctions, and behavioural and policy responses by households and governments. Future research should draw on qualitative knowledge to collect domain-relevant data, and combine these with better estimation techniques and study design. However, only the adoption of a risk-assessment framework based on prospective data collection and monitoring can certify claims that civilians are adequately protected from the impact of sanctions.

1. Introduction

In foreign politics and international relations, sanctions are restrictions to customary ties imposed by a state or group of states on a target, usually a state, to induce change in its political constitution or conduct.² The extent of demanded change ranges from preventive requests of restraint to the undertaking of specific actions such as the achievement or restoration of compliance with a given norm or standard, or all the way to explicit strategies of regime destabilization. To exert sufficient leverage for these aims, economic sanctions impose aggregate output costs.³ They do so by a diverse set of measures, tracking the evolving opportunities in the global economy to inflict economic damage, and including: legal bans on trade in goods and services, either broad-based or limited to strategic commodities such as weapons and oil; withholding of financial transactions such as foreign direct investment or official aid (including humanitarian, development or military assistance); and confiscation of assets and travel bans applied to “blacklisted” persons and entities.⁴ Garfield, Devin & Fausey (1995:455) proposed the term “embargo” to encompass both sanctions, understood as limitations on exports to the target, and boycotts, defined as “the refusal to purchase goods and services from a supplier” (see also Smeets, 2018). This is only partially validated by current use, as sanctions are often meant to denote any restriction, while the term embargo is sometimes employed for long-standing, all-encompassing episodes.

“No one is under the illusion that this does not affect the population”

European Union diplomat, talking about sanctions against the Syrian Arab Republic in 2012¹

Military history shows that recourse to sanctions was not uncommon before the 20th century and could be traced back to classical antiquity (Hufbauer et al., 2007:39–41). One well-established historical regularity concerns trends during and after the Cold War, as depicted in Fig. 1, which plots episodes of trade sanctions against low- and middle-income countries (LMICs) between 1950 and 2019 as documented by the Global Sanctions Database (Felbermayr et al., 2020).⁵ In the aftermath of the Second World War, western countries established tight export controls on members of the Soviet-led Council for Mutual Economic Assistance (Comecon) and China (Mastanduno, 1988; Cain, 1995). During the Cold War, the usefulness and actual use of sanctions were limited by the structure of alliances within each bloc and the scarcity of non-aligned states (Garfield, 2002). This translated into limited action by the United Nations (UN) Security Council, which the UN Charter authorizes to use “measures not involving the use of armed force”, including “the complete or partial interruption of economic relations” (United Nations, 1945).⁶ The early 1990s witnessed a marked increase in the use of sanctions, as either an alternative or a supplement to military intervention, and they were often portrayed as a benign method of dispute resolution that was more consistent with human rights objectives and concerns.

However, accounts of salient episodes, such as in Haiti (1991–1994), Iraq (1990–2003) and the former state union of Serbia and Montenegro⁷ (1991–2001), raised widespread concern that most of the burden of economic isolation might fall on civilians, with adverse implications for population health, especially in poor countries (Garfield, Devin & Fausey, 1995; Garfield, 2002, 1999a).⁸ These events mobilized the medical profession (Morin & Miles, 2000; Appleyard, 1998; Parnham-Cope, 1997; Delamothe, 1997), spawned controversy on the ethics of sanctions and the possibility to remove their potentially indiscriminate character (Gordon, 2019, 2011, 1999; Lopez, 2012, 1999; Tostensen & Bull, 2002; Sidel, 1999), motivated discussion on the legal bases of any obligation entrusted upon sanctioning parties (Marks, 1999), and led to a surge in empirical research on the causes and consequences of sanctions (Özdamar & Shahin, 2021; Early & Cilizoğlu, 2020; Peksen, 2019). In the last two decades, the issue gained renewed prominence as

¹ Quoted in Lyme (2012:11, fn. 3).

² See similar definitions in Felbermayr et al. (2020), Hufbauer et al. (2007), Garfield (2002, 1999a). Non-state targets include terrorist groups and drug dealers, but “designated” persons and firms with governmental connections are also increasingly included (Hufbauer & Jung, 2020). For a history of sanctions as a foreign policy tool, see Mulder (2022).

³ Henceforth, the terms “sanctions” and “embargo” refer to economic sanctions, unless stated otherwise. We focus on measures with some economic dimension, as we deem direct constraints on material resources, as opposed to broader assets such as international reputation, to be the *condicio sine qua non* for sizeable impacts on health. Thus, while relevant interactions between political and economic elements of sanctions are discussed, types of sanctions that are largely political in nature, such as the long-term severance of diplomatic relations or the refusal to attend international events (e.g. Olympic Games), fall outside the scope of this report. We also exclude unconventional trade policies, although the distinction between these and sanctions is sometimes blurred, as in the case of “weaponized tariffs” imposed by the United States of America against China during the Trump administration (Hufbauer & Jung, 2020).

⁴ A more complete typology is provided by Garfield (1999a:5).

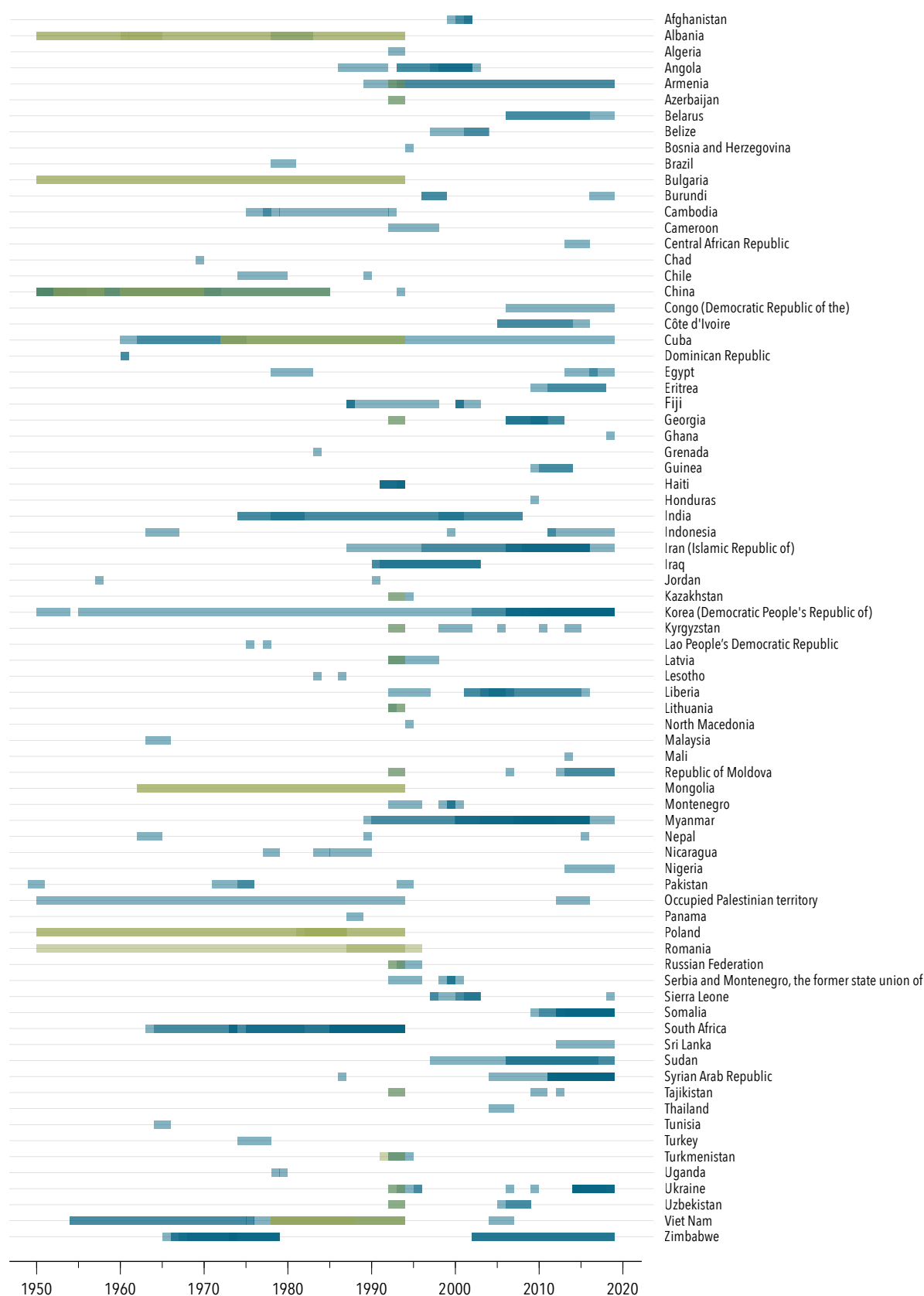
⁵ For similar plots of financial sanctions, arms embargoes, restrictions to military assistance, travel bans and other measures, see Appendix 1.

⁶ In this period, UN sanctions were imposed only twice, against Rhodesia (1965–1979) and South Africa (1962–1994).

⁷ This report reviews literature on the impact of sanctions in successor states to the former Socialist Federal Republic of Yugoslavia. It uses the name “the former state union of Serbia and Montenegro” when describing the focus of the sanctions episodes related to the Yugoslav Wars. However, the cited literature may also consider a time span during which other names for the state were in use.

⁸ These concerns are not without historical precedents. In the First World War, Britain imposed a naval blockade against Germany, which affected imports of food and fertilizer. Claims that the *Hungerblockade* caused starvation among civilians have been debated ever since. Recently discovered anthropometric data from school-based measurements suggests that a deterioration of nutritional status among school children did indeed occur during the blockade (Cox, 2015).

Fig. 1. Timeline of economic sanctions in LMICs, 1950–2019^a



^a Green: Cold War-related. Greater colour intensity denotes overlapping measures. Source: Global Sanctions Database (GSDB) V.2, available at GSDB@drexel.edu (Felbermayr et al., 2020). The following target aggregates were split into component countries: Balkans, western countries, Economic Community of West African States, International Criminal Court (ICC) Rome Statute signatories, League of Arab States, European Economic Community, European Union (EU), Council for Mutual Economic Assistance (Comecon). Episodes involving the Union of Soviet Socialist Republics (USSR) and Yugoslavia were respectively recoded to post-Soviet states, and both Serbia and Montenegro after 1991. Countries were included if classified as low income or lower middle income during their entire available period. In addition, countries were included limited to episodes initiated in a year when they were so classified, or using the closest year available; or if they were so classified for at least half the available years of the episode. The classification used is the World Bank Analytical Classifications 2019. Zimbabwe refers to Rhodesia before 1979, Viet Nam refers to North Vietnam before 1975. Cold War-related sanctions include sanctions against members of Comecon not imposed by the Soviet Union; sanctions imposed by the Soviet Union against countries not members of Comecon; sanctions imposed by the CoCom and ChinCom organizations; and exclude North Vietnam and Cuba before Comecon membership, sanctions against Cambodia, China, Democratic People's Republic of Korea and Yugoslavia; and sanctions against the USSR from neutral European states (Austria, Finland, Sweden and Switzerland). Episodes started and ended in the same year were coded to end in the subsequent year to allow visualization.

sanctions were imposed or tightened on countries experiencing armed conflict or economic and political turmoil, such as the Islamic Republic of Iran, the Russian Federation, the Syrian Arab Republic and Venezuela.

The post-Cold-War experience shows that the risk of adverse health consequences must be considered when societies choose their conduct during international disputes. Any such welfare analysis will depend on: societal goals, which may allow for the balancing of political and humanitarian considerations in a “pain-and-gain calculus” (Weiss et al., 1997); all (health and non-health) costs and benefits of sanctions; and the costs and benefits of alternative options, which may include “going to war or leaving unpunished important crimes, such as genocide” (Garfield, 1999a:4). This latter point underlines the importance of counterfactual thinking in providing empirical ground to assist normative deliberation about sanctions. In this report, we review the existing evidence to date on whether – and if so, why – economic sanctions affect health and health systems in LMICs. In doing so, we improve upon (scarce) previous summaries through a more comprehensive retrieval of a fragmentary and heterogeneous literature, and by explicit and more systematic consideration of issues of causality and mechanisms.

The rest of this report is organized as follows: part 2 outlines methodological issues in conceptualizing and implementing the review; part 3 presents results, first by a synthesis of the characteristics, findings and quality of the reviewed studies, and then by a thematic narrative; and part 4 concludes by providing recommendations for future research and sanction policy-making.

2. Methods

This part of the report details the basic methodological set-up of the review. First, we provide a design-based conceptual framework to consider the subject matter and identify key dimensions involved in its analysis. We then document the search strategy used to retrieve existing literature. Finally, we discuss problems of quality assessment and synthesis, and illustrate the solutions adopted.

2.1 Conceptual framework: sanctions as natural experiments

To generate and assess evidence on the causal effects of sanctions on population health, sanctions are best regarded as natural experiments. The definition of this concept is currently debated (de Vocht et al., 2021). We follow Titunik (2020) and define natural experiments as probabilistic events with an unknown allocation mechanism that are external to the subjects of the study population. Exemplifying this recent definition brings out its relevance and adequacy to the study of the consequences of sanctions on civilians.

Unknown allocation mechanism. Sanctions are imposed to pursue a variety of goals, and stated motives might express a commitment to the welfare of civilians involved, or at least to the prevention and mitigation of unintended harm. In practice, however, prospective data collection and risk-assessment procedures are not incorporated into their implementation, as is typically the case when health hazards are present – for example, in some production processes.¹ Moreover, being part of foreign policy, decisions to impose sanctions are often opaque and confidential, so that whatever relevant information is recorded may be hard to access. As a consequence, information on the factors determining the probability that a given country is targeted by sanctions and on the timing and intensity of such exposure is unavailable in advance and incomplete in retrospect. In other words, researchers do not observe the allocation mechanism of sanctions and therefore cannot rely on it to construct balanced comparisons, with countries facing the same probability – but a different realized state – of exposure to sanctions. An attempt to attain such comparisons must instead be made by modelling the allocation mechanism, and accounting for differences in the probability of exposure to sanctions by means of statistical adjustment. This situation contrasts with the classical experimental setting, where the allocation mechanism is specified prospectively by the evaluator, and places the assessment of sanctions firmly into the realm of retrospective observational studies – with the additional complication that data collection itself may be adversely affected by sanctions, an aspect it has in common with disaster epidemiology (Birnbaum, Daily & O'Rourke, 2015; Galea, Maxwell & Norris, 2008).

External exposure. The risk of a country incurring sanctions is largely determined by political decisions and behaviours of the national and foreign governments. In particular, while governments may under- or overestimate the risk associated to a particular conduct, they are in general able to anticipate an order of risk. However, civilians in the country have typically little influence on these processes. Influence on governments' political behaviour is mediated by institutions and collective action, and is thus indirect and uncertain, especially in policy domains that influence the risk of sanctions. Civilians also face clear limits in influencing their own individual exposure if their country is sanctioned or anticipated to be so. The large size of targets – usually entire countries – limits the general ability of populations to avoid exposure by relocating, and individuals face obvious constraints in preserving for themselves formally interrupted economic ties. In sum, there are *prima facie* reasons to believe that civilians do not self-select into (or out of) sanctions.² Following terminology introduced by Heckman (2000) and Deaton (2010), the imposition of sanctions is thus external to (i.e. not directly affected by) decisions by members of the population at risk. It is worth stressing that externality refers to the exclusion of individual behaviours as a determinant of exposure status, not the lack of behavioural responses caused by the exposure. Once sanctions are in place, all social actors in the country can be expected to react in an attempt to mitigate and modify the consequences. Households may change consumption habits or join the informal sector, a black market of smuggled goods may emerge, firms may seek alternative foreign partners, and governments may change economic and public policies. Crucially, these responses may vary across episodes but are all pertinent to the research question and part of the effect of interest. Thus, the overall value of an external exposure in

¹ This situation is amenable to change, as indeed demanded by some scholars (Garfield, 1999a). Guidelines have been developed, but the extent of their application is unclear (Bessler, Garfield & McHugh, 2004a, 2004b). For this reason it seems that, as far as health is concerned, sanctions are best regarded as “exposures” rather than “interventions”. Note that the ethical and feasible way of learning about impacts, by incorporating health concerns and surveillance into decision-making rather than by experimental allocation, is also more typical of exposures than interventions.

² Exposure status may not always be straightforward to ascertain accurately for reasons other than self-selection. First, there could be “spillovers” to non-sanctioned countries that are heavily involved in trade with a sanctioned country. Compensations or exceptions are sometimes offered to these countries, perhaps in an effort to elicit compliance (Özdamar & Shahin, 2021; Hufbauer & Jung, 2020). Bove, Di Salvatore & Nistico (2021) show that spillovers on neighbouring countries exist, but can be either positive or negative. Second, sanctions are increasingly accompanied by extraterritorial provisions: secondary measures aimed at penalizing firms from non-sanctioned countries which do not comply with sanctions – usually by further prohibiting business with them. However, the relevance of these effects for health in nominally non-exposed countries is likely negligible, and taking them into account requires relatively simple information.

a natural setting lies in the fact that, while choices of individuals and governments will be incorporated in the observed effect, it is unlikely that the latter is a by-product of correlated but substantively irrelevant behaviour.

This definition is based on general subject-matter features and represents a useful heuristic. Its value lies in suggesting desirable elements of study design. First, the externality assumption must be corroborated by background evidence and operationalized by precise measurement of the timing and geographical coverage of sanctions. Second, it is important to understand that externality corroborates but does not imply unconfoundedness, which can be violated in ways other than self-selection into the exposure (Titunik, 2020; Deaton, 2010). Therefore, there is an undiminished need to control for baseline differences in outcomes between sanctioned and non-sanctioned units, paying particular attention to confounding caused by other external and population-level factors, such as the correlated shocks that often anticipate, accompany or follow sanctions: armed conflict, large-scale political and economic instability, and natural disasters.

In sum, viewing sanctions as natural experiments underscores the need to approach the literature in the light of its foundational characteristics, the interpretive benefits of an external exposure and a natural setting, and the best uses of often severely limited data collection capacity.

2.2 Search strategy and inclusion criteria

We undertook a systematic search, seeking to identify relevant academic and grey literature. Our search strategy was composed of three complementary approaches: a PubMed search, a Google Scholar search and a snowball search incorporating streams of literature stemming from prominent early papers and additional records discovered while retrieving sources identified through all previous methods.

Each source, if located and accessible, was screened on title and abstract as a first pass, and then in its entirety if necessary, to decide whether it was appropriate to include it in the review. The inclusion criteria followed were:

- Being written in English.
- Having a focus on sanctions targeting countries satisfying the World Bank definition of low- or middle-income in the relevant time period, or a cross-country approach inclusive of those countries.
- Having relevance to the topic. Anticipating a highly heterogeneous set of contributions, we aimed at a two-tiered classification of relevant sources. Studies providing information interpretable as an impact estimate for any outcome domain related to health and health systems – however measured – qualified as core references. This was meant to require numerical measures of, and variability in, health or health system outcomes and exposure to sanctions (see Appendix 2 for definitions). Core sources were inspected in detail, and salient aspects of their analysis were extracted and tabulated. They form the building blocks of the review and were given primary importance in developing our commentary and informing our conclusions. On the other hand, a group of non-core sources was defined in order to preserve content that, despite falling short of providing an impact estimate, was deemed insightful in terms of methodology or subject-matter knowledge. Non-core sources included studies with sparse quantitative information, previous literature reviews, commentaries, editorials and opinion pieces, and qualitative studies of health and sanctions rich in background knowledge about specific aspects of the problem. These sources were used to inform discussion and contextualize core sources, noting points of agreement and disagreement.
- Having an adequate editorial status. By this criterion, we mean full-text articles published in peer-reviewed journals and manuscripts whose institutional author is included in a prespecified grey literature list. This list included all UN agencies and working paper series of academic and research institutions, and excluded pre-prints from unsupervised repositories. Executive summaries and conference abstracts were not considered, although articles summarizing other work were included. An effort was made to identify published versions on the search date and during the review process by using targeted searches. If they still met the inclusion criteria, uncovered published versions were preferred – although unpublished versions were retained as contextual references if they included relevant information not present in the published version. Versions selected and exceptions are documented in Appendix 3.

Two sets of searches were implemented, in two different chronological periods. A first round of searches was implemented in October 2019, limiting publication date to the period 01/1970 to 10/2019. A second round of searches was implemented in December 2021 and March 2022, limiting publication date to the period 01/2020 to 12/2021. For each search system, the search terms were identical. The searches were performed as follows (further details can be found in Appendix 3). First, we undertook a simple,

broadly defined PubMed search, comprising the co-incidence of the words “sanctions” and “health” in the title or abstract. Second, anticipating wide dispersion of sources across disciplines and publication formats, including a large body of grey literature, we searched Google Scholar. Recent assessments show Google Scholar to be too limited to be relied upon as a primary search system in systematic and other reviews (Guesenbauer & Haddaway, 2020; Bramer, Giustini & Kramer, 2016). Key shortcomings include limited search reproducibility, no support for MeSH (Medical Subject Headings) terms, and limits on admissible Boolean operators, string length (256 characters) and accessible results (first 1000). However, its coverage is multidisciplinary and, albeit unknown, is very likely to exceed by a large measure all other existing databases. Therefore, it can be a powerful complement to primary search systems when the target literature’s research domain involves disciplines in which evidence synthesis is not yet well-established, is characterized by generic rather than specialized terminology and may include a large grey literature – all features we expected to be pertinent to our case (Haddaway et al., 2015). Moreover, frequently mentioned logistic shortcomings related to record management, such as lack of download facility for the entire search and search history, could be addressed by dedicated software. For the first period, we performed five title-only searches, and selected one of intermediate dimensions. Third, retrieval of sources from the first Google Scholar search resulted in the discovery of additional records of potential relevance. These were included in a separate source pool for screening, and their specific origin was recorded. Finally, during the course of the review, additional sources were identified by inspecting the references of included sources. Those which met the inclusion criteria were also included.

2.3 Data extraction and task division

Identified records were exported or transcribed in table-formatted Excel spreadsheets. For Google Scholar, extraction and preliminary automatized removal of exact duplicates was facilitated by a dedicated software (Harzing, 2007). Various sets of characteristics were also stored in separate datasets in order to generate summary statistics of the reviewed literature: bibliographic characteristics, including editorial format, discipline and publication year; substantive and design features, including geographical focus, type of contribution and research method (definitions in Appendix 2); for core studies, additional characteristics were extracted, including the outcome variables employed, effect estimates and sample sizes when available. The visualizations and synthesis method was based on attributes without missing observations.

Two authors were responsible for the two main searches: Marc Suhrcke (MS) for PubMed, Matteo Pinna Pintor (MPP) for Google Scholar; while one author (MPP) kept track of additional sources found in the process, produced an integrated list and extracted study characteristics. Included studies were equally split between two authors (MS, MPP), who reviewed them independently, with sample cross-validation. When deemed necessary, authors of reviewed studies were contacted to inspect datasets and obtain additional information. All reviewed core sources were discussed and, in case of initial divergent judgement on their inclusion and classification, a consensus was found.

2.4 Quality assessment and synthesis methods

Characterizing sanctions as natural experiments with an undesirable exposure clustered at the level of countries or large areas has implications for evidence synthesis. Recent protocols to evaluate observational studies have been tailored to prospective studies of clinical interventions (Sterne et al., 2016). Currently, debate is ongoing over the extent to which such an approach can be generalized to other types of events and study designs (Thomson et al., 2018; Bero et al., 2018; Humphreys, Panter & Ogilvie, 2017). Anticipating similar problems of applicability, we reviewed the ROBINS-I tool after full-text assessment of core studies, and identified a number of conceptual issues and associated solutions.

First, the nature and current knowledge of the subject imply that only a very extensive definition of the effect of interest is possible: the impact of sanctions on population health and health systems in LMICs. The range of study designs, outcomes and effect measures consistent with this definition is large, and precludes a single prespecified list of confounders. Retrieved studies are too few and scattered across available options to enable synthesis for separate groups. As a solution, it was thus decided to assess confounders by iterative comparisons between all core studies, with additional information from non-core studies. The problem of scarce information relative to existing research degrees of freedom carries over to the evaluation of some implementation choices. For example, in studies with difference estimators, an unobserved factor may be a confounder if time-varying or an effect modifier if fixed. However, the information required to evaluate the choice was often available. Current subject-matter knowledge is also insufficient to fully evaluate specification choices in regression analyses, such as functional form, the re-scaling of variables and the construction of indices. We concluded that judgements about confounding that were so conjectural ought not to be given a scalar score, and were best left in verbal form. The lack of clear

benchmarks for these choices also complicates the assessment of reporting, as there might be no way to adjudicate between multiple, equally plausible analysis plans. This makes it difficult to demarcate between, for example, exploratory specification searches and a more arbitrary selection of hypotheses to test and report. An overall judgement at the literature level was deemed more appropriate, while data integrity was found to be an important issue omitted by the tool.

A second set of implications stems from the fact that, currently, sanctions are neither interventions aimed at improving health nor prospectively monitored health hazards, and are instead (approximately) external exposures. As motives and opportunities for self-selection are limited, retrospective ascertainment of exposure status per se is a poor indicator of the risk of misclassification, which must be evaluated instead by assessing the quality of the information used and whether robustness checks or falsification tests are implemented to investigate the sensitivity of results to alternative definitions of exposure. We focus on these aspects, on which the tool provides little guidance. Moreover, the nature and current knowledge of the subject suggest that, as far as health-related outcomes are concerned, no intended or typical experience of sanctions can be identified. As the effect of interest is presumed to be harmful, there is no intended course of action conditional on exposure. Hence, notions related to compliance (e.g. adherence, implementation failure, etc.) have no meaningful analogue in this setting. A typical course of events under the exposure might exist, but there is little interest in defining one such benchmark, and doing so would require background information that is currently unavailable. Absent those pre-specifiable benchmarks, we assess suggestions and analyses for all proposed effect size modifications and mediators (also known as channels), regarding them as relevant components of the effect of interest.

In sum, the ROBINS-I tool requires a fuller characterization of the effect of interest than currently available in the literature, and some of its signalling questions fit poorly with key design-relevant features of sanctions. We thus concluded this mismatch to be at present too large for meaningful application of the tool. At the same time, the literature lacks a structured assessment of internal validity, which can guide the design of future research efforts. To strike a balance, we have developed an alternative procedure (details in Appendix 4). We rely on the seven bias domains of ROBINS-I, augmented by an additional dimension, to present risk-of-bias concerns in a semi-structured way. For each study, a count of the domains for which concerns were identified provides a rough measure of overall study quality. As this quality score is not directly obtained from the construction of target trials as unique benchmarks for assessing reported effects, it is expected to rely more heavily on the reviewers' statistical knowledge. For this reason, each rating was thoroughly discussed and established by consensus among the reviewing authors (MPP, MS). The score is understood as a valuable tool to further characterize the "high-risk spectrum" occupied by the virtual entirety of our sample of core studies.

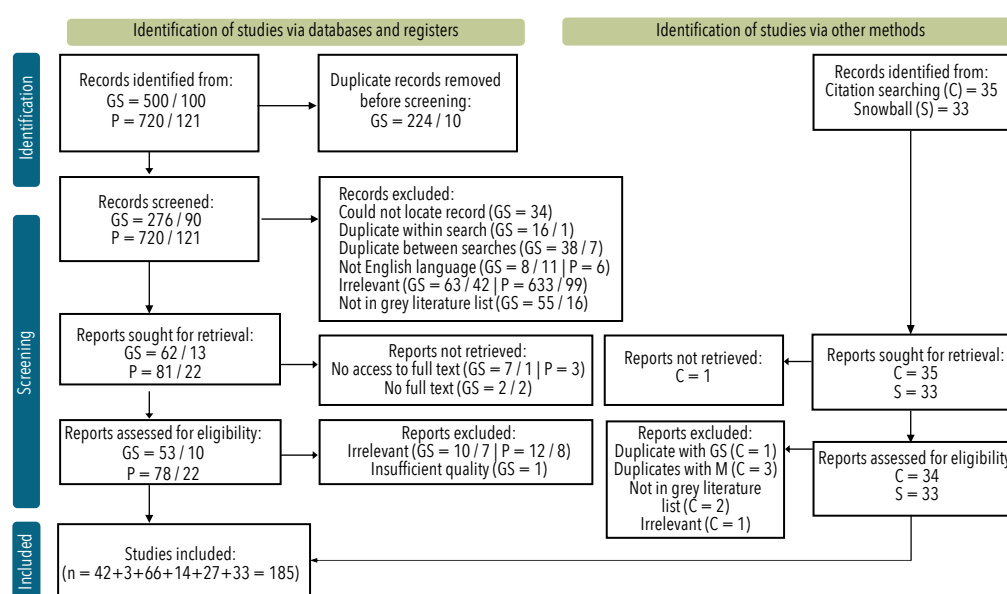
The high heterogeneity of the core studies, and the lack of measures of precision for some of them, precludes meta-analysis and calls for alternative synthesis methods. Following current guidance (McKenzie & Brennan, 2019), we develop a vote counting algorithm to assess whether the literature, taken as a whole, provides evidence for the existence of an adverse impact of sanctions. We assign a direction-of-effect score to each impact estimate presented in each core study, and aggregate them into an overall study score following a simple and conservative rule: only studies consistently reporting a single effect direction across all outcomes considered were counted as showing evidence for an effect in that direction (details in Appendix 4). We use the overall scores of quality and direction of effect to visualize – and test hypotheses about – the quantitative kernel of the literature. The value of this approach lies in no small part in its relevance for possible uses of the evidence, as assessing the existence, nature and direction of effects, without quantifying their precise magnitude, could be regarded as sufficient to motivate at least some policy action – including action to incorporate prospective data collection in new sanction episodes to facilitate future assessment. Finally, to explore possible causes of effect heterogeneity, the synthesized findings were contextualized in the broader literature through a thematic narrative, based on a set of salient themes identified based on previous reviews, in the spirit of Ogilvie et al. (2020a), who advocated a "dry stone wall" approach to combining quantitative and qualitative information in evidence synthesis of natural experiments.

In developing this two-tiered approach to synthesis, we share the position that mapping methodological gaps and proposing explanatory frameworks is, for emerging literatures, a more realistic objective than ensuring a homogeneous base for meta-analysis (Ogilvie et al., 2020b; Ogilvie et al., 2005). The reporting of methodological details complies with PRISMA and SwiM guidelines (Page et al., 2021; Campbell et al., 2020) (Appendix 5).

3. Results and discussion

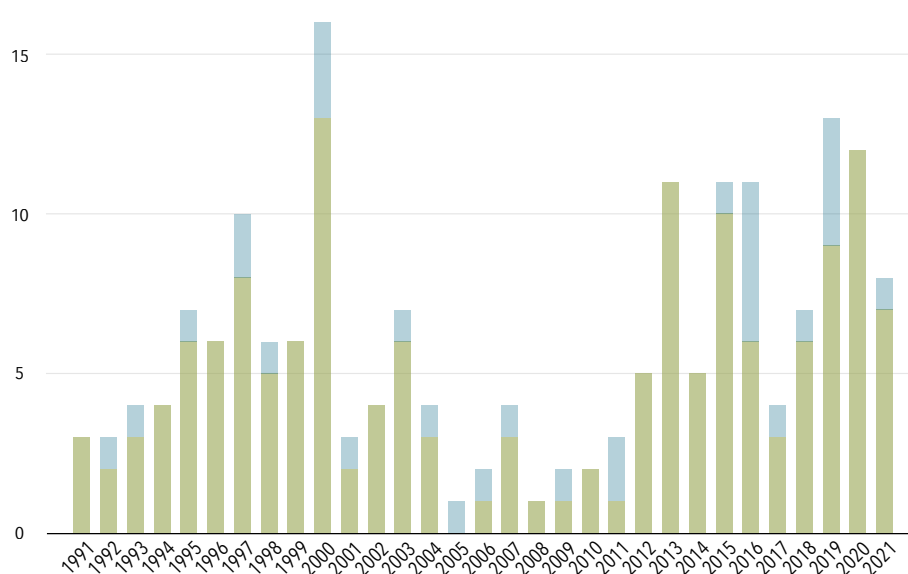
The search and screening process produced a total of 185 sources for inclusion in the review, 31 of which qualified as core studies (Fig. 2, Table 1). The profile of publication years charted in Fig. 3 suggests that the literature went through a first phase in the 1990s, and then subsided for about a decade, resuming in the 2010s. This profile is consistent with the timing of major sanction episodes, such as those involving Haiti and Iraq in the first period, and the Islamic Republic of Iran in the second period. Editorial status was relatively homogeneous, with the vast majority of included records coming from peer-reviewed medical and public health journals. However, a few reports and working papers from UN agencies and research institutions, and several sources from the social sciences, were also included in both core and non-core samples (Fig. 4). A large share of the included sample was composed of records containing expert opinions, long commentaries and essays based on existing findings, and literature reviews. This material made up the bulk of non-core sources consulted to obtain a perspective on the subject matter.

Fig. 2. PRISMA flowchart ^a



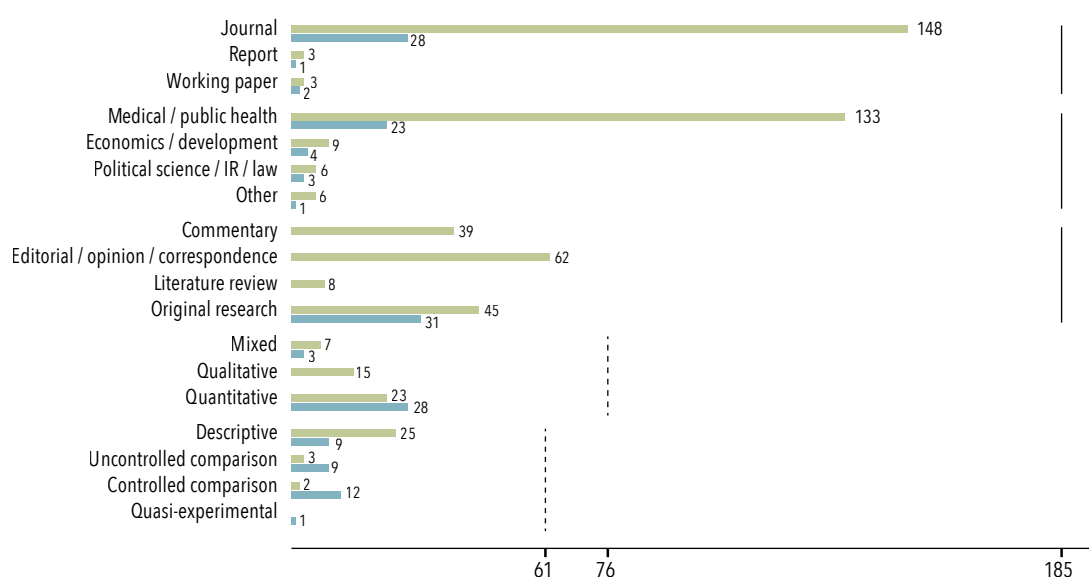
^a GS: Google Scholar; P: PubMed. For each search system, numbers for the first and second chorological periods are given separated by a slash. Template courtesy of Page et al. (2021). More information can be found at www.prisma-statement.org.

Fig. 3. Included sources by publication year^a



^a Blue: core; green: non-core.

Fig. 4. Included sources by editorial status, discipline, type of contribution and research method^a



^a Blue: core; green: non-core; IR: international relations. Definitions of categories can be found in Appendix 2. Disciplinary sector attributed by journal, or by departmental affiliation of first author or publisher for grey literature and general-purpose journals.

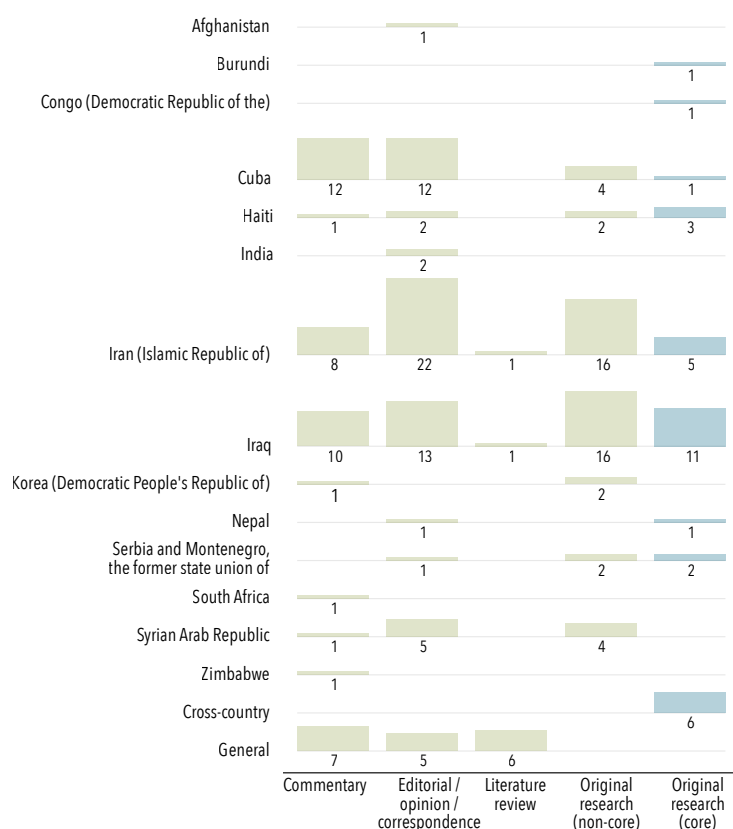
The 76 records that could be defined as original research mostly contained quantitative analyses, although mixed-method and qualitative studies were also present. Of the 61 studies with some quantitative analysis, including all core studies, most adopted a descriptive approach. In its simplest form, this entailed producing two-way tables comparing values under sanctions with those before or after them, or plotting time series over the point in time at which sanctions were imposed. A few studies tested hypotheses about group or period differences produced in a similar bivariate framework, while a slightly larger number of studies made the further step to account for potential confounders, effectively making these comparisons conditional on the maximization of some measure of similarity between observations in terms of chosen covariates. Perhaps surprisingly, only one study consistently applied what would be considered standard empirical methodology for quasi-experimental, causal impact evaluation. Finally, Fig. 5 shows that in both the entire sample and the core subsample the retrieved literature is dominated by two target countries, Iraq and the Islamic Republic of Iran. However, core studies included cross-country designs and covered countries not discussed by non-core studies. On the other hand, a large number of records, mostly devoid of original findings, discussed sanctions against Cuba, while the Democratic People's Republic of Korea and the Syrian Arab Republic received attention in the literature but were not investigated in ways that could produce impact estimates.

Most core studies were concerned with the relationship between sanctions and health outcomes, while a minority employed health system indicators and only six studies included both types of variables (Fig. 6). Among the health outcome variables, indicators of mortality were the most common and were virtually all specific to an early childhood age group. Perhaps as a consequence of the widespread view that child mortality tracks material conditions in the general population, very little information was found about adult mortality. Despite its greater sensitivity to earlier age mortality, life expectancy incorporates information about the general population; however, only one study adopted this indicator. The other frequently used class of indicators comprises measures of morbidity, in particular, prevalences of various conditions – first and foremost child malnutrition.¹ A small number of studies conveyed information about morbidity by incidence rates or frequency of cases. Two studies resorted to anthropometric indicators of malnutrition without transforming them into prevalence measures. Perhaps due to the more demanding conditions for measurement, biomarkers were used in only one study. Health system outcomes were mostly focused on the availability of and access to specific drugs and vaccines, while little coverage was given to water, sanitation and hygiene indicators and non-pharmaceutical health care and health inputs² (including nutrients).

¹ For consistency with the literature reviewed, which mostly predates recent changes in conventional terminology, we henceforth use the term malnutrition to denote undernutrition – unless mentioned otherwise.

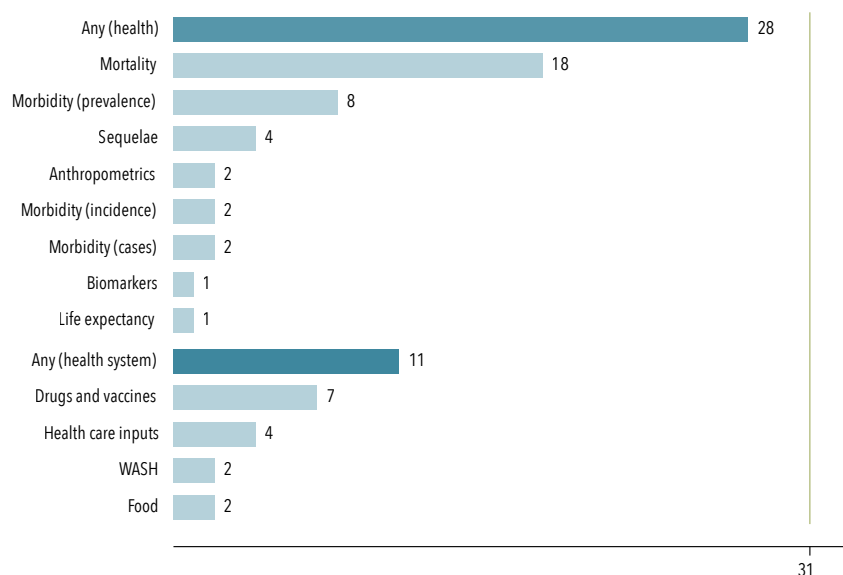
² In this report, a health input refers to any factor, usually but not necessarily an economic good or service, affecting health.

Fig. 5. Included sources by type of contribution and geographical focus^a



^a Blue: core; green: non-core. Studies focusing on multiple selected countries (as opposed to cross-country studies) are observed repeatedly. Category "general" includes studies without appreciable geographical focus.

Fig. 6. Outcome indicators in core studies, by measurement domain (health, health systems) and subdomain^a



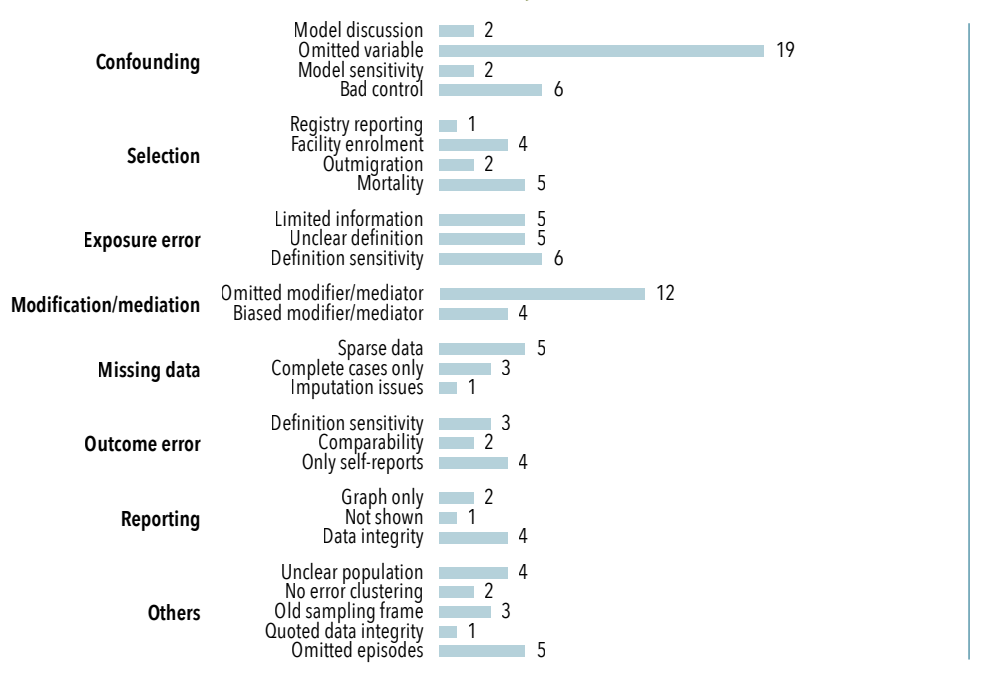
^a Outcome subdomains include the following specific indicators. Mortality: 1-month mortality rate (neonatal mortality rate); 1–12 months mortality rate (post-neonatal mortality rate), infant mortality rate (IMR), under-3 risk of death, 1–4 mortality rate, under-5 mortality rate (U5MR), under-6 mortality rate, under-2 risk of death 12 months after first visit, child deaths due to measles, maternal mortality rate, deaths due to cardiovascular diseases, 5-year survival rate after bone cancer treatment, all-cause mortality, all-age cause-specific mortality, under-15 crude HIV/AIDS-related death rate. Morbidity (prevalence): low birthweight (kg < 2.5), type-2 diabetes, overweight/obesity, dental caries, HIV/AIDS among women, stunting based on height-for-age Z score (HAZ < 2), wasting based on weight-for-height Z score (WHZ < 2), underweight based on weight-for-age Z score (WAZ < 2). Sequelae (health states caused by disease or injury): population in need of disaster relief, arthropathy score (haemophilia patients), annual bleedings (haemophilia patients), seizure frequency (epilepsy patients). Anthropometrics: 6–59 months HAZ, under-1 weight Z score, under-3 height Z score. Morbidity (incidence): new TB cases per 100 000 population, new HIV/AIDS cases among under-15 population. Morbidity (cases): diagnosed hepatitis B, diagnosed retinopathy. Biomarkers: serum ferritin (thalassaemia patients). Life expectancy: life expectancy at birth. Drugs and vaccines: city-level deliveries of hepatitis B vaccine, self-reported adherence to epilepsy treatment, self-reported ease of access to epilepsy treatment, self-reported (patient and doctor) access to thalassaemia treatment, facility-level availability of asthma medications, defined daily dose per 1000 population, unit dose per 1000 population per day, unit price of imported retail medicines in dosage form. Health care inputs: annual health expenditure per capita, X-rays per year, laboratory tests per year, size of national formulary, value of medical imports, annual blood transfusions (thalassaemia patients), public expenditure on disaster preparedness. Water, sanitation and hygiene (WASH): share of contaminated water samples, share of population with access to chlorinated water. Food: per capita calorie availability, per capita protein availability, free-sugars consumption.

The review of core studies uncovered a wide range of shortcomings in their design and estimation strategies (Fig. 7). Data availability and quality likely lie behind a diverse set of limitations, such as complete-case analyses, gaps in time series of population-level indicators, and changes in definitions of key variables across comparison periods or groups. Conceptualizing sanctions as natural experiments clarifies the key role of precise and reliable information about their timing and spatial coverage, but this was not provided in some studies. For example, Kheirandish et al. (2018) perform structural break tests on time series of pharmaceutical availability, but do not report the exact date of the assumed change. In some studies, the possibility of exploring the sensitivity of results to small changes in the definition of exposure and outcome variables was apparent but left unexploited – an exception is the study of Parker, Foltz & Elsea (2016). The reporting of findings reflected the emerging stage of the literature, the opportunistic nature of key design choices, and the general lack of scholarly consensus about how to best investigate the health impact of sanctions.

Beyond this uncertainty, shortcomings in reporting that clearly jeopardized study quality include the omission of numerical results for some findings and statistical tests. Moreover, as previously mentioned, a major and peculiar feature of the literature concerns the existence of four studies based on potentially comprised data collection efforts, due to evidence and credible allegations of tampering (see below, section 3.5).

A risk of selection bias was detected in studies where unobserved behavioural changes caused by sanctions or by some of its determinants could have affected data collection, including outmigration or mortality in survey or facility catchment areas. Studies with individual data from cross-sectional surveys or health facilities were particularly vulnerable, although some addressed the problem by relying on recalls or on longitudinal records (Karimi & Haghpanah, 2015; Asadi-Pooya et al., 2016; Asadi-Pooya et al., 2019; Ascherio et al., 1992). For example, the cross-country study by Petrescu (2016) reports a counterintuitive, positive effect of in utero exposure to sanctions on height among children aged under three. This result may well stem from the fact that elevated mortality after in utero exposure to sanctions – also documented in the study – disproportionately affects shorter children, who may be more frail.¹

Fig. 7. Risk-of-bias concerns and limitations in core studies, by bias domain and subdomain^a



31

^a Definitions of bias domains can be found in Appendix 4.

¹ Further insight is provided by the fact that inclusion of an interaction between the exposure indicator and the under-3 mortality rate prevailing during each episode returns a significant and negative coefficient, while the (relatively smaller) positive exposure coefficient grows in size and precision. These findings could be related to the fact that, in high-mortality populations, adult height reflects the opposing forces of mortality selection and scarring due to non-fatal disease (Bozzoli, Deaton & Quintana-Domeque, 2009). Hence, it might be that the balance of these forces differs within the sample and, if attention is focused on children exposed to sanctions in countries with sufficiently high mortality, scarring (e.g. malnutrition) ensures that even exposed surviving children are, on average, shorter than unexposed children. However, this interpretation is hard to assess and to specifically relate to sanctions, as the study also arguably fails to control for baseline differences in mortality levels and trends between exposed and unexposed children.

Lack of pre-specifiable guidance did not prevent concerns about confounding from being identified as the main class of problems, first and foremost due to studies in which a clear case could be made that relevant covariates were omitted. In regression analyses, the models chosen were sometimes poorly justified, subjected to little or no sensitivity checks, or included covariates that were likely affected by sanctions – also known as the “bad control” problem (Rosenbaum, 1984; Wooldridge, 2005; Angrist & Pischke, 2009). For example, Reid et al. (2007) estimated the impact of sanctions on the mortality of young children enrolled at a health facility, controlling for malnutrition at enrolment. As sanctions could have altered the facility’s user population, thereby selecting children with systematically different baseline nutritional status into the exposure group, the step could be useful. However, sanctions might have also causally affected the nutritional status of exposed children, contributing to the impact of sanctions on mortality. This substantially complicates the interpretation of coefficients for both sanctions and malnutrition.

As for other natural experiments, an important challenge in addressing confounding is posed by the frequent co-occurrence of other large-scale shocks in exposed countries. Most core studies faced this challenge, although a small minority arguably avoided it by design (Fig. 8). Controlling for correlated shocks is difficult when events largely overlap, which is more likely in studies of individual countries and with lower-resolution data. Large shocks are often hard to define, and impact estimates could be either confounded and/or modified by them depending on assumptions about their effect. For example, studies of Haiti face the problem that the years immediately preceding sanctions were characterized by widespread – but unmeasured – political instability and violence (Berggren et al., 1993; Mulder-Sibanda, 1998; Reid, et al., 2007). Even assuming instability to be time-invariant, what before-and-after comparisons retrieve may be the effect of sanctions specific to a politically unstable environment. If instead instability varies across time, a before-and-after estimate can be biased. Consistent with this possibility, Reid et al. (2007) report that, relative to the post-sanction period, child mortality is elevated not only under sanctions but also in the pre-sanction period – although the latter estimate is smaller and not significant. Similar considerations affect virtually all studies on Iraq, where the Gulf War is often a likely confounder, and almost always a likely effect modifier. The exception is Daponte & Garfield (2000), who studied the limited period between the imposition of sanctions and the outbreak of armed conflict. Cross-country studies, for which all the correlated shocks identified in the literature can be presumed relevant, attempt to control for these events by means of various indicators, although only one study addresses all type of events.

Fig. 8. Correlated shocks in core studies^a



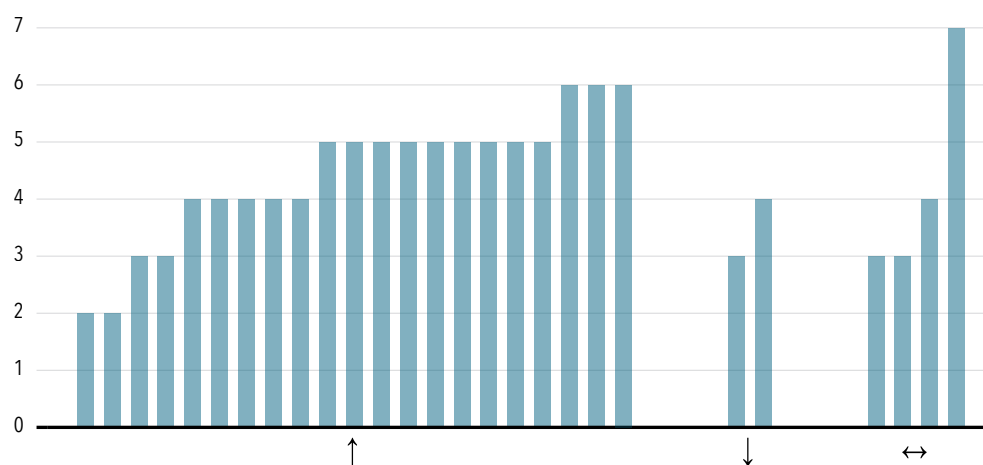
^a Full dots denote studies not addressing plausible confounding due to correlated shocks, including confounding arising only under specific assumptions about time-varying structure and lagged effects. Empty dots indicate studies with an explicit strategy to control for such confounding, including the presence of additional control observations plausibly unaffected by the shock.

Finally, we identified limitations in aspects not related to internal validity, such as: the lack of clustering of standard errors of survey estimates; the omission of important sanction episodes in some cross-country studies; the reliance upon a sampling frame that might not accurately list the population in sample surveys; and a general lack of clarity about the population assumed to be relevant for the study.

Excluding four studies with data integrity issues, 21 out of 27 studies consistently reported adverse effects of sanctions on health and health systems (Table 1, Fig. 9). This proportion is significantly higher than what is expected by assuming no adverse effect and an equal likelihood of false positives and negatives, and even by assuming the expected proportion of false positives to be as high as 60%, for example, due to publication bias (see Appendix 4, Table A4.2).¹ Studies which consistently report adverse effects do not appear to be systematically focused on earlier, or more recent, sanction episodes; nor do they appear to be older, or more recent, in terms of publication period (see Appendix 4, Table A4.3). Based on the constructed quality score, studies focusing on more recent episodes appear to be of significantly higher quality than studies focusing on earlier episodes, while the improvement in terms of publication period is smaller and not statistically significant. This discrepancy might stem from the fact that determinants of study quality specific to more recent episodes, such as data quality, might be more important than those generally improving with time – such as statistical methods. Finally, no significant difference in quality is apparent between studies consistently reporting adverse effects and all other studies (Fig. 10; see Appendix 4, Table A4.4).

In sum, the studies constituting our sample of core sources are mostly peer-reviewed, mostly single-country, largely coming from the medical and public health sciences, heavily reliant on descriptive data, light on statistical methods and chiefly concerned with three important target countries – Iraq, Haiti and the more recent case of the Islamic Republic of Iran. Almost all studies suffer from important limitations in multiple bias domains. Some of these weaknesses have well-known remedies which future research can fruitfully provide, especially if combined with data collection efforts inspired by qualitative knowledge of sanctions. Others are likely to reflect more fundamental subject-matter challenges, such as the complexity of the exposure, its low-frequency and context-specific nature, and the broad range of possible empirical effects. A robust majority of studies consistently reported that sanctions had an adverse effect on health or health systems – a significant proportion, which does not appear to be related to quality, a focus on earlier or more recent sanction episodes, or publication period.

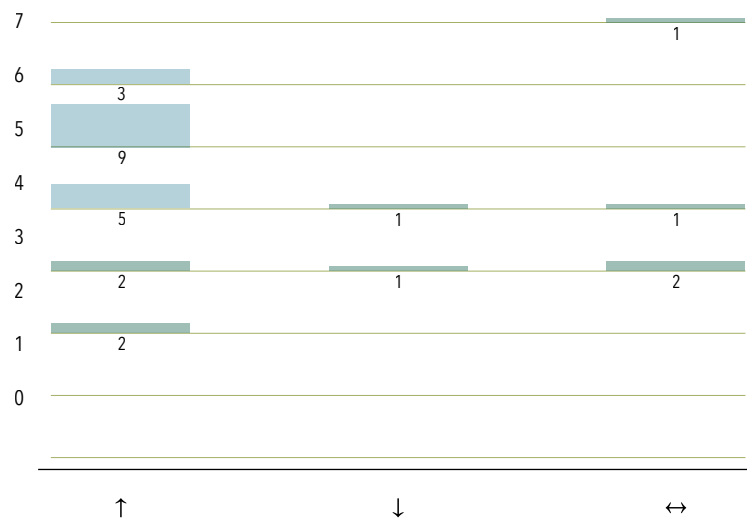
Fig. 9. Harvest plot of overall direction-of-effect scores in core studies, adjusted by overall quality score^a



^a Arrows denote adverse effect (↑), beneficial effect (↓), and conflicting evidence (↔). Details of the construction of the scores are given in Appendix 4. Four studies with data integrity issues were omitted.

¹ Only three core studies came from grey literature: two working papers of research institutions (Berggren et al., 1993; Bundervoet & Verwimp, 2005), and one UN agency report (Garfield, 2001a). The number is too small to meaningfully test for correlations with effect direction or quality. It is worth noting that one working paper was retained in this version because the published version drops the analysis of sanctions entirely.

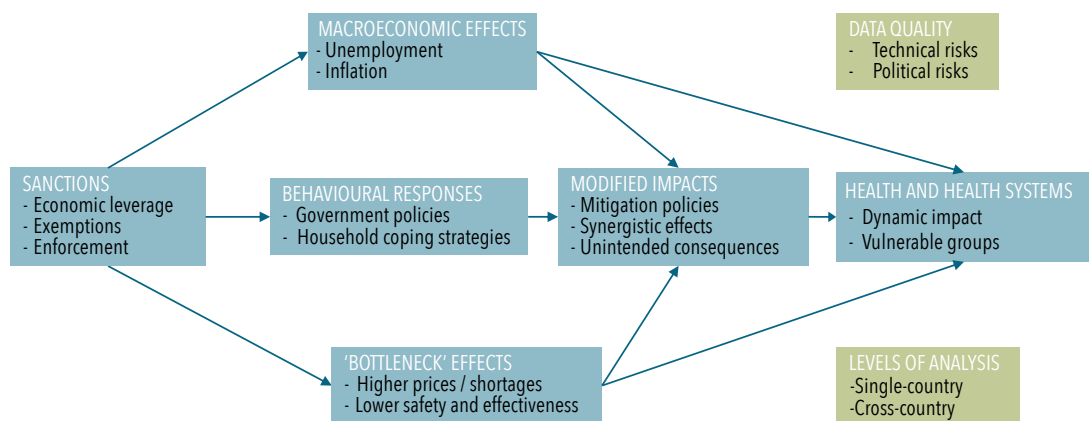
Fig. 10. Overall direction-of-effect scores in core studies, by overall quality score^a



^a Arrows denote adverse effect (↑), beneficial effect (↓), and conflicting evidence (↔). Details of the construction of the scores are given in Appendix 4. Four studies with data integrity issues were omitted.

The remaining part of this report puts the synthesized evidence in context, by integrating qualitative and mixed-method information extracted from the rest of the included literature. This provides an opportunity to present broader interpretations of core findings in light of subject-matter knowledge about factors that are likely relevant for assessing impact estimates, but are currently not measured and therefore excluded from quantitative studies. Fig. 11 illustrates the structure, which should be intended as an analytical map of the report, outlining how the following sections relate to each other and promoting a unified understanding of the topic (Anderson et al., 2011). The connected modules can also be seen as illustrating a causal diagram of sanction impacts, abstracting from possible confounders. The diagram emphasizes that sanctions are multidimensional exposures, and that causal impacts are produced through multiple possible mediators – two features that have been taken as markers of complexity in health interventions research (Guise, et al., 2017). The thematic narrative aims to make sense of sanctions as highly complex social events, and should be regarded as an informed proposal of an explanatory framework.

Fig. 11. Structure of the thematic narrative and causal model of sanction impacts on health and health systems^a



^a Causal diagram in blue.

Table 1. Findings in core studies. Triangles denote adverse effect (▲), beneficial effect (▼) and conflicting evidence (◄►). Details on the construction of the direction-of-effect score are given in Appendix 4.

D _i	Reference	Sanction episode	Country	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification/mediation	Limitations/comments
▲	Al-Ani, Al-Hiali & Al-Farraj (2011)	UN sanctions (Aug 1990–May 2003). Correlated shock: Gulf War (Jan–Feb 1991).	Iraq (city of Haditha)	Infant mortality rate (IMR)		Descriptive statistics from time series of administrative register (Sample: 59 424 live births).	▲ Average annual IMR was 34.7 in 1987–1988, 29.5 in 1989–1990, 38.8 in 1991–2002, 28.6 in 2003–2007 and 27.7 in 2008–2010. The highest and lowest values were 46 in 2002 and 16 in 2006. IMR declined from 1987 to 1990, increased from 1991 to 2002, decreased until 2006, fluctuated upward until 2008 and declined afterwards.	Increase during 1991–2002 attributed to sanctions.	Confounding: no adjustment for armed conflict (if lagged effect). Selection: no adjustment for changes in reporting of vital events. Modification/mediation: no analysis of interaction with armed conflict (if lagged effect). Other: some comparisons with national and regional figures rely on findings from UNICEF's Iraq Child and Maternal Mortality Survey (ICMMS) survey, the reliability of which has been questioned. $Q_i = 4$
▲	Ali (2004)	UN sanctions (Aug 1990–May 2003). Correlated shock: Gulf War (Jan–Feb 1991).	Iraq (city of Mosul)	Cases of viral hepatitis B	Hepatitis B vaccine availability (doses per year)	Descriptive statistics from facility register (Sample: 254 children aged 2–7)	▲ Of 254 children referred to screening for hepatitis B in June 2000 to June 2001, 74 tested positive and 62 of them attended an immunization clinic. A majority of those (32/62) were born in the 2 years registering lower availability of vaccine doses, while the lowest number of births occurred in the year registering the highest availability (8/62).	Variation in vaccine stocks attributed to sanctions and the implementation of the Oil-for-Food Programme (OFFP).	Selection: no control for changes in facility enrolment. Measurement error in exposure: unclear definition of exposure groups (OFFP); limited information on exposure (OFFP). Modification/mediation: no analysis of interaction with armed conflict (if lagged effect). Other: no information on target population. $Q_i = 4$

Table 1. Findings in core studies. Triangles denote adverse effect (▲), beneficial effect (▼) and conflicting evidence (◆). Details on the construction of the direction-of-effect score are given in Appendix 4. (*continued*)

D _i	Reference	Sanction episode	Country	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification/mediation	Limitations/comments
▲	Asadi-Pooya et al. (2019)	United States sanctions (Nov 1979–ongoing), esp. measures reintroduced after withdrawal from the Joint Comprehensive Plan of Action (Aug 2018–ongoing).	Islamic Republic of Iran (cities of Shiraz, Tehran, Ahvaz)	Self-reported changes in seizure control	Self-reported difficulty in obtaining antiepileptic medication	Pearson chi-square test on cross-sectional survey from 3 facilities (Sample: 244 epilepsy patients more than a year post-diagnosis).	▲ Significantly larger share of patients on imported medications reporting “significant hardship” in obtaining treatment after tightened sanctions than patients on domestic medications (72%, 30%, $P < .0001$). ▲ Incidence of seizures significantly higher in patients experiencing “significant hardship” in obtaining treatment than in patients who reported no difficulty (36%, 22%, $P < .05$).	Impact attributed to shortage of imported pharmaceutical intermediate and finished products, caused by restrictions on international transactions due to sanctions	Measurement error in exposure: unclear definition of exposure period. Measurement error in outcome: only self-reported outcomes (no control for recall bias or biased reporting). Other: limited information on target population. $Q_i = 5$

Table 1. Findings in core studies. Triangles denote adverse effect (▲), beneficial effect (▼) and conflicting evidence (◄►). Details on the construction of the direction-of-effect score are given in Appendix 4. (*continued*)

D _i	Reference	Sanction episode	Country	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification/mediation	Limitations/comments
▲	Ascherio et al. (1992)	UN sanctions (Aug 1990–May 2003). Correlated shock: Gulf War (Jan–Feb 1991).	Iraq	IMR, under-5 mortality rate (U5MR), under-1 month, 1–12 months and 12–60 months mortality rates		Unadjusted and adjusted (Poisson regression) relative mortality rates from cross-sectional survey (Sample: 16 172 live births)	▲ Relative to various baseline periods before 1991, in the first 8 months of 1991 under-1 month mortality was 1.8 (95% CI: 1.4–2.4) times higher; 1–12 months mortality was 4.1 (95% CI: 3.3–5.2) times higher; 12–60 months mortality was 3.8 (95% CI: 2.6–5.4) times higher. Controlling for age of child and mother, education of residence, estimates are 1.8, 4.3 and 5.2, respectively. The associated IMR and U5MR changes between the two periods are 32.5 to 92.7 and 43.2 to 128.5, respectively. Extrapolating results to a projected national population with stable growth and fertility returns 46 900 excess child deaths in the first 8 months of 1991.	Between the two periods, age-adjusted mortality due to diarrhoea rose from 2.1 to 11.9 per 1000 person-years	Confounding: no control for armed conflict. Selection: no adjustment for changes in mortality of eligible respondents. Effect modification: no analysis of interaction with armed conflict. Missing data: incomplete cases excluded. Measurement error in outcome: only self-reported outcomes (no control for recall bias in birth histories). Others: limited adjustment of sampling frame for population change due to armed conflict and sanctions; no clustering of standard errors at survey cluster level; possible bias in excess deaths due to fertility decline during war and sanctions. $Q_i = 2$

Table 1. Findings in core studies. Triangles denote adverse effect (▲), beneficial effect (▼) and conflicting evidence (◆). Details on the construction of the direction-of-effect score are given in Appendix 4. (*continued*)

D _i	Reference	Sanction episode	Country	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification/mediation	Limitations/comments
▲	Bundervoet & Verwimp (2005)	Sanctions by the Great Lakes Regional Peace Initiative (Jul 1996–Jan 1999). Correlated shock: Burundian civil war (Oct 1993–Aug 2005)	Burundi	Height-for-age		Ordinary least squares and logit regressions on cross-sectional survey (Sample: 2575 children aged 6–59 months).	▲ In rural areas, a percentage point increase in exposure to sanctions during the early growth spurt (6–24 months) reduces height-for-age by .005 ($P < .001$) standard deviations, conditional on any exposure to armed conflict – which has a similar effect size. The effect implies a reduction of 0.5 standard deviations for exposure to sanctions throughout the early growth spurt period. Insignificant positive effect of sanctions in urban areas. Selection: no control for selective migration, mortality selection. Modification/mediation: no control for exposure-mediator interaction (food prices) and armed conflict (if lagged effect). $Q_i = 5$	If monthly exposure to sanctions is replaced by a set of relative food prices, the price of beans has a significant and negative effect on height-for-age. This price is thus suggested as a channel of the impact of sanctions.	
▲	Daponte & Garfield (2000)	UN sanctions (Aug 1990–May 2003). Correlated shock: Gulf War (Jan–Feb 1991).	Iraq	Under-6 mortality risk		Adjusted relative risks (Cox regression) on cross-sectional survey (Sample: 14 118 children under 6)	▲ Controlling for maternal education and age, child sex, parity and urban vs rural location, the risk of death for the reference group (rural males born from primiparous women aged 25–29 with high-school education) increased by 4.54 ($\beta = 1.51$, $se = .09$) after the imposition of sanctions (Jan 1985–Aug 1990 vs Sep–Dec 1990). Missing data: incomplete cases excluded. Notes: re-analysis of subsample from Ascherio et al. (1992). $Q_i = 6$	Impact attributed to sanctions, including potential hoarding due to anticipated shortages.	

Table 1. Findings in core studies. Triangles denote adverse effect (▲), beneficial effect (▼) and conflicting evidence (◄►). Details on the construction of the direction-of-effect score are given in Appendix 4. (*continued*)

D _i	Reference	Sanction episode	Country	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification/mediation	Limitations/comments
▲	Garfield (2001a)	Sanctions by UN, EU and USA (May 1991–Jan 2001, with gaps). Correlated shock: Yugoslav Wars and breakup (Mar 1991–Nov 2001).	The former state union of Serbia and Montenegro	Prevalence of malnutrition and low birthweight (< 2500 g); IMR, U5MR, maternal mortality ratio (MMR), deaths from cardiovascular diseases, 5-year survival after bone cancer treatment	Health expenditure per capita, water quality	Descriptive statistics from national datasets, household survey, secondary literature; field observations from focus groups and semi-structured interviews (Sample: not shown)	▲ Between 1991 and 1993 IMR and U5MR increased 15.4 to 17.3 and 17.6 to 19.4, respectively, temporarily reversing previous decline. ▲ Deaths from cardiovascular diseases increased from about 50 000 in 1990 to around 60 000 in 1996. ▲ From 1996 to 2000, prevalence of under-5 acute and chronic malnutrition increased .05% to 1.9% and from 2.1% to 5%, respectively. Negligible increase in the prevalence of low birthweight.	▲ 5-year survival rate after bone cancer treatment declined from 50% (late 1980s) to 33% (late 1990s) due to decline in the cure rate from 90% to 10%. ▲ Health expenditure per capita declined from US\$ 200 to US\$ 40 in 1990–1999. ▲ Share of contaminated water samples rose from 30% in 1989 to a 30/40% range in 1992–1998.	Confounding: no control for armed conflict and political instability; limited control for pre-sanction trends. Modification/mediation: no analysis of interaction with armed conflict. Missing data: sparse data (data gaps within exposure periods). Reporting of results: some data in graphical display only. $Q_i = 3$

Table 1. Findings in core studies. Triangles denote adverse effect (▲), beneficial effect (▼) and conflicting evidence (◆). Details on the construction of the direction-of-effect score are given in Appendix 4. (*continued*)

D _i	Reference	Sanction episode	Country	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification/mediation	Limitations/comments
▲	Garfield & Leu (2000)	UN sanctions (Aug 1990–May 2003). Correlated shock: Gulf War (Jan–Feb 1991).	Iraq	U5MR (predicted)		Prediction from logistic regression on cross-sectional survey and national statistics (Sample: 195 countries)	▲ Predicted mortality increase from 36 (95% CI: 33–40) in 1990 to 103 (95% CI: 90–119) in 1991 and 87 (95% CI: 80–95) in 1996. The 1990 prediction is not statistically different from the IST survey estimate (Ascherio et al., 1992). The prediction for 1991 is statistically different and smaller, a fact attributed to war-related factors omitted in the model.	Increase in malnutrition, decline in adult literacy and access to potable water.	Confounding: limited sensitivity analysis to alternative specifications; no control for armed conflict (if lagged effect). Modification/mediation: no analysis of interaction with armed conflict (if lagged effect). $Q_i = 5$

Table 1. Findings in core studies. Triangles denote adverse effect (▲), beneficial effect (▼) and conflicting evidence (◄►). Details on the construction of the direction-of-effect score are given in Appendix 4. (*continued*)

D _i	Reference	Sanction episode	Country	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification/mediation	Limitations/comments
▲	Garfield & Santana (1997)	United States embargo (Jul 1963–ongoing), esp. Cuban Democracy Act (Oct 1992–ongoing). Correlated shock: economic crisis of <i>período especial</i> (1991–2000)	Cuba	Prevalence of low birth weight (< 2500 g), tuberculosis (TB) incidence, IMR, MMR, general and cause-specific mortality rates	Per capita calorie and protein availability, coverage of chlorinated water supply, value of medical imports, laboratory tests and X-rays per year, size of national formulary	Descriptive statistics from national datasets and other secondary sources (Sample: not shown).	▲ Small temporary increase in IMR between 1993 and 1994, MMR increased in some years throughout 1988–1996. All-cause mortality rose from 6.4 per 1000 in 1989 to 7.2 in 1994. From 1989 to 1993, deaths per 100 000 rose 8.3 to 13.9 for infectious and parasitic diseases, and from 23 to 40.7 for influenza and pneumonia. ▲ Prevalence of low birthweight increased from 7.3% in 1989 to 9% in 1993. ▲ TB incidence rose 5.5 per 100 000 in 1990 to 15.3 in 1994.	▲ Per capita protein and calorie availability declined by 25% and 18% in 1989–1992. ▲ Share of people covered by chlorinated water declined from 98% to 26% in 1990–1994. ▲ In 1990–1994 laboratory tests declined 36%, X-rays declined 75%, the national formulary shrank from 1300 to 889 items. ▲ The value of medical imports was US\$ 227 million in 1989, US\$ 67 million in 1993, US\$ 104 million in 1995.	Confounding: limited control for pre-sanction trends, no control for economic crisis. Modification/mediation: no analysis of interaction with economic crisis. Missing data: sparse data (data gaps within exposure periods). Reporting of results: some data in graphical display only. $Q_i = 3$

Table 1. Findings in core studies. Triangles denote adverse effect (▲), beneficial effect (▼), and conflicting evidence (◆). Details on the construction of the direction-of-effect score are given in Appendix 4. (*continued*)

D _i	Reference	Sanction episode	Country	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification/mediation	Limitations/comments
▲	Ghiasi et al. (2016)	United States and EU sanctions against the Central Bank of Iran (unspecified).	Islamic Republic of Iran (city of Tehran, 22 districts)		Availability of asthma medicines	Student's <i>t</i> -test on panel survey (Sample: 40 community pharmacies).	▲ After tightened sanctions (Jul 2012 vs Mar 2013), availability declined by 15 ($P < .1$), 35 ($P < .01$), 42.5 ($P < .001$) and 17.5 points for four classes of imported medicines; and by 7.5 (not significant), 25 ($P < .05$), 32.5 ($P < .005$), 20 ($P < .1$), 32.5 ($P < .01$) and 20 ($P < .1$) percentage points for six classes of domestically produced medicines.	Decline attributed to sanctions on both finished products and intermediate inputs.	Measurement error in exposure: limited information on exposure. Other: limited information on target population. $Q_i = 6$

Table 1. Findings in core studies. Triangles denote adverse effect (▲), beneficial effect (▼) and conflicting evidence (◄►). Details on the construction of the direction-of-effect score are given in Appendix 4. (*continued*)

D _i	Reference	Sanction episode	Country	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification/mediation	Limitations/comments
▲	Gutmann, Neuenkirch & Neumeier (2021)	32 sanction episodes, 1977–2012.	98 less developed and newly industrialized countries	Life expectancy at birth		Weighted least squares regression after matching (entropy balancing) on country panel (Sample: 2483 country-years before matching).	▲ UN sanctions associated to life expectancy reductions of 1.16 and 1.44 years for men and women, respectively ($P < .01$). United States sanctions associated to life expectancy reductions of .37 ($P < .1$) and .46 ($P < .05$) for men and women, respectively. Differences across sanctions sender and sex are statistically significant. Annual impacts become significant after 2 years, except that of UN sanctions on women – which is always significant. The impact becomes not significantly different, and significantly larger for men, after 8 and 3 years for UN and USA sanctions, respectively. The impact of United States sanctions decreases with distance from the USA. Estimates broadly robust to control for unimplemented sanction threats, excluding episodes longer than 10 years, excluding the Cold War period.	UN sanctions increase U5MR by 4.25% ($P < .05$) and cholera deaths by 1.08% ($P < .01$) for the first 2 and 3 years, respectively; and decrease per capita health care spending by 0.3% ($P < .01$) every additional year. No significant effect of United States sanctions. These outcomes are interpreted as possible channels of sanction effects on life expectancy.	Confounding: no control for pre-sanction outcome trend and natural disasters. Modification/mediation: no control for pre-existing outcome differences by sanctioning party, no control for multiple mediators. Other: major episodes excluded (Cuba, Iraq, Islamic Republic of Iran, the former state union of Serbia and Montenegro). $Q_i = 5$

Table 1. Findings in core studies. Triangles denote adverse effect (▲), beneficial effect (▼) and conflicting evidence (◆). Details on the construction of the direction-of-effect score are given in Appendix 4. (continued)

D _i	Reference	Sanction episode	Country	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification/mediation	Limitations/comments
▲	Karimi & Haghpanah (2015)	United States and EU sanctions in 2012 (unspecified).	Islamic Republic of Iran (city of Shiraz)	Clinical outcomes for thalassaemia (serum ferritin levels, annual transfusions) and haemophilia (arthropathy score, annual bleedings)	Self-reported access to pharmaceuticals	Student's <i>t</i> and chi-square tests on longitudinal facility register and cross-sectional survey (Sample: 69 thalassaemia and 40 haemophilia patients).	▲▲ In haemophilia patients, severity of arthropathy was significantly higher in 2012 (32.5) than in 2006 (23.3, <i>P</i> < .001) and 2009 (24.5, <i>P</i> < .001). Average annual bleedings in 2012 (40) were significantly higher than in 2006 (12, <i>P</i> < .001) and 2009 (13, <i>P</i> < .001). ▲▲ In thalassaemia patients, serum ferritin was higher in 2012 (3201 ng/ml) than in 2006 (2345, <i>P</i> < .05) and in 2009 (2358, <i>P</i> < .1). Blood transfusion volume in 2012 (196) was insignificantly higher than in 2006 (195) and 2012 (192). No change across 2006–2009 was significant.	Self-reported availability of iron chelators and blood-clotting factors declined between 2009 and 2012. Domestically produced drugs exhibited smaller reported declines. Higher morbidity attributed to drug shortages, and shortages to poor mitigation of sanction impacts.	Measurement error in exposure: unclear definition of exposure groups; limited information on exposure. Other: no information on target population. <i>Q_i</i> = 6
▲	Kheirandish et al. (2018)	United States and EU sanctions against the Central Bank of Iran in 2011 and 2012 (unspecified).	Islamic Republic of Iran	Monthly averages of defined daily dose per 1000 population, mg per 1000 population/day, unit dose per 1000 population/day, for diabetes, asthma, cancer and multiple sclerosis.	Monthly averages of defined daily dose per 1000 population, mg per 1000 population/day, unit dose per 1000 population/day, for diabetes, asthma, cancer and multiple sclerosis.	Chow test for structural break (ordinary least squares and generalized least squares models) on time series (Sample: 26 time series of 68 months).	▲ Statistically significant reductions in 13 of 26 therapeutic groups; 6 included only imported products, 1 included only domestic products, and 6 included both imported and domestic products. Other 10 groups showed statistically insignificant reductions.	Macroeconomic effects (currency devaluation, inflation, income declines), inadequate sanction mitigation policies (supply chain mismanagement, regulatory capture).	Confounding: limited discussion of model specification. Measurement error in exposure: unclear definition of exposure groups; limited information on exposure; no sensitivity analysis to alternative definition of exposure periods. <i>Q_i</i> = 5

Table 1. Findings in core studies. Triangles denote adverse effect (▲), beneficial effect (▼) and conflicting evidence (◄►). Details on the construction of the direction-of-effect score are given in Appendix 4. (*continued*)

D _i	Reference	Sanction episode	Country	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification/mediation	Limitations/comments
▲	Kim (2019a)	51 sanction episodes, 1990–2012	64/84 LMICs	Female proportion of above-15 HIV/AIDS prevalence.		Fixed effects regression (country level) on country panel (Sample: 584/600 country-years)	▲ Sanctions increase the female proportion of HIV/AIDS prevalence by .66 ($P < .05$) percentage points, a 1.5% increase at the sample mean (42.94).	If female labour market participation is included in the model, a negative impact is estimated ($.412, P < .01$) and the coefficient of sanctions is one fourth smaller ($.50, P < .05$). Reduced labour market participation is proposed as a channel to higher female prevalence.	Confounding: no control for armed conflict and natural disasters; limited control for pre-sanction outcome levels; no control for pre-sanction outcome trend; some controls potentially affected by exposure. Measurement error in exposure: no sensitivity analysis to alternative exposure dataset. Modification/mediation: no control for exposure-mediator interaction (labour market participation). Measurement error in outcome: no sensitivity analysis to alternative outcome dataset. Reporting of results: various tests not reported. Other: major episodes excluded (Cuba, Haiti, Iraq, Islamic Republic of Iran). $Q_i = 2$

Table 1. Findings in core studies. Triangles denote adverse effect (▲), beneficial effect (▼) and conflicting evidence (◄►). Details on the construction of the direction-of-effect score are given in Appendix 4. (*continued*)

D _i	Reference	Sanction episode	Country	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification/mediation	Limitations/comments
▲	Kim (2019b)	51 sanction episodes, 1990–2012	59/71 LMICs	Ratio of new HIV/AIDS cases among under-15 children, under-15 crude HIV-related death rate		Fixed effects regression (country level) on country panel (Sample: 740/878 country-years)	▲▲ Sanctions increase the ratio of new child HIV cases by 11.4% ($P < .01$) and the crude HIV-related death rate by 4.9% ($P < .1$). Confounding: no control for armed conflict and natural disasters; limited control for pre-sanction outcome levels; no control for pre-sanction outcome trend; some controls potentially affected by exposure. Measurement error in exposure: no sensitivity analysis to alternative exposure datasets. Measurement error in outcome: no sensitivity analysis to alternative outcome datasets. Other: major episodes excluded (Cuba, Haiti, Iraq, Islamic Republic of Iran).		$Q_i = 4$

Table 1. Findings in core studies. Triangles denote adverse effect (▲), beneficial effect (▼) and conflicting evidence (◄►). Details on the construction of the direction-of-effect score are given in Appendix 4. (*continued*)

D _i	Reference	Sanction episode	Country	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification/mediation	Limitations/comments
▲	McLean & Whang (2019)	602 sanction episodes, 1945–2005.	201 countries	Individuals in need of disaster relief per event	Public spending on disaster preparedness and defence as a share of GDP; annual value of disaster-related economic losses per event	Mixed-effects regression on country panel (Sample: disaster outcomes, 3009 country-years; public expenditure, 239/115 country-years)	▲ Sanctions increase by 88% and 95% disaster-related economic losses and population affected, respectively ($P < .05$). Impacts are reduced after controlling for disaster frequency (66%, 88%) or pre-sanction outcome level (56%, 79%), but remain statistically significant ($P < .05$). Impacts are smaller and marginally significant (71%, 54%, $P < .10$) for countries with a standardized log GDP per capita below 1. The effect is driven by restrictions to target exports and by cases of flood, landslides and storms, relative to other types of sanctions and disasters.	▲ Under sanctions, the GDP share of government spending on disaster preparedness is 18% ($P < .05$) lower, while no significant reduction occurs for military spending. Controlling for year fixed effects, the impact is reduced but remains statistically significant ($-.08$, $P < .05$). For each additional year under sanctions, disaster preparedness spending is 3% ($P < .05$) lower, military spending is 1% ($P < .05$) higher.	Confounding: limited control for pre-sanction outcome level, no control for pre-sanction outcome trend; some controls potentially affected by exposure. Measurement error in exposure: no sensitivity analysis to alternative exposure dataset Other: major episodes excluded (Islamic Republic of Iran post-2006) $Q_i = 5$
▲	Mladenovich & Langegeen (2009)	Sanctions by UN, EU and USA (May 1991–Jan 2001, with gaps). Correlated shock: Yugoslav Wars and breakup (Mar 1991–Nov 2001)	The former state union of Serbia and Montenegro (city of Belgrade)	Risk of retinopathy		Unadjusted odds ratios between birth cohorts from school-level survey (Sample: 165 visually impaired children).	▲ Students born in 1990 and after were 2.4 (95% CI: 1.2–4.6) times more likely to be blind than those born before 1990; if blind, they were 1.63 (95% CI: 1.08–2.46) more likely to be blind due to retinopathy of prematurity.	Increase in preterm delivery attributed to maternal stress due to armed conflict and sanctions.	Confounding: no control for armed conflict and political instability. Selection: no control for changes in facility enrolment, mortality selection. Modification/mediation: no analysis of interaction with armed conflict. $Q_i = 4$

Table 1. Findings in core studies. Triangles denote adverse effect (▲), beneficial effect (▼) and conflicting evidence (◆). Details on the construction of the direction-of-effect score are given in Appendix 4. (*continued*)

D _i	Reference	Sanction episode	Country	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification/mediation	Limitations/comments
▲	Mulder-Sibanda (1998)	Embargo by the Organization of American States (OAS) (Oct 1991–Aug 1993) and UN (Jun–Aug 1993, Oct 1993–Oct 1994). Correlated shock: political instability (1987–1991).	Haiti	Prevalence of malnutrition (stunting, underweight, wasting), 1–4 mortality rate.		Descriptive statistics from household surveys (Sample: nutritional surveys, 5004 (1978), 1718 (1990), 2502 (1994) children aged 6–59 months; 1–4 mortality, not shown).	▲ After declining from 77 to 63 and 56 in 1975–1979, 1980–1984 and 1985–1989, respectively, 1–4 mortality increased to 61 in 1994–1995. ▲ Prevalence of stunting, underweight and wasting declined 12.1%, 32.6% and 47.5%, respectively in 1978–1990. Between 1990 and 1994–1995, stunting declined 4.1%, underweight and wasting increased 6% and 96.5%.		Confounding: no adjustment for political instability (if time-varying) and seasonality. Missing data: sparse data (data gaps within exposure periods). Measurement error in outcome: limited control for changes in definition of malnutrition across surveys. Other: no adjustment of survey weights for population change due to political instability. Notes: data before 1994–1995 already used in Berggren et al. (1993). $Q_i = 4$

Table 1. Findings in core studies. Triangles denote adverse effect (▲), beneficial effect (▼) and conflicting evidence (◄►). Details on the construction of the direction-of-effect score are given in Appendix 4. (*continued*)

D _i	Reference	Sanction episode	Country	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification/mediation	Limitations/comments
▲	Parker, Foltz & Elsea (2016)	Dodd-Frank Wall Street Reform and Consumer Protection Act, Section 1502 "conflict mineral" clause and associated actions (Jul 2010–ongoing)	Democratic Republic of the Congo (5 provinces).	IMR		Linear probability model on cross-sectional survey (Sample: 7697 live births).	▲ Under sanctions, villages in targeted areas and close to at least one mining site experienced an increase in infant mortality between 86 and 182 per 1000, from a pre-sanction baseline of 60 per 1000, according to specification. Results broadly robust to controls for mother fixed effects, spatial and temporal definition of exposure, alternative spatial clustering of standard errors.	Baseline estimates suggest the role of proximity to 3T (tin, tungsten and tantalum) mining activity. Further evidence is provided that women in treatment villages were less likely to sleep under a bednet and to receive prenatal care, consistent with adverse effects of legislation playing out through reduction in 3T mining, related labour income and income-elastic demand for health inputs.	Selection: limited control for selective migration. Modification/mediation: no control for exposure-mediator interaction (armed conflict). $Q_i = 5$
▲	Reid et al. (2007)	Embargo by OAS (Oct 1991–Aug 1993) and UN (June–Aug 1993, Oct 1993–Oct 1994). Correlated shock: political instability (1987–1991).	Haiti (Grand Anse department, Jeremie county)	Risk of death 12 months after health facility enrolment (first visit), prevalence of malnutrition (underweight).		Adjusted relative risks (Cox regression) on facility panel data (Sample: 1593 children under 2 at first visit)	▲ Controlling for malnutrition at enrolment, the risk of death is 4 ($\beta = 1.39$, $se = .34$) times higher under sanctions (1992–1994) and 2 ($\beta = 0.74$, $se = .56$) times higher before sanctions (1989–1992) than afterwards (1995–1996)	Significantly higher prevalence of malnutrition under sanctions. In regressions, no significant interaction between malnutrition and sanctions and between child sex and sanctions. Mortality increase attributed to rising prevalence of malnutrition and non-nutritional factors.	Confounding: some controls potentially affected by exposure. Selection: limited control for changes in facility enrolment. $Q_i = 5$

Table 1. Findings in core studies. Triangles denote adverse effect (▲), beneficial effect (▼) and conflicting evidence (◆). Details on the construction of the direction-of-effect score are given in Appendix 4. (*continued*)

D _i	Reference	Sanction episode	Country	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification/mediation	Limitations/comments
▲	Sharma, Mishra & Kaplan (2017)	India-Nepal border blockade (Sep 2015–Feb 2016). Correlated shock: Gorkha earthquake and aftershock (Apr–May 2015).	Nepal		Unit prices of 5 categories of health commodities	Forecast from nonlinear regression (Sample: 4 times series of 67 monthly data)	▲ Under blockade, monthly unit price of “medicaments, therapeutic, prophylactic use, in dosage form” was significantly higher than the pre-blockade trend, entailing an estimated extra cost of US\$ 22.3 million. No significant deviation from pre-earthquake trend in the period between earthquake (Apr–May 2015) and blockade.	No significant deviation from trend for selected sub-categories. Price increase attributed to supply constraint due to blockade.	Confounding: limited discussion of model specification, no sensitivity analysis to alternative specifications. Modification/mediation: no analysis of interaction with natural disaster (if lagged effect). $Q_i = 5$
▼	Asadi-Pooya et al. (2016)	United States, UN and EU sanctions in 2012 (unspecified).	Islamic Republic of Iran (city of Shiraz)	Incidence of seizure-free state	Self-reported missed doses per month and causes of poor drug adherence	Chi-square, Fischer’s exact and Mann-Whitney U tests on facility longitudinal register. (Sample: 199 patients diagnosed with epilepsy)	▼ Under sanctions (Mar 2010–2011 vs Sep 2012–2013) there were statistically insignificant increases in satisfactory adherence to treatment (139 to 146, $P > .1$), and seizure-free patients (106 to 111, $P > .1$).	Statistically significant decrease in poor adherence due to “other reasons” (14 to 4, $P < .05$), marginally significant increase in poor adherence due to “price and availability issues” (3 to 8, $P < .1$). Increase of poor adherence due to price and availability issues attributed to intensified sanctions, attenuated by government subsidies.	Measurement error in exposure: limited information on exposure. Missing data: cases with insufficient follow-up visits excluded. Measurement error in outcome: only self-reported outcomes. $Q_i = 4$

Table 1. Findings in core studies. Triangles denote adverse effect (▲), beneficial effect (▼) and conflicting evidence (◄►). Details on the construction of the direction-of-effect score are given in Appendix 4. (*continued*)

D _i	Reference	Sanction episode	Country	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification/mediation	Limitations/comments
▼	Joury, Al-Kaabi & Tappuni (2016)	UN sanctions (Aug 1990–May 2003). Correlated shock: Gulf War (Jan–Feb 1991).	Iraq	Prevalence of type 2 diabetes, overweight/obesity, dental caries	Free-sugars consumption	Descriptive statistics from published literature (Samples: not shown).	▼ Prevalence of type 2 diabetes among adults increased from 4.1% under sanctions (2000) to 6.5% afterwards (2006). ▼ In 2000 and 2006 respectively, overweight prevalence increased from 5.5% to 34.1% in adults aged 25–65, and from 6% to 13.6% in urban children aged 6–13. For this latter group, obesity increased from 1.3% to 10.5%. ▼ Dental caries prevalence in children aged 5–6 fell from 80.5% in 1985 to 61.2% in 1995 in urban areas, and from 36.5% to 7.1% and 18.8% in 2004–2005 in rural areas; in children aged 11–12, prevalence went from 82.6% in 1985 to 66.1% in 1995 in urban areas and from 39.1% to 12.3% in rural areas; among children aged 14–15, prevalence went from 87.7% in 1985 to 69.9% in 1995 in urban areas, and from 41.2% to 15.4% in rural areas.	▼ Average annual sugar consumption per person went from 50 to 16.3 to 24.1 kg before (1984–1990), during (1991) and after sanctions (2005), respectively.	Confounding: no adjustment for armed conflict (if lagged effect). Modification/mediation: no analysis of interaction with armed conflict (if lagged effect). Missing data: sparse data (data gaps within exposure periods and no data for some exposure periods). Measurement error in outcome: no comparability of sources for some exposure periods. $Q_i = 3$

Table 1. Findings in core studies. Triangles denote adverse effect (▲), beneficial effect (▼) and conflicting evidence (◆). Details on the construction of the direction-of-effect score are given in Appendix 4. (*continued*)

D _i	Reference	Sanction episode	Country	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification/mediation	Limitations/comments
◆▲	Berggren et al. (1993)	Embargo by OAS (Oct 1991–Aug 1993) and UN (Jun–Aug 1993, Oct 1993–Oct 1994) Correlated shock: political instability (1987–1991).	Haiti	IMR, U5MR, 1–4 mortality rate, deaths due to measles, prevalence of malnutrition		Descriptive statistics from national datasets, household surveys, facility registers; field observations and interviews (Sample: facility register, 3168 live births).	▲▲ Under sanctions (1992), relative to the pre-sanction period (1991), a facility register shows IMR declining 48 to 39; 1–4 and U5MR increasing 10 to 18 and 87 to 115, respectively; measles mortality increasing 1% to 14%. Under alternative scenarios, extrapolating the absolute or percentage increase in U5MR to the national level returns excess deaths estimates ranging between 1200 and 24 000 for the 1991–1992 period. ◆▲ Annual data from 38 fixed surveillance stations from 1991 to 1993 fails to show consistent trends in prevalence of under-5 malnutrition across the country and in 4 large regions.	Blackouts and fuel shortages leading to disrupted cold chain, and the interruption of relations between the government and international organization involved in vaccination, are proposed as mediators of the contribution of sanctions to declines in measles vaccine coverage and rising measles mortality.	Confounding: no adjustment for political instability (if time-varying). Selection: no adjustment for changes in facility enrolment. Measurement error in exposure: unclear definition of exposure period. Missing data: sparse data (data gaps within exposure periods). $Q_i = 3$

Table 1. Findings in core studies. Triangles denote adverse effect (▲), beneficial effect (▼) and conflicting evidence (◄►). Details on the construction of the direction-of-effect score are given in Appendix 4. (*continued*)

D _i	Reference	Sanction episode	Country	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification/mediation	Limitations/comments
◄►	Peksen (2011)	96 sanction episodes, 1970–2000.	154 countries	U5MR		Ordinary least squares regression on country panel (Sample: 4055/4209 country-years).	◄► Insignificant effect of any sanctions, positive or negative depending on specifications. ▼ Insignificant negative effect of multilateral sanctions. ▲ United States sanctions are associated to a 22.7% to 28.7% increase in U5MR ($p < .01$). Results broadly robust to an alternative U5MR dataset.	A 1 percentage point increase in sanction severity score (losses as a share of GDP) increases U5MR by 0.7 to 1% ($P < .05$), implying a ~4% increase for a 1 standard deviation change at the sample mean. No significant effect of any sanctions across GDP levels.	Confounding: limited control for baseline outcome level, no control for pre-sanction outcome trend and natural disasters; some controls potentially affected by exposure. Measurement error in exposure: no sensitivity analysis to alternative exposure dataset. Missing data: limited control for missing outcome data (no reporting of imputation statistics, no sensitivity analysis to excluding imputed data).

$Q_i = 4$

Table 1. Findings in core studies. Triangles denote adverse effect (▲), beneficial effect (▼) and conflicting evidence (◆). Details on the construction of the direction-of-effect score are given in Appendix 4. (*continued*)

D _i	Reference	Sanction episode	Country	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification/mediation	Limitations/comments
◆◆	Petrescu (2016)	45 sanction episodes, 1914–2006.	69 countries	Infant weight, under-3 height, under-3 mortality risk		Ordinary least squares regression on pooled cross-sections (Sample: 70 114 infants, 18 7099 or 22 827 under-3 children).	▲ 1-month in utero exposure to sanctions associated to a .008 ($P < .05$) standard deviation decrease in infant weight. ▲ 1-month in utero exposure to sanctions associated to a statistically insignificant increase in mortality risk. ▼ 1-month in utero exposure to sanctions associated to a statistically insignificant .007 increase in height.	1-month in utero exposure to sanctions associated to a .001 ($P < .05$) increase in mortality risk in the first year of sanctions; a .002 ($P < .05$) increase in mortality risk and $-.01$ ($P < .1$) standard deviation in infant weight in the second year of sanctions. No significant effects in the third year and for height. Interaction between in utero exposure to sanctions and average mortality associated to a decrease in height ($-.17$, $P < .05$), conditional on a positive effect of in utero exposure (0.2, $P < .01$).	Confounding: no control for political instability, pre-sanction outcome level and trend; some controls potentially affected by exposure. Selection: no control for changes in mortality for surveyed children. Measurement error in exposure: no sensitivity analysis to alternative exposure datasets. Measurement error in outcome: no sensitivity analysis to alternative outcome datasets. Other: major episodes excluded (Cuba, Iraq, Islamic Republic of Iran, the former state union of Serbia and Montenegro) $Q_i = 3$

Table 1. Findings in core studies. Triangles denote adverse effect (▲), beneficial effect (▼) and conflicting evidence (◄►). Details on the construction of the direction-of-effect score are given in Appendix 4. (*continued*)

D _i	Reference	Sanction episode	Country	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification/mediation	Limitations/comments
◄►	Zaidi (1997)	UN sanctions (Aug 1990–May 2003). Correlated shock: Gulf War (Jan–Feb 1991).	Iraq (city of Baghdad)	IMR, U5MR		Unadjusted relative mortality rates from panel survey (Sample: not shown).	◄ In 1996, IMR and U5MR are estimated at 33 and 38 per 1000, respectively, much lower than levels for 1995 reported by Zaidi & Fawzi (1995). In households followed up from Zaidi & Fawzi (1995), only 9 out of 83 deaths matched, while 65 and 9 were only recorded in the first and second survey respectively. In later interviews with some respondents who reported a death in the first survey only, 9 deaths were confirmed, 4 were found to be miscarriages or stillbirths, and 13 could not be confirmed.	Errors in the reporting or coding of deaths created a large difference in mortality rates with those reported in Zaidi & Fawzi (1995). The author conjectures that an accurate estimate lies between the two estimates.	Notes: follow-up on a subset of 64 clusters sampled by Ascherio et al. (1992), 20 of which were sampled also in Zaidi & Fawzi (1995). $Q_i = 7$
N/A	Ali & Shah (2000)	UN sanctions (Aug 1990–May 2003). Correlated shock: Gulf War (Jan–Feb 1991).	Iraq	IMR, U5MR		Descriptive statistics and adjusted relative risks (logistic regression) from cross-sectional survey (Sample: 95 028 and 60 614 live births in southern/central and northern Iraq).	After the imposition of sanctions (1984–1989 vs 1994–1999), IMR and U5MR increased from 47 to 108 and from 56 to 131, respectively, in the centre/south, and declined from 64 to 59 and from 80 to 72, respectively, in the north. Findings are robust to controls for place of residence, subregion, maternal age and education, child sex and parental blood affiliation.	Confounding: no control for armed conflict (if lagged effect). Modification/mediation: no analysis of interaction with armed conflict (if lagged effect). Reporting of results: findings based on UNICEF's ICMMS survey, the reliability of which has been questioned. Notes: annualized estimates presented in Ali, Blacker & Jones (2003) $Q_i = N/A$	

Table 1. Findings in core studies. Triangles denote adverse effect (▲), beneficial effect (▼) and conflicting evidence (◄►). Details on the construction of the direction-of-effect score are given in Appendix 4. (*continued*)

D _i	Reference	Sanction episode	Country	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification/mediation	Limitations/comments
N/A	Ali, Blacker & Jones (2003)	UN sanctions (Aug 1990–May 2003). Correlated shock: Gulf War (Jan–Feb 1991).	Iraq	IMR, U5MR		Descriptive statistics from cross-sectional survey (Sample: not shown).	In the centre/south region, there was a statistically significant increase in IMR and U5MR from 46.8 and 59.4 in 1990 to 98.7 and 116 in 1991, respectively. Such levels were sustained until 1998, when they were 113 and 142.5. For the northern region, there was a statistically significant increase from 72.4 and 91.9 in 1990 to 103.1 and 128.2 in 1991, reversed in 1992 (68 and 87.7) and 1993 (52.5 and 67.8), with no statistically significant change afterwards. Excess deaths attributable to armed conflict and sanctions are computed based on two counterfactuals: constant mortality level at the 1986–1990 average (381 947) and constant mortality trend extrapolated from available survey data for the pre-1990 period (481 893).	Confounding: no control for armed conflict. Modification/mediation: no analysis of interaction with armed conflict. Reporting of results: findings based on UNICEF's ICMMS survey, the reliability of which was later questioned. Notes: 5-year estimates presented in Ali & Shah (2000). $Q_i = \text{N/A}$	

Table 1. Findings in core studies. Triangles denote adverse effect (▲), beneficial effect (▼) and conflicting evidence (◄►). Details on the construction of the direction-of-effect score are given in Appendix 4. (*continued*)

D _i	Reference	Sanction episode	Country	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification/mediation	Limitations/comments
N/A	Dyson (2006)	UN sanctions (Aug 1990–May 2003). Correlated shock: Gulf War (Jan–Feb 1991).	Iraq	IMR, U5MR		Descriptive statistics from household surveys and population census (Sample: not shown).	Combining survey U5MR and UN population estimates, and assuming a counterfactual of constant U5MR from 1986–1990 to 2003, an estimate of 668 000 excess under-5 deaths attributable to armed conflict and sanctions is computed. Under a counterfactual of constant mortality decline, extending a linear extrapolation from data over 1960–1990 by Ali, Blacker & Jones (2003), the estimate is 878 888.		Confounding: no control for armed conflict. Reporting of results: findings based on UNICEF's ICMMS survey, the reliability of which was later questioned. $Q_i = \text{N/A}$

Table 1. Findings in core studies. Triangles denote adverse effect (▲), beneficial effect (▼) and conflicting evidence (◆). Details on the construction of the direction-of-effect score are given in Appendix 4. (*continued*)

D _i	Reference	Sanction episode	Country	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification/mediation	Limitations/comments
N/A	Zaidi & Fawzi (1995)	UN sanctions (Aug 1990–May 2003). Correlated shock: Gulf War (Jan–Feb 1991).	Iraq (city of Baghdad)	IMR, U5MR, prevalence of under-5 malnutrition (underweight, stunting, wasting)		Unadjusted relative mortality rates and descriptive statistics from panel survey (Sample: 2120 live births, 594 children examined for malnutrition).	Compared with last 1 and 5 years before sanctions, IMR in Aug 1994 to Aug 1995 and U5MR in 5 years of sanctions were, respectively, 2 (95% CI: 1.15–3.49) and 4.88 (95% CI: 3.43–6.94) times higher. The prevalence of malnutrition ($Q_i = \text{N/A}$) increased 12% to 28% (stunting), 7% to 29% (underweight), and 3% to 12% (wasting) from 1991 to 1995.	Effect attributed to sanctions.	Confounding: no control for armed conflict (if lagged effect) Selection: no adjustment for changes in mortality of eligible respondents. Modification/mediation: no analysis of interaction with armed conflict (if lagged effect). Measurement error in outcome: only self-reported outcomes (no control for recall bias in birth histories). Reporting of results: this study has been partially retracted (Zaidi, 1997). Others: limited adjustment of sampling frame for population change due to armed conflict and sanctions; no clustering of standard errors at survey cluster level. Notes: Follow-up on a subset of 25 clusters sampled by Ascherio et al. (1992). $Q_i = \text{N/A}$

3.1 Multidimensionality of sanctions

The existing literature makes it clear that sanctions are not a homogeneous construct. The term works instead as an umbrella, comprising a variety of restrictive measures differing in the goods and services targeted, penalties imposed on violators, definitions of key operational terms, implementation rules and enforcement systems. A full characterization of the impact of sanctions should therefore ideally apportion the observed variation in outcomes to variations in these dimensions. Investigating these potential differences is important, because policies aimed at mitigating threats to population health might need to focus on different factors, depending on the type of sanction in place.

3.1.1 Identity of the sanctioning party

Perhaps the most intuitive characteristic of a sanction episode is the identity of the sanctioning party. Two cross-country studies seek to account for the role of the sanctioning party by interacting or constructing their sanction indicators to code separately for United States and multilateral sanctions (Gutmann, Neuenkirch & Neumeier, 2021; Peksen, 2011). For any given country targeted by sanctions, the identity of the sanctioning party places bounds on the flows of goods, services and people that can be affected. Hence, *ceteris paribus*, sanctions that are comprehensive, imposed by neighbouring countries, large trade partners and multilateral organizations can be expected to exert a greater impact (Garfield, 2002, 1999a).¹

This plausible conjecture is borne out by the evidence presented in Gutmann, Neuenkirch & Neumeier (2021), in which the estimated adverse impact of UN sanctions on life expectancy is significantly larger than that of sanctions imposed by the USA. This is not the case in Peksen (2011), in which only sanctions imposed by the USA, as opposed to those imposed by multilateral organizations, are estimated to have a significant adverse impact on under-5 mortality. The difference is hard to pin down to a specific feature, but the expected result of Gutmann, Neuenkirch & Neumeier (2021) might simply reflect a more justifiable lag structure in the control for baseline outcome level.²

Care is needed in interpreting these differential effects, as the probability that a given country is targeted by sanctions is likely to differ by sanctioning party – if anything, because different international actors have different goals and sanction policies.² Different actors may sanction countries that differ systematically in population health, or in characteristics modifying the impact of sanctions. Indeed, in the sample of Gutmann, Neuenkirch & Neumeier (2021), life expectancy in country-years under UN sanctions is about 15 years lower than in observations not under sanctions, whereas for sanctions imposed by the USA the difference is less than 4 years. The authors include the baseline level of life expectancy in the reweighting procedure adopted to balance their “sanctions” and “no sanctions” groups, but do not include its interaction with the sanctioning party variable in their regressions.³ As a result, differences in impact estimates by sanctioning party might reflect not just their relative economic leverage, but also differences in pre-existing characteristics of countries subjected to sanctions by the UN and USA.

3.1.2 The role of exemptions

An aspect of sanctions that is commonly discussed in the literature is the scope for exemptions. Most sanctions allow for a list of essential commodities, usually food and some categories of pharmaceuticals and medical equipment, for which penalties do not apply due to humanitarian reasons. However, despite the common inclusion of such a clause, many non-core studies point out that the difference made by exemptions largely depends on the specifics of their implementation. Implementing exemptions requires putting in place a licence scheme and an associated monitoring system, both of which are costly. It then becomes important to see who bears these costs.

In discussing the exemption policy of the Cuban Democracy Act (CDA) passed by the USA in 1992, Kirkpatrick (1996) argues that costs were largely born by traders. In addition to application fees for licences and associated administrative tasks, the inspection of exempted goods traded was required to be “on-site” and at traders’ own responsibility – implying Cuba’s acceptance of monitoring activities on its national territory and considerable additional costs for companies from the USA willing to participate in the system. These additional provisions might explain why licensed companies from the USA under the CDA were a mere 4% of those who traded with Cuba under the previous embargo regime. Garfield (1999b:21) also

¹ As knowledge of this factor is likely incorporated in decisions to impose sanctions, there might be limited observed variation in sanctioning parties. At the very least, sanctions are unlikely to be imposed unilaterally by countries that occupy a negligible position in exchanges with the potential target. On the other hand, the observed incidence of sanctions also excludes instances in which a threat was sufficient to achieve the intended goal.

² For example, UN sanctions require Security Council approval, which likely results in a different choice of targets vis-à-vis sanctions imposed unilaterally by a single country (e.g. the USA).

³ Alternatively, separate reweighting for each group could have been carried out (Green & Stuart, 2014).

noted that: “foreign companies tend to shun sanctioned countries even when they are not required to do so, in part because of the extra bureaucratic hurdles”.

Moreover, vagueness in the definition of exempted categories and their interpretation in court mean that firms cannot fully discount the possibility of incurring penalties due to involuntary violations. These penalties are then factored into the expected costs of participating in the exemption system, further discouraging those firms that err on the side of caution – an “overcompliance” effect that has been noted by qualitative research on the Democratic People’s Republic of Korea and the Syrian Arab Republic (Lyme, 2012; Zadeh-Cummings & Harris, 2020; Cohen, 2018). In the case of the CDA, Kirkpatrick (1996) argues that this factor acted as an important deterrent due to the draconian fines and prison terms entertained by the legislator.¹ In reporting results of interviews with trade operators in pharmaceuticals and medical equipment from the Islamic Republic of Iran and various western countries, Namazi (2013) argues that deterrence due to uncertain exemption rules extended from export manufacturers to providers of complementary trade facilities, such as banking and shipping insurance. As a consequence, the limited capacity to process orders by available channels might have further constrained licensed trade. Moreover, whatever trade eventually takes place can carry with it additional transaction costs for importers if, as Namazi (2013) argues to be the case for the Islamic Republic of Iran, foreign partners interpret the shortages of banking services as increasing the risk of insolvency and react by closing commercial credit lines to importers and demanding cash-advance terms.

Vagueness in defining exempted items might mirror shifting attitudes of sanctioning parties towards so-called dual-use items – products and technologies that can have both civilian and military applications. Dual use has been held as sufficient reason not to exempt an item from sanctions, but different approaches can prevail in the process – especially if a diversity of opinion exists concerning the relative importance of humanitarian versus military uses among the sanctioning parties. In extreme cases, claims of dual use invoked to justify exclusion from exemption lists have turned out to be unfounded. Garfield mentions “the denial of purchasing rights for spare parts for breast X-ray equipment for Cuba for the stated reason of the potential for ‘medical terrorism’ and the denial of permits to import nitro-glycerine paste for Iraqi angina patients due to the mistaken belief that the medicine had a potential application in building bombs” (1999a:24). Despite calls for codifying and de-politicizing the treatment of dual-use items, the issue remains contested ground. Recently, concerns over the banning of intermediate inputs in the production of radiopharmaceuticals have been expressed by health care professionals in the Islamic Republic of Iran (Farsad et al., 2019; Zakavi, 2019; Ameri et al., 2018).

This aspect of sanctions related to incomplete information is more general and seems to involve all key operational concepts in the exemption system. A former UN humanitarian coordinator for Iraq during part of the sanction period argued that the lack of a precise definition of compliance facilitated “arbitrariness in application and therefore misuse” of sanctions (Sponeck, 2002). In their study of sanctions in Haiti, Berggren et al. (1993) point out that the clause restricting foreign aid to humanitarian purposes was implemented in such a way that an United States nongovernmental organization’s agricultural development programme could be reformulated as humanitarian, whereas their water and sanitation programme could not, and thus had to be discontinued. Clauses prohibiting the cooperation with government personnel may, if interpreted extensively, effectively impede all exempted humanitarian trade and aid when target countries have most of their social and health infrastructure under the government domain (Zadeh-Cummings & Harris, 2020). Another potential implication of vagueness is that the scope for exemptions can constitute ground for bargaining, as seems to have been the case between the Government of India and the World Bank in 1998, when funding approval for three development projects under UN sanctions was first postponed and then deliberated, “thanks to a liberal interpretation of these loans as humanitarian aid” (Kumar, 1998b:125, Kumar 1998a).

Despite extensive discussion in non-core literature, no statistical modelling of exemption policies has been carried out in any of the quantitative studies reviewed. Ali (2004) and Garfield (2000b) report annual variations in child morbidity (hepatitis B and malnutrition) in Iraq throughout the implementation of important exemptions under the Oil-for-Food Programme (OFFP), but no clear exemption period is defined. More generally, poor measurement of exemptions is likely to explain this gap, which might be fruitfully tackled by future data collection efforts.

¹ In addition to material incentives, firms might be deterred from participating in exemption schemes by reputational costs. However, we did not find discussion on this point in the broader set of non-core sources.

3.1.3 Other determinants of the severity of sanctions

Beyond exemptions, sanctions can vary in their severity for other reasons – for example, according to which categories of trade and financial flows are affected and how strongly restrictions are enforced.¹ Absent direct measures, some of the reviewed cross-country studies rely on proxies. For example, Peksen (2011) and Petrescu (2016) interact a sanction indicator with the measure of “sanction cost” computed by Hufbauer et al. (2007): an estimate of the average annual value of trade and financial losses attributable to sanctions as a share of GDP throughout the sanction episode. Setting aside the difficulties in accounting for the fact that the numerator and denominator are correlated and both potentially influenced by sanctions, this outcome-based measure can be useful to assess the importance of the macroeconomic channel of sanctions (see below, section 3.2.2.2). It is less useful to understand which upstream factors, such as legal and operational characteristics, make sanctions particularly severe, and which downstream factors can translate trade losses into impaired health and health systems. In Peksen (2011), coefficient estimates for this interaction are consistent with its motivation, as a larger cost is associated with higher child mortality, in line with current evidence on income shocks and early-age mortality (Baird, Friedman & Schady, 2011). Conditional on the main (and negative) effect of sanctions on infant weight, Petrescu (2016) obtains a positive coefficient for the interaction and speculates that the result might be due to a disproportional provision of humanitarian aid to hardest-hit countries. This interpretation, however, is not consistent with the limits to aid effectiveness under sanctions emphasized by some field reports (Berggren et al., 1993).

To model severity, Gutmann, Neuenkirch & Neumeier (2021) rely instead on a classification established by Wood (2008), and on an indicator identifying sanctions qualified as “targeted” by the Targeted Sanctions Consortium database.² All estimated coefficients on these interactions are either insignificant, or marginally significant but inconsistent with the severity scale (a stronger effect being estimated for milder sanctions). It remains to be clarified as to what extent these results are substantively informative – for example, about targeted sanctions – or due to the fact that the relevant determinants of severity were not successfully measured.

In one of their robustness checks, Gutmann, Neuenkirch & Neumeier (2021) interact the indicator for United States sanctions with a measure of distance from Washington DC, arguing that distance between sanctioning and target countries represents a source of exogenous variation in the severity of sanctions due to the trade volume affected. The finding that adverse impacts decrease with distance is reassuring, and a large literature on gravity models of international trade justifies viewing distance as reflecting the volume of trade affected (Bergstrand & Egger, 2013). However, the fact that distance between the countries is predetermined relative to life expectancy does not make it exogenous, unless the influence of a predetermined omitted variable can be ruled out. The authors state that: “while it is plausible that countries sanctioned by the US differ from other countries beyond the covariates we account for, there is no reason to assume that the effect of these omitted variables is correlated with the distance to the US” (p. 32). One might argue that expectations about the influence of distance are just one such reason. In other words, because distance is known and its role in affecting trade and trade restrictions may also be approximately known, a country might impose systematically more, less or qualitatively different sanctions against targets at different distances. For example, sanctioning countries might invest more in costly enforcement to sanction closer countries, or sanction them more frequently, because they know that geographical proximity increases the severity of sanctions, and believe that this will increase the probability of success.³ Alternatively, countries might try to impose harsher sanctions on far-away countries in an attempt to offset the effect of distance. In both scenarios, variation in the impact of sanctions with distance from the sender will reflect not only differences in trade volumes affected but also differences in enforcement or other characteristics of sanctions. Importantly, while world geography is fixed, the ways in which distance enters into sanction policy-making might change. Therefore, these estimates are probably best interpreted as capturing the effect of economic leverage but also sanction characteristics, pointing once more to the need to unpack the black box of sanctions to account for their structural features.

3.1.4 Sanctions evolving over time

The existence of the above-mentioned characteristics and the fact that they are amenable to change implies that sanctions can evolve over the course of individual episodes, as implied by talk of sanctions being strengthened or relaxed. Thus, variation in sanction characteristics can contribute to the evolution of health impacts over time. For example, the identity of the sanctioning party can change, as occurred in Haiti when sanctions imposed by the USA superseded those imposed by the Organization of American States (OAS)

¹ A similar concern with assessing exposure intensity arises in studies of armed conflict – see, for example, Chaudoin, Peskowitz & Stanton (2017).

² Global Governance Centre: Targeted Sanctions Initiative [website]. Geneva: Geneva Graduate Institute (<https://graduateinstitute.ch/research-centres/global-governance-centre/targeted-sanctions-initiative>, accessed 1 June 2022).

³ For example, the requirement of on-site verification for exempted items included in the CDA, which has been taken as diminishing the effectiveness of the CDA's exemption system, is arguably a factor of severity that would not have been implemented in sanctions against distant countries.

(Berggren et al., 1993). In the case of Cuba, Drain & Barry (2010) point out that it was not until the CDA was implemented that a deterioration in Cuban population health was observed. Before then, population health trends in Cuba had been comparable to those of other Latin American countries, despite the United States embargo having been in place since 1961. They reason that whereas the concomitant collapse of Soviet trade must have played a role, the strengthening of the terms of the United States embargo is likely to have contributed. Similar interpretations are advanced by other reconstructions of the episode (Garfield & Santana, 1997; Román, 1998, 1995a, 1995b; Kirkpatrick, 1997, 1996; Keck & Reed, 2012). In the case of Iraq, UN sanctions were initially imposed in August 1990 soon after the invasion of Kuwait. They were later relaxed in 1995, when a UN Security Council resolution adopted the OFFP, granting Iraq a limited amount of oil sales to finance UN-certified essential imports – although the first deliveries entered Iraq only in 1997 (Garfield, 1999c).

Due largely to data limitations, no study considers that the terms of restrictions against a country can change over time, although some explore the change in the impact (see below, section 3.3). From this perspective, the benefit of investing in more accurate measurement of sanction characteristics would be that of distinguishing between two possible sets of reasons behind the evolving impact of sanctions within an episode: changes in the multiple dimensions of sanctions, and changes in channels of impact.

3.2 Channels of impact

The other main reason for why the impact of sanctions may vary is the multiplicity of causal pathways potentially involved – the many ways in which a causal impact can be produced. While quantitative studies emphasize total effects with limited analysis of mediators, the broader literature suggests two types of channel: changes in supply and demand, and deliberate behavioural or policy responses.

3.2.1 Total and partial impacts

The existing literature mostly estimates impacts on summary indicators of population health – notably indicators of early-age mortality (e.g. infant or child mortality).

Gutmann, Neuenkirch & Neumeier (2021) estimate that, on average, an episode of UN sanctions reduces life expectancy by 1.16 and 1.44 years for men and women, respectively, while smaller reductions (0.37 and 0.46 years) are associated with sanctions imposed by the USA. Peksen (2011) finds that, conditional on an insignificant effect of all sanctions, sanctions imposed by the USA are associated with a 23% to 29% increase in child (under-5) mortality, while no significant effect is estimated for sanctions imposed by international organizations. In single-country studies, Bundervoet & Verwimp (2005) estimate that in rural areas in Burundi, full exposure to sanctions throughout the early growth spurt period (6–24 months) decreases child height-for-age by half a standard deviation, and raises the risk of malnutrition from 61% to 79% compared to no exposure. In the Democratic Republic of the Congo, Parker, Foltz & Elsea (2016) estimate that sanctions imposed by the USA increased infant mortality from 60 per 1000 live births to values ranging from 86 to 182 depending on specifications. In Haiti, Reid et al. (2007) estimate that the proportion of children with moderate-to-severe malnutrition and of children who died within 12 months after their first childcare visit were respectively 6 and 5 percentage points higher under sanctions than afterwards. Controlling for malnutrition, the under-3 risk of death was found to be four times higher under sanctions than afterwards. In Iraq, a highly cited study found that in the first 8 months of 1991, relative to the period before the imposition of sanctions imposed by the UN in August 1990, neonatal mortality (under 1 month) was 1.8 times higher, post-neonatal mortality (1–12 months) was 4.1 times higher, and child mortality (1–4 years) was 3.8 times higher – results that were robust to regression adjustment for child, maternal and geographical characteristics (Ascherio et al., 1992). A re-analysis of the same data showed that, for the under-6 age group, a fourfold increase in mortality under sanctions occurred before the Gulf War broke out (Daponte & Garfield, 2000).

This list of total effects is not exhaustive, and most studies involved have important weaknesses: first and foremost the (at best) limited extent to which important confounding factors, such as armed conflict and other competing shocks, could be controlled for. However, at least some limitations are arguably alleviated by the diversity of contexts, research designs and datasets involved. Given the occurrence of correlated shocks (such as wars and natural disasters) in many sanction episodes, it is illustrative to compare the total impacts with the impact of these large-scale confounders and modifiers. The comparison is not academic, because protections granted under international humanitarian law are not currently deemed applicable to sanctions, a situation that prompted the striking comment that “most people would be materially better off in occupied territory during or after a war than in a country with comprehensive sanctions” (Garfield, 2002:97). Adverse impacts of UN sanctions on life expectancy lie roughly in between those of minor (–.56 years for men, –.57 for women) and major (–2.51 for men, –2.21 for women) armed conflicts (Gutmann,

Neuenkirch & Neumeier, 2021). In the analysis of Burundi, the half-standard-deviation reduction in child height-for-age after exposure to sanctions for the full duration of the early growth spurt is similar to that of any exposure to civil war (Bundervoet & Verwimp, 2005). This is in turn only slightly larger than the standardized impact of any in utero exposure to war on infant weight (−0.44) in Petrescu (2016), where the impact of in utero exposure to sanctions throughout pregnancy is about six times smaller – although this last study is arguably weaker in its design (quality score: 3) than the previous two (quality score: 5 and 5). This very rough exercise suggests that comparing sanctions to wars may not be too far-fetched.

While estimates of the total effect of sanctions on population health are needed in order to summarize the overall burden, policies aimed at minimizing it will depend, at least in part, on knowledge about the channels through which this total effect is produced.

One way to explore a potential channel is to incorporate it into the exposure variable, using interactions to cut estimated impacts of sanctions along lines that are indicative of a possible mechanism. In their study of United States legislation aimed at preventing electronics companies operating in the Democratic Republic of the Congo from trading in minerals with local guerrilla groups, Parker, Foltz & Elsea (2016) model the sanction variable as a triple difference. They interact indicators for the period when sanctions were implemented, the regions targeted by the policy, and for those regions that are close to mining sites. The resulting exposure indicator identifies mining regions targeted by sanctions, after the date of their implementation. Estimating coefficients for this and other complementary groups allows them to infer that proximity to mining sites contributes to defining the impact, which suggests that the sanction legislation worked (unintentionally) through a reduction in incomes from mining, as opposed to the intended reduction in guerrilla activities. In a further attempt to understand whether sanctions led to any reduction in armed conflict in the area, the authors augment their main regression specification with variables for the occurrence of armed conflict in the vicinity of each child's residence during the first year of life. Finding the sanction coefficient unchanged, they suggest this channel was muted. However, this may simply reflect the fact that estimated coefficients for armed conflict are mostly very close to zero – a result that might have prompted further investigation. More generally, this “difference method” for the analysis of mediators is problematic whenever the variable in question may also independently affect the outcome, for example, by mediating other exposures – a possibility which must be explicitly entertained (VanderWeele, 2015:30).

Another possible strategy is to replace the exposure with the candidate channel. In their study of the impact of sanctions on child stunting in Burundi, Bundervoet & Verwimp (2005) replace their sanction indicator with a set of relative food prices, and interpret the significant negative coefficient estimated for the price of beans as a channel of sanctions. As the sanction indicator is replaced, it is impossible to verify whether its effect is altered by the channel. This is important because, even though the relationship between food prices and child height is arguably straightforward, food prices might respond to factors other than sanctions. For example, the adjustment made for children's individual exposure to armed conflict is unlikely to fully control for the broader influence that the war might have had on food supply and prices, which are then as likely a channel of war as of sanctions.

Finally, partial impacts have been explored by estimating auxiliary regressions relating candidate channels to sanctions. To assess possible steps in the chain running from sanctions to mining income to infant mortality, Parker, Foltz & Elsea (2016) re-estimate their baseline model for indicators of bednet and prenatal care use, and interpret the significant coefficients on their main exposure variable for sanctions as evidence that reduced income from sanctioned mining increased infant mortality through a reduction in the demand of those health inputs. Gutmann, Neuenkirch & Neumeier (2021) replicate their baseline estimates substituting their main outcome, life expectancy, with under-5 mortality, the number of cholera deaths, public health care expenditure per capita, and the share of total population with access to basic sanitation. They find that UN sanctions are associated to higher child mortality and cholera deaths, and lower per capita public health care expenditure. In these applications, the estimated impacts of sanctions on channels were not related to suitably modified models for the final outcome, leaving the characterization of the causal pathway incomplete. This concern is somewhat reduced when channel and outcome are related by construction, as mortality and life expectancy are. Another drawback of this approach is that it does not assess multiple channels jointly, even though these might not be independent. Joint assessment of multiple candidate channels is important to corroborate empirically their designation – that is, to provide evidence that the variables are in fact identifying distinct pathways that survive reciprocal control. Gutmann, Neuenkirch & Neumeier (2021) is a case in point, because the modelled channels might overlap to some unknown extent. The example is useful to illustrate the importance of understanding channels for mitigation policies. If an increase in child mortality under sanctions is entirely attributable to an increase in cholera deaths, which is itself due to reduced health care spending, then ring-fencing health care spending will be key in mitigating the impact. However, if cholera deaths increase for a variety of reasons, such as falling water treatment standards and population displacement, a different strategy may be warranted.

As implied by the above discussion, the few studies that did attempt to shed light on potential channels of impact have resorted to traditional approaches to mediation analysis (Baron & Kenny, 1986; Susser, 1973). Such approaches have recently been criticized by new methodological work, spelling out the assumptions required for the estimates of total and partial effects to be interpreted as causal (VanderWeele, 2015). Future work in the analysis of sanctions would benefit from considering the applicability of some of the methodological advances in this area.

3.2.2 Bottlenecks and macroeconomic effects

Following the literature, an intuitive way to conceptualize the channels of impact is to differentiate between the “bottleneck” effect of a large reduction in the import and supply of specific health inputs, including but not limited to those humanitarian items that exemptions have the stated goal to protect, and the macroeconomic effects brought about by a general reduction in foreign trade and capital movements.

3.2.2.1 Bottlenecks

Supply bottlenecks lead to higher import – and, if unmitigated, consumer – prices of affected health inputs, and greater time costs to access public stocks. In extreme cases, these inputs eventually become unavailable. In a basic economic model of health production in which households demand inputs to pursue desirable health outcomes, these price changes will lead households to look for cheaper substitutes (substitution effect) and adjust their expenditure priorities to the new, reduced level of purchasing power (income effect) (Mwabu, 2008; Strauss & Thomas, 2008). Variations in these demand responses to price changes (demand elasticity) might be quite subtle, especially if time costs are included. For example, a low-income mother weaning her baby may respond to an increase in the price of baby foods by reverting to exclusive breastfeeding or resort to home-made gruel, but at even lower income levels, these substitutions may be too costly in terms of time subtracted from income-generating activities. Similarly, a day worker affected by a chronic condition might relinquish pay to look for a scarce drug in town, or queue at a local health centre, but will grow discouraged as stocks get depleted, queues longer and weekly income lower. Moreover, whereas technologies in health care are commonly believed to be characterized by a large degree of substitutability between inputs (Folland, Goodman & Stano, 2017:166), countries targeted by sanctions might have more rigid technologies, and accordingly less room to prevent specific shortages from affecting health care delivery and thus health. Intellectual property rights over health technologies might further restrict choice, and Kirkpatrick (1996) provides some evidence that sanctions imposed by the USA against Cuba involved drugs that were only produced by United States companies in the USA. To the extent that substitutions are possible, they might involve quality deteriorations (see below, p. 47). Finally, some characteristics of the targeted country, such as its trade structure, may facilitate the emergence of bottlenecks. Hence, comprehensive sanctions led to food scarcity and rationing in Iraq, which posted food trade deficits as large as 60% and 85% for cereals in the 2 years before sanctions were first imposed, and in Cuba, where approximately half of the proteins and calories consumed in the 1980s were imported (Drèze & Gazdar, 1992; Garfield & Santana, 1997).

Evidence of bottlenecks is fragmentary, and it has been observed that “although affected countries routinely blame shortages of essential drugs, medical supplies, and surgical equipment almost entirely on the sanctions, it has seldom been possible to demonstrate this” (Garfield, 2002:101). A somewhat consistent picture can be assembled in the case of the Islamic Republic of Iran, for which there has been frequent anecdotal reporting of shortages and higher prices of pharmaceuticals, especially for chronic conditions (Mohammadi, 2013; Gorji, 2013, 2014; Heidari, Akbari qomi & Tavoosidana, 2017; Ghalibafian, Hemmati & Bouffet, 2018; Shahabi, 2015). These medications represent a small share of national pharmaceutical consumption, but are crucial for therapy, resulting in high import prices and consumer price subsidies (Hosseini, 2013). In some cases, shortages have been attributed to bottlenecks in intermediate inputs (Mohammadi, 2013).¹

Surveying pharmacies in Tehran, Ghiasi et al. (2016) report large, statistically significant reductions in the availability of four classes of imported asthma medications in the 8 months after additional sanctions were imposed in July 2012. Smaller reductions were observed for domestically produced medications – and attributed to the presence of imported content. Overall, the proportion of pharmacies stocking essential asthma medications fell from 60% to 28%. Kheirandish et al. (2018) analysed time series of national monthly availability for pharmaceuticals to treat asthma, diabetes, cancer and multiple sclerosis, from 2008 to 2013. Tests for structural breaks indicate significant reductions after the imposition of sanctions against either the banking system (December 2011) or the Central Bank of Iran (July 2012) for 13 out of 26

¹ Lyme (2012) makes a similar argument for the Syrian Arab Republic. A counterexample is provided by the former state union of Serbia and Montenegro, in which reportedly 60–90% of pharmaceutical products were entirely produced domestically, limiting shortages to drugs for specialized treatment (Garfield, 2001a).

classes of pharmaceuticals – including six of the nine types that were uniquely imported during the period and six of the 14 that were partly imported. In a facility-based study of epilepsy patients, Asadi-Pooya et al. (2016) compared rates of self-reported drug adherence and incidence of seizures before and after tightened sanctions (July 2012). These indicators showed a small and statistically insignificant improvement in adherence and clinical status. Among the causes of non-adherence, a marginally significant increase was estimated in the proportion of patients who quoted lack of availability or high prices. The authors reason that price subsidies might have muted the association, and supply some evidence that, in the whole sample, treatment adherence is not correlated with most patient characteristics. Another (possibly overlapping) sample of epilepsy patients was surveyed 6 months after the re-tightening of United States sanctions following the country's exit from the nuclear trade agreement in May 2018: patients on imported medications were significantly more likely to report increasing difficulties in obtaining them, and less ability to control their seizures (Asadi-Pooya et al., 2019). Finally, another facility-based study of a sample of haemophilia and thalassaemia patients documented a significant increase between two pre-sanction baselines (2006 and 2009) and 2012 in mean annual bleedings and serum ferritin, among haemophilia and thalassaemia patients, respectively, indicating worsening clinical status (Karimi & Haghpanah, 2015). Separately, self-reports from patients and doctors suggest that key medications (iron chelators and blood-clotting factors) became less available under sanctions.

These studies have clear limitations, first and foremost the reliance upon a binary exposure indicator to model the complex timeline of the Iranian case, resulting in potentially ad hoc comparison periods. Perhaps as a consequence, background information to motivate the defined comparison periods was scarce. While hard to address with survey data, this shortcoming can be alleviated by sensitivity analyses and placebo tests on selected cut-off points in time-series studies. Reliable information on sanction intensity would be needed to enable the kind of continuous approach that appears to fit the Iranian case.¹ Despite the weaknesses, these findings can be seen as a set of snapshots of an underlying dynamic impact. Collectively, they suggest not only that shortages occurred, but also that they selectively affected items with imported content. This is in turn suggestive of supply bottlenecks, although the studies cannot distinguish between legal barriers to specific imports and worsening terms of trade due to currency devaluation following macroeconomic deterioration.

Direct evidence of an effect of sanctions on pharmaceutical import prices was provided by Sharma, Mishra & Kaplan (2017), who estimated that the India–Nepal border blockade between late 2015 and early 2016 led to US\$ 22.3 million in extra costs for pharmaceuticals in “retail dosage-form”. While the significant price spike contemporaneous to the onset of the blockade is hard to explain otherwise, it is at least conceivable that Nepal's earthquake of April–May 2015 modified the effect – for example, by depleting national inventories or raising demand for imported drugs that was only temporarily met by foreign aid. Using a case series of children screened for hepatitis B at one facility in Mosul, Iraq, Ali (2004) reported that the annual number of positive cases was inversely correlated with annual vaccine deliveries to the city.² Annual reported cases were lower, and vaccine stocks larger, in 1997, the year the exemptions of the OFFP began to be implemented. Finally, Garfield (2001a) mentions anecdotal evidence of lower cure rates in the treatment of bone cancer and rare autoimmune diseases in the former state union of Serbia and Montenegro, and a consequent increase in mortality for those causes, ascribing these to lower quality and shortages caused by sanctions.

Among other sensitive health inputs mentioned in the literature, some are quite specific: chemicals used to synthesize proteins (Román, 1995a), or to chlorinate water and as laboratory reagents (Garfield & Santana, 1997); fertilizers and pesticides (Román, 1995a, Berggren et al., 1993); prosthetic materials (Shahabi et al., 2020); and barium or cobalt-60 for X-ray and teletherapy machines (Garfield et al., 1997, Ameri et al., 2018). Others are more general-purpose, affecting the production of health inputs inter alia, such as energy and vehicle spare parts for ambulances, blood storage and vaccine cold chains, as mentioned by various qualitative field studies. Travel bans and restricted access to educational materials for medical training and research have been mentioned in the cases of Cuba and the Islamic Republic of Iran (Habibzadeh, 2016; Román, 1995a). Rigorous assessment of these shortages is, however, missing from these studies – which could only report anecdotal evidence or descriptive changes such as: “from 1990 to 1994, the number of laboratory exams provided in the country's 273 hospitals declined by 36% and the number of X rays declined by 75%” (Garfield & Santana, 1997:18).

When the substitution of items in shortage is possible, it may entail a decline in “quality” aspects – such as the effectiveness of a pharmaceutical product or an item's safety profile. This trade-off between price and quality can be known, and lower effectiveness or additional risks can be accepted as the best course of

¹ See for example Laudati & Pesaran (2022) in the related literature on economic impacts of sanctions.

² A correlation coefficient of -0.84 can be computed from the data provided.

action available.¹ As quality is often difficult to ascertain, however, the risks may easily be underestimated. In both cases, a demand may exist for substitutes that fail to improve health – or even deteriorate it.² Thus, prohibitively higher prices and shortages might induce substitution with harmful surrogates. For example, the lower quantity and quality of antimicrobials under sanctions has been mentioned as a possible factor driving drug-resistant infections (Mehtarpour et al., 2020; Abbara et al., 2018; Black, 1993).

Supporting evidence is again anecdotal and fragmentary. In the Islamic Republic of Iran, a sequence of cases of unexpected blindness after eye surgery was attributed to the use of substandard equipment (Aloosh & Aloosh, 2015). In Cuba, cases were reported of unintentional poisoning from caustic soda and kerosene, which were being used as substitutes for scarce soap products (due to falling fats imports) and electricity (Garfield & Santana, 1997), respectively. Changes towards cheaper but less nutritious diets can also fall under this rubric. In Haiti, farmers were observed shifting production towards less labour-intensive, less nutritious crops (Berggren et al., 1993). In the former state union of Serbia and Montenegro, a decline was reported in the regular consumption of meat, dairy products, fruits and vegetables, while a larger share of the population reported eating more than half a kilogram of bread per day (Garfield, 2001a). In Cuba, the collapse of food imports during the *período especial* (special period) crisis, following the fall of the Soviet Union and tightened United States sanctions, led to a decrease in protein availability and an increase in the share of calories obtained from sugar – the only major domestic source of energy intake (Garfield & Santana, 1997). High sugar consumption and lack of animal proteins were later implicated as significant risk factors in a well-documented epidemic of neurological disorders that affected the population during the period (The Cuba Neuropathy Field Investigation Team, 1995; Román, 1995a, 1995b). Similar risky adaptations can occur within health care itself, as observed in Iraq by Garfield, Zaidi & Lennock (1997:1474), who noted that 6 years after the Gulf War “shortages of surgical appliances abounded, leading to modifications in usual practice”, such as the “reluctance to begin an operation that might consume much suture material”, or the use of “a nasogastric tube attached to a surgical glove used in place of a urinary catheter and bag” (see also Barnouti, 1996).

Resorting to lower-quality substitutes in health systems and in the consumption habits of large sections of a population thus appears to be a recurring alarm signal of sanction-related shortages. Moreover, while these expedients might not always produce large and immediate damage, they might decrease health system preparedness and increase vulnerability to future shocks. In the context of the coronavirus pandemic, Takian, Raoofi & Kazempour-Ardebili (2020) have observed that in the Islamic Republic of Iran the “lack of medical, pharmaceutical, and laboratory equipment such as protective gowns and necessary medication has been scaling up the burden of the epidemic and the number of casualties” (similar statements can be found in Karimi & Turkamani, 2021; Abdoli, 2020). Once more, however, anecdotal information about these phenomena has not been consolidated into systematic quantitative assessments. Overall, the field of comprehensive evaluation of bottleneck effects of sanctions on population health remains largely under-researched.

3.2.2.2 Macroeconomic effects

A general trade slump, especially when involving sizeable reductions in capital inflows (including export revenues) and imports of general-purpose intermediate inputs such as energy and fuel, can reverberate through various sectors and, if sufficiently large relative to the size of the economy, lead to a contraction of macroeconomic activity. The resulting inflationary pressures and unemployment will cause a generalized decline in real incomes. In this case, income rather than substitution effects are the potential drivers of changes in health and health systems performance.

For sanctions to exert a macroeconomic impact on health, a sequence of mediating steps must unfold. First, the external shock must be large enough. This depends both on the volume and composition of trade and financial flows involved, and on the extent of integration between the sectors that are directly exposed and the rest of the economy. Hence, macroeconomic consequences can be expected to vary across economies with different sectoral compositions and degrees of trade openness. The case of pre-sanctions Iraq, where substantial export revenues were generated by a single industry (oil) but played a large role in financing domestic investment, exemplifies a vulnerable configuration (Drèze & Gazdar, 1992).

Second, and related, the ability of firms to absorb the shock and thereby avoid its propagation throughout the economy and across time, must be limited. A traditional assumption to the contrary is that firms directly exposed to sanctions will be able to diversify their trade away from the sanctioning parties (Friedman, 1980).

¹ For example, describing illicit smuggling of pharmaceuticals into the Islamic Republic of Iran, Namazi (2013:7) points out that “the end consumer can easily fall prey to expired drugs, counterfeit products or medicine that was corrupted due to improper transportation and handling. People are often aware of the risks but have no other recourse since the medication they need is not available on pharmacy shelves”.

² This pattern of demand would put pressure on quality and safety regulations, and would be consistent with the frequently noted emergence of black markets under sanctions, mentioned in the case of Haiti (Berggren et al., 1993), Islamic Republic of Iran (Mohammadi, 2013; Namazi, 2013), the former state union of Serbia and Montenegro (Garfield, 2001a; Black, 1993) and the Syrian Arab Republic (Abbara et al., 2018).

However, in a world with transport and foreign market entry costs, changing import suppliers and export destinations entails adjustments, which may not be negligible (Bergstrand & Egger, 2013). Third, as the external shock triggers a slowdown in economic activity, the latter must not be fully countered by macroeconomic policies. This is a credible instance, as a LMIC targeted by sanctions is likely to experience both supply-side problems and demand-side complications – witnessing high inflation, high unemployment and balance of payment problems. Even setting aside fears of retaliation by the sanctioning party, macroeconomic uncertainty can further discourage foreign direct investment from other countries.¹ Under these conditions, the effectiveness of conventional macroeconomic stabilization tools might itself decrease. It is equally possible, of course, that adequate macroeconomic management is simply not pursued. Indeed, charges of economic mismanagement of some sort have been levied in virtually all episodes for which literature was found, although the issue has never been properly articulated. In short, if the changes in production costs brought about by sanctions are large enough, and are not compensated by effective responses of firms and governments, then losses in output and employment will trigger declines in income, with the potential to affect health.²

A related literature on the economic outcomes of sanctions provides some evidence that such a chain of events is operative in targeted countries. Neuenkirch & Neumeier (2016, 2015) find that sanctions lead to large GDP contractions across countries, and an increase in both the intensive and extensive margins of poverty. Haidar (2017) studied the response of Iranian firms to export sanctions imposed by 31 countries in 2008, finding that “export deflection” towards non-sanctioning countries did take place but was incomplete, as only about two thirds of exports suppressed by sanctions were successfully redirected towards alternative destinations. This diversion was associated with lower unit prices, although possible effects on profitability and employment could not be investigated. A more general analysis of the Islamic Republic of Iran is provided by Laudati & Pesaran (2022), who estimate time-series models for key macroeconomic variables, relating them to a sanction intensity index based on international newspaper coverage. They find that a one-standard deviation increase in sanction severity leads to currency devaluations of about 10% per annum and to a 3.6% direct decrease in output growth, while inflation dynamics appear to be mostly driven by domestic factors. Forecasts based on these models show that a similar increase in sanction severity for a single quarter has effects on output lasting up to 2 years. Regression models that allow for all possible channels from sanctions to output, and control for competing domestic and international shocks, suggest that a standard deviation increase in sanction severity decreases annual economic growth by about 2%. Additional analyses show the effect to be concentrated in manufacturing, and to be associated with sizeable reductions in employment and (especially female) labour market participation.

In the reviewed literature, capital shortages have been mentioned as factors in the large decline in industrial output (65% from 1989 to 1993) and investment rates (from 30% in the 1980s to 15% in 1995) in Cuba after the fall of the Soviet Union and the CDA (Garfield & Santana, 1997). High inflation and unemployment, with output losses concentrated in the export sector, are mentioned by qualitative field reports (Garfield, 2001a; Berggren et al., 1993, Drèze & Gazdar, 1992). Among core studies, the most carefully documented example of a macroeconomic effect of sanctions is provided in the study of United States “conflict minerals” legislation (Parker, Foltz & Elsea, 2016). Here, the role of income loss due to an external shock to a local industry (mining) is first suggested indirectly by the contribution of proximity to mining sites in modelling the exposure to sanctions, and then documented more directly by estimating impacts for variables such as the use of health care and bed nets that are likely to intervene between sanctions and the final health outcome (infant mortality).

The picture emerging from the literature is thus one in which both bottlenecks and macroeconomic effects could be operative in varying degrees, and acute shortages of key commodities might occur against a backdrop of aggregate distress. Finally, but crucially, both bottleneck and macroeconomic effects on population health are likely to affect people differently according to their private incomes and public entitlements. For example, if the demand elasticity for prescription drugs increases at very low-income levels, then factors determining the distribution of income can mediate the health impact of high prices for drugs in shortage. Moreover, at a given level of household income, institutional aspects of the demand for health inputs, such as the financing of health insurance or eligibility for social programmes, can modify the response of households to changes in prices and income.³ Sanctioned countries can differ in these respects for two reasons: they can inherit these factors from before sanctions, or they can produce the differences through their reactions to the sanctions themselves.

¹ Thus, referring to the former state union of Serbia and Montenegro, Garfield (2001a:61) argues that financial sanctions “limited access to capital far in excess of their official dollar value as they signalled an insecure investment environment to potential private investors”.

² The conditions in which adverse macroeconomic performance causes deteriorations in health are an area of active research (Pamar, Stavropoulou & Ioannidis, 2016; Margerison-Zilko et al., 2016; Catalano et al., 2011).

³ For example, estimated price elasticities for prescription drugs are lower in settings with a tax-based health insurance system (Gemmil, Costa-Font & McGuire, 2007), and higher in the presence of co-payments, especially at lower income levels (Kiil & Houlberg, 2013).

3.2.3 Responses to sanctions: policies and institutions

The consequences of sanctions are likely to extend beyond changes in supply and demand for goods and services in the markets and public sector, and include more complex strategic responses aimed at reacting to perceived adversities. These responses are likely to involve different agents, from national and local governments to communities and households. The total effect of sanctions on health and health systems will then typically incorporate such “endogenous” responses triggered by sanctions within the examined jurisdiction. Disentangling these responses is important to understand why a given sanction policy may or may not succeed, and how various actors in the sanctioned country can coordinate to mitigate threats to population health. The ways in which governments and societies respond to sanctions can be critical in affecting the final outcome, but the direction of these effects is *ex ante* ambiguous. This report focuses on government and household responses, as the (sparse) information found in the reviewed studies refers to them.

Altering government policies and institutions in the sanctioned country is, ultimately, the reason why sanctions are imposed. The question is whether the intended and observed changes coincide. In political science, a sceptical position argues that sanctions frequently backfire because governments of targeted states, especially when non-democratic, are likely to retain sufficient room for manoeuvre to build consensus by invoking sentiments of national solidarity, and weakening those sections of society from which challenges to the status quo may originate by passing the costs of sanctions onto them.¹ Similarly, some of the reviewed studies suggest that sanctioned governments can and did reorganize existing resources to modify impacts, with varying effectiveness.

A role for government policies as mediators of the effect of sanctions is consistent with a comparative assessment of diverging trends in early-age mortality in three well-studied episodes: Iraq (1990–2003), Haiti (1991–1994) and Cuba (1992–1994). Before sanctions, infant mortality in these countries was in secular decline – if at different ranges. Evidence suggests an increase in risk factors for infant mortality such as low birthweight and severe malnutrition under sanctions (Garfield, 2000b; Berggren et al., 1993; Mulder-Sibanda, 1998; Garfield & Santana, 1997); however, the duration and seriousness of these adverse trends appear to have been different in the three countries. In Iraq, both infant and under-5 mortality increased several-fold in the immediate aftermath of the imposition of sanctions and the Gulf War (Ascherio et al., 1992; Daponte & Garfield, 2000). Moreover, although the nationwide prevalence of under-5 malnutrition before sanctions is not known, there is evidence that it increased and stabilized to high levels from the immediate postwar period until at least 1999 (Garfield, 2000b). On the other hand, evidence for Haiti points to a continued decline in infant mortality despite increases at other under-5 age groups, and moderate increases in malnutrition (Reid et al., 2007; Gibbons & Garfield, 1999; Mulder-Sibanda, 1998; Berggren et al., 1993). Finally, in Cuba, the secular decline in infant mortality experienced a small, 1-year fluctuation but resumed thereafter (Garfield & Santana, 1997). While there is no doubt that these differences partly reflect the greater severity of the Gulf War vis-à-vis the political and economic shocks that occurred in Cuba and Haiti, there is also qualitative evidence of different policy responses (Garfield 2000a, 1999a).

In Cuba, rising prevalence of underweight among pregnant mothers and neonates was countered by targeting women and children with extra food supplements in schools and community centres, and by sustained promotion of breastfeeding – which reportedly increased from 63% to 97% between 1990 and 1994 (Garfield & Santana, 1997). On the other hand, years into sanctions, only 80% of Iraqi mothers were estimated to breastfeed, and in 1997 the government decided, against United Nations Children's Fund (UNICEF) advice, to promote reliance upon infant formula by including it in the official ration (Garfield 2000a). Mitigation policies and their effective implementation are likely to be shaped by institutional characteristics inherited from the pre-sanction period. Measures taken in Cuba were in line with, and perhaps facilitated by, the infrastructure created through the family medicine scheme launched in 1984, which oriented the health system towards community-based primary health care, capillary outreach, health education and prevention (Keck & Reed, 2012; De Vos et al., 2012; Garfield, 2002, 2000a). On the other hand, Iraq's pre-war health system has been characterized as a “curative and high-tech oriented, hospital-based health service” in which, even after years of sanctions, “money is often spent on high-tech equipment rather than common and preventable conditions such as immunizations and simple curative medicines” (Garfield, 1999a:2, 16). Garfield (2000a:18) notes that in Iraq “many physicians were educated abroad in advanced clinical specialties but few public health or community health specialists were trained”. This observation

¹ Özdamar & Shahin (2021) label the former effect “siege morality”, while Peksen (2019:4) describes the latter process as targeted governments “intervening in the economy to divert existing wealth and resources made scarce by sanctions towards their supporters and away from their rivals and average citizens”. We note a close analogy with arguments made by sceptics of development aid (Deaton, 2013). Needless to say, these changes, especially if aimed at shifting costs to vulnerable groups, are incompatible with the goal of minimizing adverse impacts on population health. Baram (2000) argues that the Iraqi government under sanctions might have intentionally neglected politically unsupportive areas, thereby inflating the humanitarian consequences of sanctions while stifling potential internal opposition. Based on personal recollection and experience, Coovadia (1999) argues that consensus-building failed in the case of South Africa, as key anti-apartheid groups were prepared to endure sanctions as a temporary cost worth incurring to increase pressure on the Government.

is consistent with the low reporting of malnutrition in a health centre's clinical records examined by Field & Russell (1992), who point to the absence of systematic child growth monitoring and lack of familiarity with the pathology as potential explanations for this apparent underdiagnosis. Non-health policies are also mentioned as successful responses in Cuba, including the liberalization of tightly regulated agricultural markets, promotion of self-employment and legalization of dollar-denominated transactions (De Vos et al., 2012; Garfield & Santana, 1997). This recourse to market incentives in Cuba's planned economy of the early 1990s suggests that while policy responses to sanctions can be shaped by sticky institutions inherited from a country's history, this continuity is not absolute, and sanctions-induced crises can catalyse political momentum for a degree of institutional innovation.¹

The literature also mentions potentially counterproductive policy responses. For the cases of the Islamic Republic of Iran (Namazi, 2013) and the former state union of Serbia and Montenegro (Garfield 2001a), it has been argued that some trade regulations and price controls have aggravated the impact of sanctions. This anecdotal evidence suggests that, under sanctions, government regulatory policies, for example towards pharmaceutical markets, might become more vulnerable to capture by special interest groups, such as enterprises enjoying political connections, and therefore depart from the socially desirable goals of ensuring equitable access and quality standards. Yousefi et al. (2019) cast a more positive light on measures taken by the Iranian government to increase access to pharmaceuticals by speeding up customs clearance, minimizing regulatory barriers to foreign direct investment and improving inventory policies – although no effort is made to attribute to these policies the reported decline in pharmaceutical prices. A spate of recent qualitative analyses of health policy-making in the Islamic Republic of Iran illustrates the dilemmas involved in devising effective mitigation measures (Bastani et al., 2021a, 2021b; Dehghani et al., 2021; Mehtarpour et al., 2020; Shahabi et al., 2020). Regulatory policy might represent an important domain of responses, because mobilizing domestic investment for health inputs affected by sanctions and ensuring their safety and fair distribution are both plausible mitigation pathways.

While country studies contribute a mixture of descriptive and anecdotal evidence casting some light on policy responses, two cross-country studies provide more systematic information at a higher level of aggregation. Direct evidence on the impact of sanctions on government policies comes from McLean & Whang (2019), who consider changes in spending composition and related outcomes. Arguing that sanctions not only harden the target government's budget constraints but also signal a risk of impending armed conflict, the authors conjecture that sanctions will lead to spending cuts that ring-fence security categories and disproportionately involve civilian "low-visibility" categories. After having documented that sanctions are indeed associated with falling government trade revenues, they report mixed-effects regressions in which spending on disaster preparedness is 8% to 18% lower under sanctions, while no significant reduction is estimated for military spending – in fact, the latter is found to increase when exposure is measured in terms of episode duration. Additional regressions show the value of economic losses and the number of population affected by disasters to be, respectively, 88% and 95% higher under sanctions. These estimates remain sizeable and significant across a wide range of robustness checks, although their size varies substantially in key instances. For example, the impact on population affected by disasters is halved if rich countries are excluded – which may be partly due to less accurate data for low-income settings. More importantly, the strategies adopted to control for baseline levels and trends in the examined outcomes fall short of ruling out that, for example, results are confounded by the differential occurrence of more severe disasters in sanctioned countries, or by pre-existing country-specific trends. Notwithstanding these limitations, the study breaks new ground in exploring government responses to sanctions, proposing a simple but intuitive and testable theory.

The second study investigates government responses indirectly, by relying on indicators of the target's form of government and other features of its political system. In order to capture the "political environment" in target countries, Gutmann, Neuenkirch & Neumeier (2021) assign a score obtained from a principal component analysis performed on three available indices: the Political Terror Scale of physical integrity rights violations, the Polity2 index of democracy, and dummies for the occurrence of minor or major armed conflict (based on number of casualties). Interacting the score with the indicator of sanctions shows that the impact changes along this dimension. For UN sanctions, a marginally significant effect, limited to women, implies a ~25% smaller adverse impact of sanctions on life expectancy (from -1.45 to -1.08 years) for a counterfactual improvement in the political environment corresponding to a standard deviation increase in the assigned score. The modification exerted on the effect of United States sanctions is larger and more

¹ The case of the former state union of Serbia and Montenegro fits this comparison only partially. Similar to Cuba, infant and child mortality experienced only small, short-lived deviations from secular decline (Garfield, 2001a). However, Garfield links this outcome to pre-existing factors rather than policy responses. Among them, the good quality of the housing stock, abundant fertile farmland, long-established ties with strong neighbouring economies, and a "network of public health institutes, primary care facilities, and extensive network of entitlements in medical care and social services" (Garfield 2001a:38). Finally, Garfield (2001a:54) notes that under sanctions people "continued to expect, demand, and create relatively good nutrition and education standards even when the economy declined", a cultural predisposition that has been emphasized as one of the long-run factors behind successful health policies in low-income countries (see next footnote 2, on page 51).

precisely estimated (.62, $P < .01$ for men, .42, $P < .05$ for women), implying that adverse effects (–.37 and –.46 years for men and women, respectively) are fully concentrated on countries with below-average political environment.

These results might be variously explained. Governments in countries prone to armed conflict and human rights violations and with fewer democratic institutions might be less willing and/or able to enact adequate mitigation policies. This causal interpretation of the estimated interaction effect requires both the effect of sanctions and that of political environment to be free from confounding influences (Keele & Stevenson, 2021; VanderWeele, 2015). This condition would fail to hold if, for example, differences in political environment were associated to unobserved differences in sanction policies and characteristics. In other words, worse outcomes in certain political environments might also stem from more severe sanctions being imposed against these countries. Deepening interpretation at the cross-country level is complicated by the coarseness of available indices, which may be poorly predictive of short-term health policy.¹ For example, the suggested difference in responses between Cuba and Iraq discussed above would not be captured by the Polity2 index – which records very similar values for the two countries throughout the relevant period. To the extent that responses are determined by long-run institutional features, broad aspects of the political system might still be a poor proxy for the type of health sector model consistent with the mitigation policies observed in the qualitative literature.² Despite these limitations, the results of Gutmann, Neuenkirch & Neumeier (2021) are in broad agreement with country studies in suggesting that political characteristics of the target country can modify the effect of sanctions.

Hence, somewhat analogously to political science findings, the reviewed literature indicates that target states can, if motivated, tap on a reservoir of underutilized resources to mitigate the impact of sanctions by implementing adequate health-related policies. Country studies suggest these include an orientation towards community-based primary health care, a specific attention to maternal and child health, and a focus on prevention.³ They also suggest that policies might be facilitated by a history of institutionalized commitment to these goals, and hampered by its absence. Systematic assessment of these important but fragmentary insights awaits the development of health-relevant indicators of institutional quality to be incorporated in cross-country and other studies.

3.2.4 Responses to sanctions: household coping strategies

The need to account for behavioural responses of households and communities when investigating the impact of various shocks on income and health in LMICs has long been recognized (Walker, 1989; Dercon, 2002; for a recent application, see Frankenberg & Thomas, 2019). In the literature on sanctions, qualitative evidence on household coping strategies can be found in studies on Cuba, the former state union of Serbia and Montenegro, Haiti and Iraq (Kuntz, 1994; Garfield, 2000a, 2001a; Black, 1993; Berggren et al., 1993; Gibbons & Garfield, 1999; Drèze & Gazdar, 1992). The studies observed the occurrence of the following strategies:

- **Changes in consumption (especially dietary) habits.** In Cuba, Haiti and Iraq, in addition to large substitution effects away from non-staple food (such as meat) and other “deferrables”, the number of daily meals was reduced. In Haiti and Iraq, the consumption of “famine foods” such as wild roots and other non-farmed vegetables was reported.
- **Internal migration.** In Haiti, reverse migration to rural areas was observed, likely motivated by the need to improve access to food. In the former state union of Serbia and Montenegro, an increase in family farming and in the reliance of urban households upon rural connections for work and food was similarly noted. In Iraq, outmigration was not observed, perhaps due to the perceived lack of potential destinations. We note that, although food prices are likely to be lower in food-producing areas, speculation on food markets under sanctions might limit the effectiveness of this strategy to countries with a relatively egalitarian land distribution or effective food price stabilizers. Moreover, migration can expose people to novel environmental hazards, and might make it difficult for health systems to track at-risk populations.
- **Distress sales.** Dissaving by selling household assets (including land and livestock in rural areas) and consumer durables has been observed. The effectiveness of this self-insurance strategy is limited by the highly correlated risk posed by sanctions, under which the market value of these goods can decline substantially.

¹ If included separately in the model, the three variables used to capture the political environment used by Gutmann, Neuenkirch & Neumeier (2021) are not significant.

² The relevant long-run factors might be closer to those suggested by Caldwell’s (1986) influential analysis of “superior health achievers”: countries that achieved large mortality reductions at low-income levels by leveraging on local traditions of widespread grass-roots political activism, women’s autonomy and appreciation of secular education. It is worth noting that Cuba, albeit excluded from Caldwell’s main analysis due to lack of data, was explicitly mentioned as belonging to this group of countries.

³ Commenting on the situation of oral health in the Islamic Republic of Iran, Fakheran (2019) makes the argument that speeding up the adoption of low-cost interventions can be a way to react to sanctions.

- **Changes in living arrangements.** In Haiti, families were observed to be consolidating into larger households. According to two surveys, the share of households reporting more than three residents per room increased from 53% in 1986 to 73% in 1993. At the same time, an increasing reliance on street food was reported. These behaviours might represent alternative ways to achieve cost and time savings by exploiting scale economies in food preparation, for example, by economizing on cooking fuel. The gain might be small, but worth the lifestyle change when income is low and a time-consuming job search crucial. If housing conditions are poor, this strategy can have the unintended consequence of increasing the incidence of airborne infections. In the former state union of Serbia and Montenegro, existing apartments were subdivided by their owners for rental, while the average size of newly built apartments declined.
- **Altered fertility patterns.** A disruption of conventional patterns of family formation was observed in Haiti: men eschewed marriage, perceiving it as too costly, while women reported attachment to partners and reliance upon sexual relationships to secure income – even at the risk of experiencing intimate partner violence. Both men and women reported greater isolation and lower likelihood of cohabitation. An increase in prostitution was observed in Cuba and Haiti. These changes may have increased the number of unplanned pregnancies and decreased planned ones. In Iraq, registered marriages decreased from 170 000 in 1989 to 121 000 in 1995, and average completed fertility among married women declined from eight to seven.¹ In the former state union of Serbia and Montenegro, the total fertility rate declined from 1.74 in 1990 to 1.48 in 1999. We note in passing that endogenous changes in fertility, if overlooked, could distort estimates of counterfactual counts, such as the number of excess deaths due to war and sanctions computed by Ascherio et al. (1992).
- **Intra-household resource reallocations.** In Haiti, it was reported that many children spent long periods outside education in order to seek income and food. In Iraq's central and southern regions, primary school enrolment, at 98% in 1988–1990, declined to 88% and 80% for boys and girls, respectively, in 1997–1998.
- **Growth of the informal economy.** In all these countries, large output losses in export-oriented industries and the public sector produced a reallocation of labour from wage employment to self-employment in street vending, handicraft production, family farming, petty commerce and similar informal occupations. Informal employment has often been found to perform a useful buffer function, and Drèze & Gazdar (1992) maintain that nominal labour earnings in Iraq were kept at roughly the same level after laid-off workers were reabsorbed into such jobs. However, informal employment might expose workers to greater or novel occupational hazards and make it harder for workers to claim benefits. In the former state union of Serbia and Montenegro, the expansion of informal activity occurred in parallel with a rise in crime and interpersonal violence.

This brief summary shows the importance of behavioural responses to sanctions by households and communities. It underlines that their role as a channel that modifies the total effect of sanctions is *ex ante* ambiguous, because the mitigation strategies pursued can lead to unintended adverse consequences for health. Moreover, the examples given testify to the complexity and variety of behaviours involved, which makes responses of households even harder to measure comprehensively than those of governments.

Coping strategies are not measured in any of the core studies, and their contribution to total impacts is unknown. In two studies, this lack of information engenders the possibility that the estimated impact of sanctions may have been biased by selective migration – that is, by an alteration of the composition of the local population as a particular group of individuals leaves the sanction-affected area (Parker, Foltz & Elsea, 2016; Bundervoet & Verwimp, 2005).² In the study of conflict minerals in the Democratic Republic of the Congo, selective migration is a concern because sanctions targeted an industry that is not homogeneously distributed across the country. Avoiding the effects by relocating was thus a real possibility, and the observed increase in infant mortality in the areas and periods targeted by sanctions could partly reflect an altered composition of the paediatric population caused by the mobility of mothers who experienced lower child mortality for independent unobserved reasons – for example, greater material resources. Parker, Foltz & Elsea (2016) lack information on migrants to account for this possibility, and must assume that location at the time of the retrospective survey they employ did not change throughout the study period. Various unobserved mobility patterns might violate this assumption, including migration between targeted and non-targeted areas of the survey region triggered by the imposition of sanctions, or the arrival of households in some of the areas covered by the survey after the peak effect of sanctions (but before data collection). By augmenting their baseline specification with mother-level fixed effects, the authors limit the scope of these

¹ We note that, if sanctions lead to severe malnutrition among women of reproductive age, fertility might decline not just due to intentional postponement, but also due to decreased fecundity (Bongaarts, 1980). This instance might bear some relevance for the immediate postwar period in Iraq.

² This situation therefore violates the assumption of externality discussed above, as some subjects in the population can exercise some discretion to avoid the exposure. This instance represents an exception, however, as it can only occur in those unusual circumstances in which sanctions target subnational entities and areas.

concerns, in the sense that only selective mobility of mothers experiencing different trends (as opposed to different levels) of infant mortality could bias the augmented estimates. This possibility is hard to evaluate without contextual information, but it might be noted that if greater resources allowed some mothers to flee from sanctioned villages, a worsening infant mortality among the mothers left behind may partly reflect the greater impact of material deprivation on mortality risk for higher-parity infants.

At best, these estimates reflect the impact of sanctions on those who did not resettle or abandon the region entirely, a group which likely experienced an adverse impact greater than the one that those who left would have faced, had they remained and experienced the event. Estimates of outcomes for these groups are important, if only to show that coping opportunities are often limited for many people. Simply adjusting estimates for mobility and other adaptations may not be useful if such strategies are a recurrent after-effect of sanctions, as they are for other large-scale shocks. However, understanding their mechanism may be more important to prospectively identify vulnerable groups with restricted coping opportunities, and to design support measures that are complementary with the actions of those who are able to respond. To gain this understanding, explicit measurement and modelling of coping strategies are required.

3.2.5 Interaction between channels

As a broader and conclusive point, the channels of impact explored above are unlikely to operate independently of one another. The degree of consistency between government and household responses will determine their joint effectiveness in mitigating impacts stemming from changes in incomes and prices, and will thereby affect the total impact on health. For example, community-based interventions that overlook that the target population might have moved from their nominal residence are likely to perform poorly. Changes in housing, family formation, co-residence and location may alter the spatial distribution of poverty and create new challenges for existing programmes. Employment-based social security measures that worked well before sanctions may work less well if sanctions lead to a large transition to informal jobs. Income support initiatives may have extra benefits if they help to prevent risky income-seeking behaviours by individuals – from mothers foregoing breastfeeding and workers' accepting dangerous tasks to smuggling and street crime. At the same time, in-kind entitlements may be more successful than cash when the latter risks fuelling hoarding and inflationary pressures. In all cases, coordination between different public and private actors is going to be important in ensuring successful mitigation of sanction-related risks.

3.3 Short-term and long-term effects

Given that sanction characteristics can be altered, that bottlenecks can emerge at different times for different items according to inventory policies, perishability and maintenance capacity, and that responses of households and governments will also unfold at a different pace, the total effect of sanctions on population health can be expected to evolve over time.

In Cuba and the former state union of Serbia and Montenegro, where sanctions caused only very limited departures from secular decline in maternal and early-age mortality and in the prevalence of low birthweight, the rapid fading away of adverse effects has been traced back to a combination of mitigation policies and favourable pre-existing conditions (Garfield & Santana, 1997; Garfield, 2001a). Another possibility is that the total impact will fade away due to firms and households reorganizing their economic activities. Parker, Foltz & Elsea (2016) propose an exercise to evaluate this possibility. They consider that their short-term results, suggesting a large increase in infant mortality and a small decrease in armed conflict due to sanctions, are still compatible with a decrease of infant mortality in the long run. This is so because the adverse effect of sanctions on local mining activity, the suggested macroeconomic channel through which mortality increased, can be eventually absorbed, while the gradual removal of armed conflict can be permanent. By relying on the larger, more optimistic estimate of the effect of sanctions on armed conflict, they reason that eventual eradication of conflict in the area would entail a long-run reduction of infant mortality of 3.9 per 1000 per year. Taking the most conservative baseline estimate of the impact of sanctions on infant mortality (86 per 1000), keeping the share of total births taking place in the treated villages constant (.29), and defining the short-run over which infant mortality is affected adversely by sanctions as 2.5 years, they compute that it would take $(.086 \times 2.5 \times .29) / .0039 \approx 16$ years for the benefits of eliminating armed conflict to offset the short-run adverse effects on infant mortality due to temporary income losses (without discounting future life years). As the authors acknowledge, the calculation ignores potential indirect benefits of eliminating armed conflicts, such as new income opportunities. However, the exercise underlines that short-term consequences, if substantial, can weigh heavily on the welfare evaluation of sanctions.

In cross-country studies, exploration of dynamics is limited to the duration of the total effect estimated, broadly interpreted as evidence on whether or not it displays a cumulative character. Gutmann, Neuenkirch

& Neumeier (2021) add to their sanction indicator an interaction with a count of years under sanctions, thereby decomposing the average effect into an intercept and a marginal effect of an additional year of sanctions. They then report that estimates were robust to the use of a quadratic term for the interaction, which suggests stable annual impacts. A common, more flexible approach involves the inclusion of a full set of binary indicators for each time period of the episode (Angrist & Pischke, 2009:237). Petrescu (2016) reports that months exposed to sanctions in utero have a positive impact on under-3 mortality in the first and second, but not third, year of sanctions. However, these estimates are very likely to be biased, as the year-specific coefficients are estimated in separate regressions, each of which thus implicitly treats the omitted periods as unexposed observations. In short, establishing empirical patterns at this level of aggregation requires more rigorous replication.

Conceptually, a subtle but potentially important distinction can be made between a changing time-specific impact and mechanisms producing a persistence of such impacts in the future – also after the lifting of sanctions. For macroeconomic effects, insights can be taken from the macroeconomics literature on “hysteresis”, which argues that recessions can decrease long-term output and employment by damaging the supply side of the economy – for example, by slowing down capital investment embodying new technology and by deteriorating experience-related skills of unemployed labour (Ball, 2014, 2009; Blanchard & Summers, 1986). For the effect of constraints on health inputs, an established theoretical and empirical literature in development economics documents the possibility that impaired health, by making people less productive, could lock them in poverty traps of low income and poor health (Thomas, 2009; Thomas & Frankenberg, 2002a; Strauss & Thomas, 1998). Finally, a large literature building on the seminal contribution of Barker (1994) illustrates that shocks in early life can affect health in adulthood, and even reverberate across future generations.¹

Whether sanctions precipitate similar dynamics is virtually unexplored in the reviewed studies, although anecdotal evidence points to the relevance of the question for future research. Presenting estimates of food prices in postwar Iraq, Drèze & Gazdar (1992:927) made the point that neither the cessation of military operations nor the introduction of exemptions related to food imports fully reversed the very large price increases that sanctions had brought about. They conjecture that persistently high prices reflect “domestic changes in the organization of trade that followed the imposition of sanctions”. Before sanctions, high procurement prices and low (subsidized) consumer prices for the main staples ensured government monopsony on imports and monopoly on the domestic market.² Sanctions brought this policy regime to an end, with the direct effect of the loss of subsidies being amplified by the indirect effect of higher demand for foreign currency by private traders, leading to currency depreciation. Garfield (1999a:29) remarked that in Haiti “years after sanctions ended economic, social and political processes catalysed by sanctions appear to be deepening into a more permanent crisis”. Finally, Garfield (2001a:57) has argued that in the former state union of Serbia and Montenegro “the end of UN sanctions resulted in decreased access to imported medicines”, attributing this paradoxical result to the disappearance of the implicit insurance provided by the exemption system in an otherwise insecure business environment, characterized by rising indebtedness of importers and lasting political risks.

Finally, the lifting of sanctions can bring about specific challenges if, for example, it results in rapid changes in consumption habits with public health implications. Presenting findings on the prevalence of dental caries among school-age Iraqi children, Ahmed et al. (2007) consider the possibility that the lifting of sanctions and consequent increase in sugar consumption might, if unaccompanied by preventive policy, lead to large increases in the prevalence of caries – as observed in other post-conflict settings. This scenario is consistent with data collated from similar studies, which collectively point to an increase in free-sugar consumption, dental caries, obesity and type 2 diabetes in post-sanctions Iraq (Joury, Al-Kaabi & Tappuni, 2016).³

This brief discussion makes it clear that knowledge about how the impact of sanctions changes over the course of an episode is very scarce. Yet such knowledge can be crucial to implement mitigation policies, for example as to the appropriate timing of a survey aimed at identifying early signs of health problems – in which delayed or temporarily compensated risks can be otherwise easily overlooked. To reconstruct the dynamic interplay between different channels, however, substantial additional measurement and broader observational efforts are needed.

3.3.1 Case study: the dynamic impact of sanctions in Iraq

The greatest research effort to track the impact of sanctions across time has been made in the case of Iraq (1990–2003). Early findings focused on the first 4 months of sanctions, before military operations, and the first 8 months of 1991, which include the period of active armed conflict. These show a several-fold increase

¹ Devakumar et al. (2014) provide a review of the literature on such effects for the case of armed conflict.

² In economics, monopsony denotes a market in which a single buyer controls a large size of the purchases.

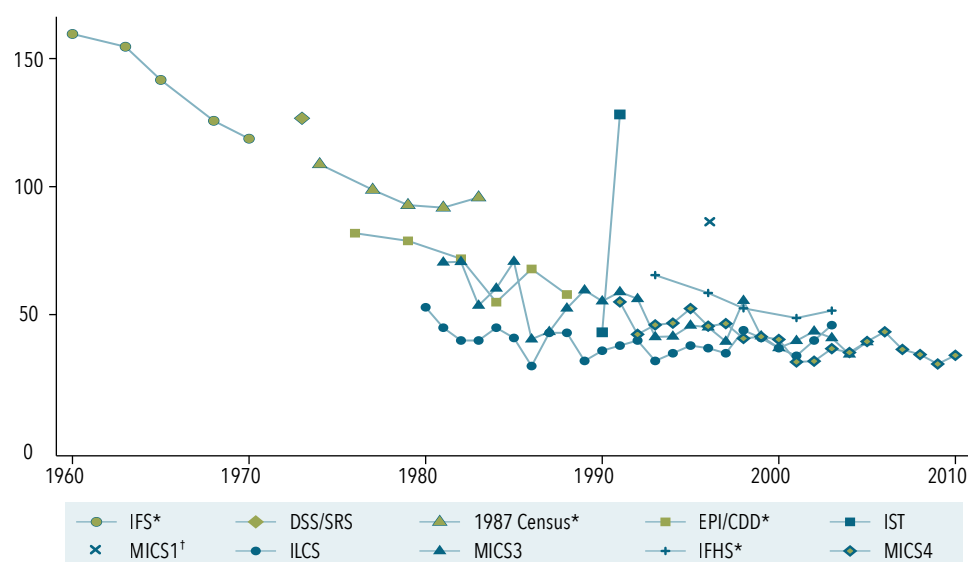
³ Compared with a subsequent period, therefore, a lower incidence of diseases related to excessive consumption of sugars and other nutrients is expected under sanctions. Hence, in the context of a synthesis based on the direction of effect, evidence of such an effect can be rated as beneficial. Aside from the obvious need to contextualize the finding in the broader picture of other documented impacts, a less intuitive but important qualification might apply: the adverse health consequences of a large increase in energy intake post-sanctions might be amplified by malnutrition in utero under sanctions (if any occurs), according to the influent developmental origins of health and disease paradigm (Stein et al., 2019).

in mortality risk among children of various age groups, relative to selected comparison periods (Daponte & Garfield, 2000; Ascherio et al., 1992). The nationally representative survey on which these findings are based is not free from concerns. Recall bias in children's year of death, and possibly in deaths themselves, may have biased upwards the estimated rate ratios – which come from a complete-case analysis. Bounds to these estimates based on assumptions as to the extent of recall bias were not provided. On the other hand, some of the mortality risk due to war and sanctions faced by children might have also affected their mothers, and the resulting survivor bias might have biased estimates downwards. Overall, the ability to replicate expected patterns of heterogeneity (by age, maternal education and rural versus urban location) supports the quality of the survey. Findings are also consistent with qualitative evidence (Harvard Study Team, 1991; Drèze & Gazdar, 1992).

Substantial uncertainty and controversy have surrounded assessments of the evolution of those effects throughout the entire episode, first and foremost due to the lack of reliable, routinely collected vital statistics. After 1991, the only two surveys of child mortality implemented before the end of sanctions in May 2003 cannot be deemed reliable (see below, section 3.5). However, information on child nutritional status was ensured by a number of cross-sectional surveys (Garfield, 2000b). Using some of these data and other available indicators, Garfield & Leu (2000) fitted logistic regression models of under-5 mortality for a cross-section of countries to predict the rate in 1996 Iraq. Their preferred specification includes adult literacy, stunting prevalence and the share of population with access to potable water as covariates, and yields a rate of 87 (95% CI: 80–95). Importantly, the model performs reasonably well in replicating the estimates of Ascherio et al. (1992) for 1990 and 1991, and expected patterns of regional variation. The exercise is limited by uncertainty over the model chosen, which may not fully capture aspects of the mortality–malnutrition relationship specific to 1996 Iraq. This result suggests a scenario in which, after an acute mortality crisis in the first year of sanctions, child mortality stabilized at a lower level than during the mortality crisis, but nonetheless substantially above the level prevailing in the immediate pre-sanction period.

A different picture emerges from surveys implemented after the 2003 United States-led invasion, suggesting that child mortality did not rise sharply under sanctions and instead fluctuated around pre-sanction levels throughout the entire episode (Fig. 12). Some of these surveys also suffer from acknowledged weaknesses. In the Iraq Living Conditions Survey 2004, which generated the lowest mortality profile, the administration of the birth history module had to be repeated after a subsample check uncovered underreporting of births

Fig. 12. Under-5 mortality rate (deaths per 1000 live births) in Iraq, 1960–2010^a



^a (†) model-based prediction; (*) based on summary birth histories, one or two most recent observations omitted from series due to known design bias (see Preston, Guillot & Heuveline, 2001:230).

Sources: Iraq Fertility Survey 1974 (IFS); Demographic Sample Survey and Sample Registration System, 1973–4 (DSS/SRS); 1987 census; Immunization, Diarrhoeal Disease, Maternal and Childhood Mortality Survey 1990 (EPI/CDD); United Nations (1992:167–8); International Study Team survey (IST); Ascherio et al. (1992); Multiple Indicator Cluster Survey 1996 (MICS1); Garfield & Leu (2000); Iraq Living Conditions Survey (ILCS); Multiple Indicator Cluster Survey 2006 (MICS3); Dyson (2009); Iraq Family Health Survey (IFHS); Iraq Ministry of Health and Ministry of Planning and Development Cooperation (2007); Multiple Indicator Cluster Survey 2011 (MICS4); Tim Dyson, personal communication.

and deaths, perhaps due to respondent fatigue (Iraq Ministry of Planning and Development Cooperation, 2005:50).¹ Whether the problem was addressed satisfactorily is unclear, and some researchers judged the final figures as too low (Daponte, 2007; Mason et al., 2005). The use of these surveys to assess the dynamic impact of sanctions is further complicated by the long recall period involved, which might distort trends and mute short-term fluctuations. In this respect, it is not clear whether the surveys question the results of Ascherio et al. (1992) or vice versa. In this second scenario, the burden attributable to sanctions roughly amounts to a decade-long interruption of mortality decline.²

Two interpretive points can be advanced. First, nothing suggests the ruling out of intermediate scenarios. An early, large increase in mortality could have been driven by self-limiting and temporary factors, such as the presence of high-risk cohorts of children accustomed to adequate prenatal nutrition, and the breakdown of immunization coverage in the early 1990s (Garfield, 1999c:16–17). As immunization was re-established and later cohorts experienced prenatal malnutrition, mortality due to malnutrition might have stabilized at a relatively lower level. This possibility underscores the need to go beyond an exclusive focus on mortality, as the high levels of non-fatal malnutrition documented under sanctions ought to be taken into account (Garfield, 2000b). A robust literature linking early-age malnutrition to chronic disease in adulthood suggests that the lagged impact of sanctions in present-day Iraq might represent a promising research avenue. Second, in light of heated debate around child mortality figures, it is perhaps worth stressing that any adjudicated scenario would still require interpretation. In long sanctions episodes such as that imposed on Iraq, the confounding effect of short-term correlated shocks might be presumed to eventually fade away, but complexity is added by unfolding societal responses. Hence, descriptive long-term trends such as those in Fig. 12, even if free from bias of practical significance, can only be ascribed to sanctions in the literal counterfactual sense which includes such responses – notably, Government policies. For Iraq, Garfield (2000a, 1999a) has made a forceful case that a combination of pre-existing institutional weaknesses and perverse government decisions aggravated the situation.

3.4 Level of analysis: cross-country versus single-country analysis

The main methodological distinction in the literature is the level of analysis: while most studies adopt a single-country perspective, several quantitative studies used country-level data from a large set of mostly LMICs. Combining general considerations about the role of different data structures in estimation with the specific features of sanctions explored in the previous sections, it is possible to outline the relative strengths of these approaches – with an eye on identifying promising avenues for future research. We begin by noting the basic point that, all other things being equal, cross-country studies have a larger sample size relative to single-country studies and include an additional source of between-country variability in the outcome variable of interest. For the purpose of estimating the impact of sanctions on this outcome, information stemming from differences between countries brings both opportunities and challenges. It can be useful to identify the impact of sanctions, but can also pose threats to its unconfounded estimation. The characteristics of the indicator chosen to measure the outcome and type of data available can be seen as parameters to specify the costs and benefits of including between-country variability – and thereby providing a rationale for specialization between cross-country and single-country approaches.

3.4.1 Cross-country studies

Six core studies used sanctions data from multiple countries. These datasets all have a panel structure, and the studies exploit variation in the prevalence of sanctions between countries and over time. In five of those studies, the unit of observation is country-years, whereas the multilevel study by Petrescu (2016) relies on pooled cross-sections at the individual level for the outcomes but includes country-level covariates.

Some factors of interest in the study of sanctions and health are likely to vary more between countries rather than within them. Sanction characteristics are likely to vary more between episodes, which in turn mostly occur in different countries, than within each episode. While many countries have been targeted by sanctions by more than one party, these different measures often overlap in time, whereas multiple distinct episodes of sanctions involving a single country are rare. The examples of the tightening of the United States embargo on Cuba and the relaxing of UN sanctions in Iraq by means of the OFFP are important instances of clear changes in sanction characteristics, but may not be representative. Another factor that

¹ The median interview length was reported to be 83 minutes (Iraq Ministry of Planning and Development Cooperation, 2005:11). As a comparison, average lengths for long Demographic and Health Survey questionnaires in South Africa (2016), Kenya (2014) and India (2015–2016) were 32, 60 and 38 minutes, respectively (Allen, Fleuret & Ahmed, 2020).

² “There is [...] no disagreement that the steady decline in child mortality rates in Iraq in the 1970s and 1980s was sharply interrupted at the time of the Gulf War in 1991” (Iraq Ministry of Planning and Development Cooperation, 2005:57). “At the national level, relatively little, if any improvement has taken place during the last 15 years” (Iraq Central Organization for Statistics & Information Technology and Kurdistan Regional Statistics Office, 2007:xvi).

varies mostly between episodes, and hence countries, is the response to sanctions by governments and households, and the established cultural and institutional factors that might shape them. This opportunity to model what existing literature suggests are important components of the total impact is challenging to pursue, however, because these components are hard to measure. For example, empirical modelling of government responses in a cross-country framework is currently limited to a well-known set of general-purpose indices of government and institutional quality, and the problem arises of how far these can adapt to the peculiar research question of sanctions. Considering the practical importance of assessing mitigation policies to sanctions and other large-scale shocks to health, there is value in constructing better indicators of institutions and policy orientations in the health domain, as only the explicit modelling of these factors can systematically assess their role as impact mediators.

The costs and benefits of including variability between countries can also vary according to the characteristics of the outcome variable chosen. In particular, given the limited duration of most sanction episodes across time, within-country variability in outcomes that are observed with low frequency may be insufficient to produce reliable estimates. This can be the case of indicators computed over relatively long time periods, generally because in the short term they are either too noisy or do not display much change. For example, life expectancy is usually observed annually, and health care budget allocations are determined on a similar periodic basis. Outcomes such as the state of water supply infrastructure are likely to change slowly, and to be time-consuming to observe. These indicators tend to be measures of characteristics of groups or systems. Analyses relying on them will thus reap greater benefits from bringing in cross-country variability. For health outcomes, aggregation of units of observation can go together with aggregation of different dimensions of health, to allow the modelling of more comprehensive impacts.

On the other hand, outcomes measured by indicators that are poorly comparable across countries can be thought of as adding measurement error. This can be the case of individual-level outcomes collected with different survey techniques and definitions, or of self-reported indicators that retain a place-specific component reflecting cultural benchmarks and reference groups.¹ While not intractable in principle, these additional problems might tilt the balance in favour of single-country approaches. Although there is no necessary relationship, in practice international comparability may be more difficult to establish for individual-level outcomes. In the reviewed literature, the exception is Petrescu (2016), who relies on Demographic and Health Surveys – a well-known but rare case of internationally standardized survey protocol.

Hence, cross-country approaches might be best employed to study the total impact of sanctions, inclusive of all components, on aggregate, comprehensive outcome measures that minimize comparability problems and encompass the potential diversity of channels involved across multiple episodes. However, this comparative advantage in more general assessment of impact and outcomes is self-limiting in one important way. Joint modelling of sanction characteristics, channels and dynamics is likely to require many variables and interactions. Larger models are also likely to be called for when outcomes are more aggregated in terms of unit of observation as well as dimensionality – such as more comprehensive health indicators – as they are affected by a larger number of factors. At the same time, as suggested above, more aggregate outcomes are likely to be observed less frequently. This would not be a problem were it not for the fact that the number of sanction episodes that have ever occurred, and the number of appropriate control observations for each implicit comparison in such a framework, are relatively small. This places a ceiling on the amount of useful information that can be leveraged for estimation. Hence, at least in some applications, such an approach will result in a large number of parameters to be estimated, effectively consuming the additional degrees of freedom gained by including cross-country variability, and potentially leading to power problems in cross-country regressions. As a consequence, the extent to which cross-country studies can cut the total effect along policy-relevant lines is probably limited. This line of reasoning suggests that the main scope for cross-country studies is to retrieve the total impact of sanctions on comprehensive outcomes, such as life expectancy or all-cause mortality for various age groups, to confirm the broad outlines of the phenomenon.

3.4.2 Single-country studies

Given that, as a rule, sanctions are directed against entire countries, single-country studies will have to rely predominantly on variation in exposure across time to identify their impact. Additional cross-sectional variation exists whenever some regions of the targeted country are spared, in part or fully, the exposure to sanctions. In these instances, an auxiliary dimension of cross-sectional comparison can be exploited for outcomes observed at subnational levels. Crucially, the lack of exposure cannot be inferred naively from an observed lack of impact and must instead be carefully documented on the basis of independent information, such as qualitative knowledge of the restrictive measures involved. This is the case for Parker, Foltz &

¹ For a discussion of self-reporting effects in health indicators see Thomas & Frankenberg (2002b).

Elesa (2016) and Bundervoet & Verwimp (2005), in which various aspects of the episodes investigated are discussed, to ground the expectation that certain areas of the study countries would not exhibit adverse impacts.

The line of reasoning pursued above suggests that single-country studies will often be unable to quantify the contribution of sanction characteristics, with the possible exception of prolonged, evolving sanction episodes. These appear to be infrequent, but might play a helpful role in developing and validating reliable measures of these characteristics. Focusing on individual countries similarly leads to the omission of long-standing institutional and cultural modifiers of the impact, as these are often constant in the relevant study period.¹ Given that the role played by these two sets of factors is of interest, and until their measurement improves sufficiently to allow more systematic cross-country approaches, qualitative information can be used to interpret estimates from single-country studies. In this respect, the choice to move from the cross-country to the single-country level can be seen as trading off improved internal validity, as the possibility to treat these hard-to-measure variables as fixed reduces the scope for confounding, for reduced external validity. This trade-off may be worth incurring, as careful appreciation of context can be sufficient to prevent misinterpretation when comparing multiple single-country studies.

As before, the choice of outcome variable can be seen as further specifying the relative merits of the approach. If the outcome is observed at the country level, two main designs can result. First, a comparison between exposed and control observations across time in the examined country – often referred to as an interrupted time-series approach (Bernal, Cummins & Gasparini, 2017).² As mentioned above, some country-level outcomes are observed infrequently, relative to the typical length of episodes, leading to a small number of observations. This issue of low data density is important in discontinuity designs, as their credibility depends upon the possibility to restrict analysis to the neighbourhood of the cut-off point that determines exposure (Lee & Lemieux, 2010). As illustrated by the case of Sharma, Mishra & Kaplan (2017), who use price data as outcome, with monthly frequency this approach is feasible, although there may be little room for supplementary analyses. For various group-level outcomes, including some population health indicators, the problem is likely to tilt the balance in favour of a cross-country approach. An intermediate alternative is represented by the second design called for by this setting: the synthetic control method for comparative case studies developed by Abadie & Gardeazabal (2003).³ Indeed, the method seems to fit the study of long individual sanction episodes particularly well.

Some outcomes, however, can be elicited with relatively high frequency; for example, individual-level self-reports and well-tested measurements. In addition to the greater value of short-term useful variability, individual-level data will also encounter less comparability problems in single-country studies than in cross-country studies. At the country level, comparability problems are largely limited to the need to control for variation in the determinants of survey representativeness or administrative coverage across time – which, as discussed above, can also be due to sanctions themselves. In fact, most of the single-country studies reviewed raise concerns of this kind. For example, in a descriptive comparison of child nutritional status in Haiti, the three cross-sectional surveys relied upon for the analysis differ in the representation of urban and rural areas as well as in the ability to control for seasonality, potentially invalidating simple comparisons (Mulder-Sibanda, 1998). However, these problems can only be compounded by up-scaling the analysis at the cross-country level.

In sum, and mirroring the considerations made for cross-country studies, single-country studies appear particularly well-suited to focus on partial impacts of sanctions and, to the extent that they are measurable with higher frequency, for investigation of more specific health outcomes. The need to avoid problems of statistical power due to a short longitudinal dimension makes recourse to individual-level data particularly valuable to analyse short-lived sanction episodes. Finally, the relative advantages of the different approaches outlined in this section are not only approximate but also contingent upon the levels of data availability, measurement and technique, and are bound to change according to innovations in those domains.

¹ However, there might be episodes characterized by long-standing institutional and cultural differences within the target country, such as differences in local government. For example, in discussing the case of Iraq, Garfield (2000a:18) mentions that, after 6 years of sanctions, “improved access to food and other services in the northern autonomous region controlled by the Kurdish parties produced a slight decline in both chronic and acute malnutrition [...] while embargo-related shortages led to a rise of both in the center and south of the country”. This different evolution could be due to different responses to sanctions caused by differences in regional government institutions relevant for the health domain.

² In nonmedical disciplines, the approach is more commonly known as the regression discontinuity design (Lee & Lemieux, 2010; Thistlethwaite & Campbell, 1960). More specifically, an interrupted time-series design is a regression discontinuity design in which time acts as the “forcing variable” which determines exposure to an event (here, sanctions). However, various authors have noted that the use of time as forcing variable introduces potential weaknesses in the method (Baicker & Svoronos, 2019).

³ In the canonical version of the method, a limited set of potential control units (here, countries not affected by sanctions) is selected, and a data-driven procedure constructs control observations for the exposed unit as optimally weighted averages of the pre-selected units. For a review of the method, see Abadie (2021).

3.5 Data quality

Another methodological challenge, apparent in both cross-country and single-country studies, is the potential for measurement error in key variables, especially in the outcome variable. For health outcomes such as mortality rates, the underlying problem is the often complete absence of functioning civil registration and vital statistics systems in many LMICs, where it is estimated that as late as 2003, 71% of births went unregistered (Setel et al., 2007). In many such countries, low-income households often postpone birth registration until needed for practical purposes, such as the claiming of benefits. Being selective on surviving children, the practice leads to the underreporting not just of births but also of deaths for the age group affected by the delay period (AbouZahr et al., 2015). As a response to this and similar problems, a wealth of modelling methods has emerged to impute missing data based on household surveys (Hill et al., 2007). The fact that different research teams find considerable differences in, for instance, under-5 mortality estimates for many LMICs does, however, underscore the partial nature of this solution (Alkema & You, 2012).¹ In our literature, the cross-country study by Peksen (2011) makes use of two of these adjusted datasets, obtaining comparable results.

While measurement error in administrative mortality data will not bias the estimator of the impact of sanctions if uncorrelated to them, this type of error may indeed vary systematically with unmeasured country characteristics that are also correlated to sanctions, distorting estimates in ways that are not easy to predict or correct.² For example, accurate reporting of vital events in LMICs might depend not so much on differences in aggregate income and institutional quality as on claimable benefits, ease of access to the registration system and the fraction of households too poor to afford the costs of timely engagement with it. If sanctioned countries fare worse on these respects, and this difference survives survey-based adjustments, analyses that do not properly control for baseline outcome levels may underestimate the impact of sanctions.

In addition to potentially sharing unobserved determinants with sanctions, data quality may also be affected by sanctions themselves. This can happen if sanctions reduce data collection capacity, or if they make it harder to collect representative data by altering the demography of the target population. For example, internal population displacement or changes in fertility may complicate the design and execution of surveys, modify the case mix in the catchment areas of health facilities and/or decrease registration coverage. As a result, observations before and after the imposition of sanctions may not be comparable. For example, the steady increase in both annual births and infant mortality under sanctions reported by Al-Ani, Al-Hiali & Al-Farraj (2011) for the city of Haditha in western Iraq may reflect changes in the reporting of births and deaths in response to the use and functioning of health facilities, population displacement and incentives put in place by the food distribution system. The sharp drop in both variables after the United States-led invasion further suggests changes in coverage. It is sobering that only partial adjustment for population displacement was possible even in a well-designed survey, such as the one carried out by the International Study Team (IST) in postwar Iraq (Ascherio et al., 1992). As a consequence, absent specific solutions, it might be unsafe to treat measurement error in outcomes as constant throughout a sanction episode. Following individuals under study throughout the episode is an effective but costly solution, although longitudinal medical records of health facilities may provide additional cost-effective opportunities (Asadi-Pooya et al., 2016; Karimi & Haghpanah, 2015). In cross-country studies, baseline levels and trends in outcomes may also fail to control for such changes in data quality, which need not reflect countries' pre-existing capacity to collect data.

Finally, sanctions can motivate targeted governments to manipulate data in order to persuade the sanctioning party to lift or relax measures for humanitarian reasons. Predictably, the issue has generated intense controversy in the literature, particularly with reference to two surveys implemented in Iraq under UN sanctions (Dyson & Cetorelli, 2017; Spagat, 2010; Dyson, 2009). The first was carried out in 1995, sponsored by the Food and Agriculture Organization of the United Nations (FAO) and the Nutritional Research Institute (NRI) of the Iraqi Ministry of Health, and followed a subset of the clusters sampled by the nationally representative study of Ascherio et al. (1992) in the capital Baghdad (Zaidi & Fawzi, 1995). Based on complete birth histories going back to 5 years before the imposition of sanctions, under-5 mortality was found to have increased from 40.6 per 1000 live births at the baseline period to 198.2 in the subsequent 5 years. This nearly fivefold increase (*RR* 4.88; 95% *CI*: 3.43–6.94) thus appeared to suggest further deterioration from the estimate of Ascherio et al. (1992), in which the sanction period for this age group was truncated by the survey date. The study also found that the prevalence of malnutrition increased from

¹ The situation is even more problematic for cause-specific mortality, a potentially important metric to explore channels of the impact of sanctions at the aggregate level. Between 1996 and 2005, only 118 of the 193 WHO Member States reported causes of death at least once: African countries did so on average once every 11 years compared with global and European averages of 5 and 3 years, respectively. Until about the previous decade, almost no data were ever reported by sub-Saharan African countries (Mahapatra et al., 2007).

² The literature in other development areas, e.g. on the role of aid on economic growth, has been shown to suffer from similar data challenges (Easterly, Levine & Roodman, 2004).

12% to 28% for stunting, from 7% to 29% for underweight, and from 3% to 12% for wasting. However, the mortality findings were later revised, as a second followup in 1996 showed no increase in child mortality (38 per 1000) and a large mismatch in reported deaths – mostly deaths reported only in the first follow-up. Investigation led to only partial reconciliation, and uncovered miscoding of stillbirths and miscarriages as infant deaths. The lead investigator conjectured that “an accurate estimate of child mortality in Iraq probably lies between the two surveys” (Zaidi, 1997:1105). Various authors have pointed out that in the first follow-up the interviewers were Government-appointed and oversight by international team members was limited, suggesting that the data were vulnerable to manipulation (Garfield & Leu, 2000; Spagat, 2010). Spagat reports a personal communication by Zaidi supporting these suspicions (2010:118).

The second survey implicated in charges of fraud is the Iraq Child and Maternal Mortality Survey (ICMMS), carried out in 1999 by UNICEF in collaboration with the Iraqi central Government and the Kurdish autonomous region, leading to two separate survey branches for the centre/south and north of the country. The survey showed a very large increase in infant and under-5 mortality in the centre/south region, from 47 and 56 in 1984–1989 to 108 and 131 in 1994–1999. The respective figures for the northern region show continued – if slower – secular decline from 64 and 80 to 59 and 72 in the same periods, with a temporary upward fluctuation in between (Ali & Shah, 2000).¹ Concerns over the reliability of the centre/south branch of the survey were first raised in the context of an independent assessment of the OFFP established by Kofi Annan, UN Secretary-General at that time. The expert panel appointed observed that most of the surge in child mortality was abnormally concentrated in the first year of life and could not be found in sources deemed more reliable, such as Iraq’s 1997 population census, concluding that this part of the survey “could conceivably have been tampered with” (Mason et al., 2005:136). A defence of the ICMMS considered possible infant-specific causes of death related to Iraq’s exceptional circumstances and possible reconciliation with census data (Blacker, Ali & Jones, 2007). Dyson (2006) speculated that the lower estimates from the Iraq Living Conditions Survey and 1997 census reflected a surge in underreporting of deaths under sanctions, as food rationing encouraged households to retain access to their dead children’s rations – although the presumed exemption of the ICMMS from this problem was left unexplained. However, after later surveys replicated the pattern depicted by Iraq Living Conditions Survey data, Dyson concluded that manipulation of the ICMMS dataset must have occurred (Dyson & Cetorelli, 2017; Dyson, 2009).

In this report, absent official retractions, both original research based on these two surveys and the sources quoting them have been reviewed, excluded from the synthesis (except for discussion in this section), and their reliance, complete or partial, on questionable data has been flagged (see Table 1 and Appendix 6). We note that, as discussed in section 3.3.1, which intentionally omits these sources, uncertainty remains over the dynamic impact of UN sanctions in Iraq even after deprecating these data.

Given the potentially complex influences between sanctions and data quality, scholars have called for the establishment of routine monitoring systems aimed at insulating data collection from technical and political risks (Garfield, 1999a). As already mentioned, protocols for these monitoring tasks have been proposed, but appear to have received limited consideration (Bessler, Garfield & McHugh, 2004a, 2004b).

3.6 Impact on vulnerable groups

A final step in reviewing the health impact of sanctions concerns the unequal impact they may exert on different sections of the exposed population. In the field of disaster risk reduction, the concept of vulnerability denotes the set of factors that makes certain systems or groups more susceptible to the adverse effects of a given hazard (UNISDR, 2009:30). A group is made vulnerable to a given condition or hazard by means of factors that interact with exposure to it, amplifying the impact. These vulnerability factors are therefore pertinent to both analysis and interventions regarding the health impacts they contribute to determine.

The main vulnerability factor investigated in the literature, again with considerable gaps, relates to differential impacts for males and females. Both genetic and environmental determinants – the latter ranging from adaptive developmental processes to socialization and customs – are known to create, independently or in combination, differences in health between men and women (Mauvais-Jarvis, 2020). The baseline configuration of these determinants may simply carry over throughout an episode of sanctions, i.e. the observed health differences fully reflect pre-existing determinants. However, determinants might also combine with sanctions to reshape health differentials, for example, by changing the relative importance of multiple operating causes.

¹ Annualized estimates for this region show that for both infant and under-5 mortality, there is a statistically significant increase in 1991, while most other observations in the 5 years before and after 1991 lie within each other’s confidence intervals (Ali, Blacker & Jones 2003).

In core studies, the main result is reported by Gutmann, Neuenkirch & Neumeier (2020), who show that the well-known female advantage in life expectancy is reduced under sanctions, as the average negative impact is larger for women. This result fits the broader picture of reduced female advantage in longevity during other types of resource and mortality shocks, such as famines and epidemics, with the residual gap mostly due to a persisting early-age penalty on males (Zarulli et al., 2018). Interestingly, while the average effect across entire episodes is larger for women, the authors show that the marginal impact of an additional year of sanctions is larger for men for both UN sanctions (0.31 years for men, 0.28 years for women) and United States sanctions (0.20 and 0.16 years). As a consequence, in sufficiently long episodes, the differential disappears (UN sanctions longer than 8 years) or is reversed (United States sanctions longer than 3 years). This pattern suggests that short-term/acute and long-term/chronic factors may be implicated, both potentially interacting with sanctions and shaping an evolving sex-specific impact. Locating this dynamic in early age is a plausible conjecture, as early-age mortality is the main driver of longevity differences among men and women in countries where its levels are high (Zarulli, Kashnitsky & Vaupel, 2021). For example, it is possible that early responses to sanctions penalize baby girls through intra-household redistribution of food and care, while baby boys' vulnerability based on biological factors may predominate if the crisis lasts long enough. Such a mechanism would fit both current understanding of sex differences in endemic malnutrition, and evidence of greater adverse impacts of resource shocks on baby girls (Thurstans et al., 2020; Baird, Friedman & Schady, 2011). Unfortunately, only one of the reviewed studies employing indicators of nutritional status discusses separate estimates for males and females: the study of Haiti by Reid et al. (2007), which reports that interactions between sex and either the sanction indicator or the additional covariate of malnutrition prevalence were found to be statistically insignificant predictors of child mortality. The interpretation of this result is hampered by the above-mentioned bad control problem, potentially biasing estimators for these variables. In their study of Burundi, Bundervoet & Verwimp (2005) report worse height-for-age scores in male than female children across the whole sample, but do not interact the sanction variable with a sex variable or stratify estimates. Smith & Zaidi (1993) do not show stratifications of their cross-sectional prevalence estimates in Iraq, but report that no statistically significant difference was found.

Evidence of differential impacts between adult men and women is also limited. Among core studies, Kim (2019a) finds that sanctions increase the female share of HIV/AIDS prevalence across countries, and proposes that this could be due to, among other things, greater exposure to unsafe intercourse as a consequence of coping and income-seeking strategies involving transactional sex or greater interaction with at-risk individuals. The credibility of reported estimates is weakened by important limitations of the study, but the finding is consistent with qualitative evidence from Cuba and Haiti (Berggren et al., 1993; Garfield & Santana 1997; Kuntz, 1994). Non-core studies report that, in the epidemic of neuropathy in Cuba, cumulative incidence near the end of the epidemic was higher among women, who mostly displayed a peripheral form of the disease, while men mostly displayed the optic form (Centers for Disease Control, 1994). A case-control study of the optic form, deemed more severe, reported two clinical outcomes stratified by sex, abnormal postural-stability sway speed and gross grip strength: the case-control difference for the former is significant only for men (Cuba Neuropathy Field Investigation Team, 1995). This difference might be due to worse matching for women, because two thirds of the study subject were men – which may in turn mirror differences in prevalence in the study area. However, the role of United States sanctions in the production of this epidemic is unclear.

The apportioning and reciprocal articulation of social and biological factors behind differences in health outcomes between men and women is a large area of ongoing research (Hawkes & Buse, 2013; Zuk, 2009). Calls to incorporate information about sex and gender into existing research are pertinent to the reviewed literature, and future studies should strive to explore how sanctions affect the lives of men and women without assuming effects and channels to be the same.

Evidence of vulnerability for other groups is anecdotal, or suggested by studies that restrict their focus on the group under consideration, and hence do not present an overall picture. Garfield & Santana (1997) argue that mitigation policies in Cuba might have over-targeted mothers and children, overlooking the elderly. Studies of patients with chronic conditions such as thalassaemia and haemophilia underscore that individuals in need of advanced treatment may face additional risks (Karimi & Haghpanah, 2015).

In summary, the existing evidence supports the expert view that “vulnerability should be assessed and not assumed. Mothers and infants are undoubtedly a vulnerable group, but [...] attention should also be paid to other, often neglected, vulnerable groups, such as the chronically ill and the elderly, or other groups that are marginalized and excluded for economic, social or political reasons” (Garfield, 1999a:1–2). Moreover, knowledge of how different groups are differentially affected can be useful for effective mitigation irrespective of whether these differences in channels of impact result in a difference in magnitude.

4. Conclusions

In this report, we reviewed the existing evidence base on the impact of economic sanctions on health and health systems in LMICs. While we found a considerable amount of studies on the subject, only a relatively small share undertook quantitative analysis. Of those, 31 met our minimum criteria of undertaking some efforts to statistically attribute the observed changes in the outcome variables to the onset or presence of sanctions. Among these core studies, again only a minority explicitly addresses existing methodological challenges, including taking into account relevant confounders. Most of the studies focused on the relationship between sanctions and health outcomes. These were moderately heterogeneous, ranging from infant or child mortality as the most frequent case, through to viral hepatitis, diabetes and HIV/AIDS, among others. Fewer studies examined health system indicators, either as a sole focus or jointly with health outcomes. These were mostly concerned with the availability of specific drugs. A vote counting procedure of studies reporting consistent direction of effect strongly suggests that sanctions have a detrimental effect on health and health systems in LMICs. The result does not seem to be associated to our study quality score, to the study of early as opposed to more recent sanction episodes, or to the period of publication. These findings are in line with previous reviews, but stem from a more comprehensive search strategy and state-of-the-art evidence synthesis methods.

As we sought to discuss and illustrate in the preceding sections, assessing – and fully understanding – the health (system) impact of sanctions is a complex and challenging undertaking, considering the multiple facets of the subject matter. Those relate, first, to the multidimensionality of sanctions, which is hard to fully capture in the data or the empirical strategy. The impact of sanctions may well vary depending on who is the sanctioning party, the specifics of the exemption system, other aspects of enforcement and their evolving pattern over time. While in some cases an overall net impact can be obtained, a second major challenge is to appreciate the channels through which any observed impact came about. These channels may involve changes in prices and quantities of specific health inputs, or declines in disposable income due to inflation and unemployment. Moreover, some of the ways in which governments, communities and households in target countries respond to sanctions may critically affect the final outcome, perhaps in subtle and contradictory ways. Knowledge of these mechanisms is needed for effective mitigation, and public policies that are consistent with societal coping strategies are required.

A further challenge in quantitative empirical work is in the quality of the data at hand. While not all types of measurement error pose major problems to the estimates, such errors are of particular concern whenever they occur in the dependent variable, i.e. for health and health system indicators. Accurate measurement of health is a challenge in any country, but the problem is more serious in the context of LMICs – and is arguably further compounded in the turbulent situations that often accompany sanctions. Focused data collection efforts are needed not only on sanction characteristics, processes and outcomes but also on potential drivers of vulnerability, as sanctions likely do not affect the exposed population homogeneously.

As empirical challenges abound, it may not be surprising that most of the reviewed studies have adopted a more descriptive approach. In their simplest form, these approaches involved the mere depiction of trends in the variables of interest over a period that cuts across the point in time at which sanctions have been imposed. In some cases, an attempt was made to more explicitly compare relevant outcomes before and during (or after) sanctions. Such approaches likely present a biased picture of the impact of sanctions, as they fail to control for differences in pre-existing factors that may have affected the outcome quite independently of the presence of sanctions. A minority of studies has sought to overcome this deficit by resorting to multivariate approaches, effectively making these before-and-after comparisons conditional on the maximization of some measure of similarity between observations in terms of these potential confounders. In this context, arguably the biggest advance in the literature that facilitated such multivariate analysis, compared with an earlier important review (Garfield, 1999a), is in the emergence of cross-country studies – a trend that has probably been helped by the availability of global country-level databases, combined with the development of sanction datasets. However, at present these approaches are not attaining the level of credibility that could be achieved by adhering to state-of-the-art techniques, and are limited by lack of country-level data on sanction characteristics, modifiers and mediators. In particular, three broad paths of improvement stand out for further research:

- **Data collection and development:** The broad-picture evidence of cross-country studies can be further refined by improved measures of legal and administrative characteristics of sanctions and their implementation (i.e. enforcement and exemptions) to separate structural elements of “severity” from targets’ vulnerability factors. In addition, country-level covariates that are tailored to capture sanction

responses (e.g. health-relevant institutional quality, health sector model) should be collected and integrated into multivariate analyses. At the micro level, targeted surveys designed to make the most of existing baseline data or to elicit reasonable recalls of a small set of key indicators, and implemented by independent well-trained teams, represent the most fruitful avenue open to researchers for assessing future episodes. Qualitative knowledge of sanctions, health systems and coping strategies in LMICs should be harnessed to ensure the relevance of measurement efforts.

- **Develop research to investigate mechanisms:** Thus far, there is little research documenting how sanctions produce price increases and shortages, although existing trade flow data at both country- and firm-level might be used to that effect.
- **Methodological development:** In both cross-country and single-country studies, even within existing data constraints, there is substantial room for improving the treatment of the many statistical problems involved in estimating the impact of sanctions. Framing sanctions as natural experiments may help organize this challenge, and a large and growing literature on causal inference using quasi-experimental methods can provide tools to address it. As new actors emerge as important users of sanctions, and the local epidemiology of typical sanctioned countries evolves, research needs to keep up with these changes, including looking at under-studied episodes and outcomes. While the future of cross-country studies depends on new theory-inspired measurement efforts, replication across existing datasets is also useful.

Additional caution in interpreting these findings stems from limitations of the review itself. First, our simplified risk-assessment procedure relies upon reviewers' statistical judgement more heavily than the original tool. Second, while effect heterogeneity appears to be important, we could only explore it through a structured narrative. While we believe these methods to be reasonable adaptations to key characteristics of the literature and subject matter, they generate additional uncertainty over the results. It is also possible that outlying results were overlooked, if published in languages other than English or contained in grey literature that was neither retrieved nor fully incorporated into retrieved publications. Moreover, due to the lack of pre-existing methodological guidance on the subject matter, no pre-registered protocol was prepared. Finally, systematic reviews, even if adequately implemented, can be fruitfully complemented by other assessments, such as Delphi-method interviews of expert panels – which exceed the scope of this report, but are likely to cast further light on the topic.

A more fundamental solution to the many limitations of this research domain, however, likely depends on its transformation into a routine monitoring activity, enabled by an adequate institutional framework. The systematic application of prospective assessment, and the extent of information exchange between governments and evaluators that goes with it, would shift research activities, at least in part, away from *ex post* documentation and towards risk reduction and control. Evaluators would face new decisions, first and foremost about data collection. While a full discussion lies beyond the scope of this review, a few points can be highlighted here with respect to the aim of improving data quality.

First, any assessment will have to begin with a comprehensive retrieval of baseline information, including the scoping of existing qualitative and quantitative data such as knowledgeable local actors, censuses, administrative registers and sample surveys – with an emphasis on determining their usefulness (e.g. if a survey's target population is known); a country analysis, documenting relevant pre-existing temporal and spatial trends; and an analysis of sanctions to establish plausible impact channels to investigate.

New data will have to be collected for a minimum sufficient set of indicators, which might change throughout the episode, to track the evolving set of possible impacts. The expert process needed to identify such a set might benefit from the recommendation of a “4+4 human security measurement domains” set, made by the only fully developed sanction assessment methodology we identified (Bessler, Garfield & McHugh, 2004a, 2004b), and from initiatives in humanitarian response, where a similar issue arises (Checchi et al., 2017; SMART, 2017; Sphere Association, 2018; Lima Constantino et al., 2020). When a useful baseline exists, data collection must aim at ensuring whatever extent of comparability is possible – for example, by replicating the methodology of a cross-sectional survey fielded before sanctions to generate a pseudo-panel. Credible reconstruction of a *de facto* baseline through fast rollout of data collection might be possible in special cases – for example, for outcomes that change gradually or that can be measured with well-formulated, pre-tested recalls. Under sanctions, most other data can probably be best acquired through compact panel surveys of households and health facilities. Given survey resources, the utility of larger samples must be carefully weighted against that of investing in training and tracking capacity to minimize non-response and attrition. Methods might have to incorporate safeguards against respondent mistrust and political pressures. For example, a pharmaceuticals price survey may be implemented by rotating panels of pharmacies if attempts to exaggerate shortages are suspected.

In analysing the data, evaluators can gain insights from multiple approaches to causal inference: graph-theoretic (Pearl, 2009; Glymour & Greenland, 2008), counterfactual (Imbens & Rubin, 2015; Abadie & Cattaneo, 2018), structural (Heckman & Pinto, 2022) and qualitative (Weller & Barnes, 2014). General concepts that must be considered include the existence of mediators; the difference between sufficient and necessary causes, and between practical and statistical significance; and time-varying, lagged and persistent effects. Focus should lie on the identification of components of the impact of sanctions that are modifiable and of practical significance – importantly, these may include factors that depend on the conduct of the sanctioned country. In issuing recommendations to sanctioning and sanctioned countries, evaluators might consider a principle of redundancy, whereby health risks are best managed if more parties than is strictly necessary act, rather than fewer.

The problem of who is to implement such assessments remains outstanding. In the past, assessments have been entrusted on a case-by-case basis to entities such as the UN Secretariat, ad hoc expert panels, and the United Nations Office for the Coordination of Humanitarian Affairs (Bessler, Garfield & McHugh, 2004a). The creation of a permanent body would have to overcome important technical and political barriers, although trends such as the growth of South–South trade might favour this solution. Sanctions are increasingly equipped with incentives to elicit compliance from third parties, such as extraterritorial provisions and diplomatic exceptions or compensations (Hufbauer & Jung, 2020). To the extent that the practice reveals an increasingly pivotal role of regional state actors in determining the viability of sanctions, these states might support the creation of a body that can further improve their bargaining position in negotiating adequate protection of exempted trade. Whether a critical mass of supportive countries can be reached, and whether such a mechanism could distribute enough material and reputational costs and benefits to avoid being undone by bilateral actions or dishonest communication, is a pressing problem to be addressed with intellectual and political ingenuity.

As a final word, we stress that the existing evidence, despite clear and important limitations, should be taken very seriously, and command attention in sanction policy-making. At a minimum, it reaffirms and strengthens the expectation that economic sanctions can hurt civilian populations in the future, as they did in the past – although not necessarily in the same way. Ultimately, only the incorporation of a risk-assessment framework based on prospective data collection and monitoring into the administrative machinery of sanctions can certify claims that civilians are adequately protected. A failure of the community of states to evolve a custom of reciprocal monitoring against these hazards represents a self-imposed obstacle on the path towards “health for all”, which these very same states committed to attaining in Alma-Ata, 45 years ago.

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Appendix 1. Additional graphs

Fig. A1.1. Timeline of financial sanctions in LMICs, 1950–2019

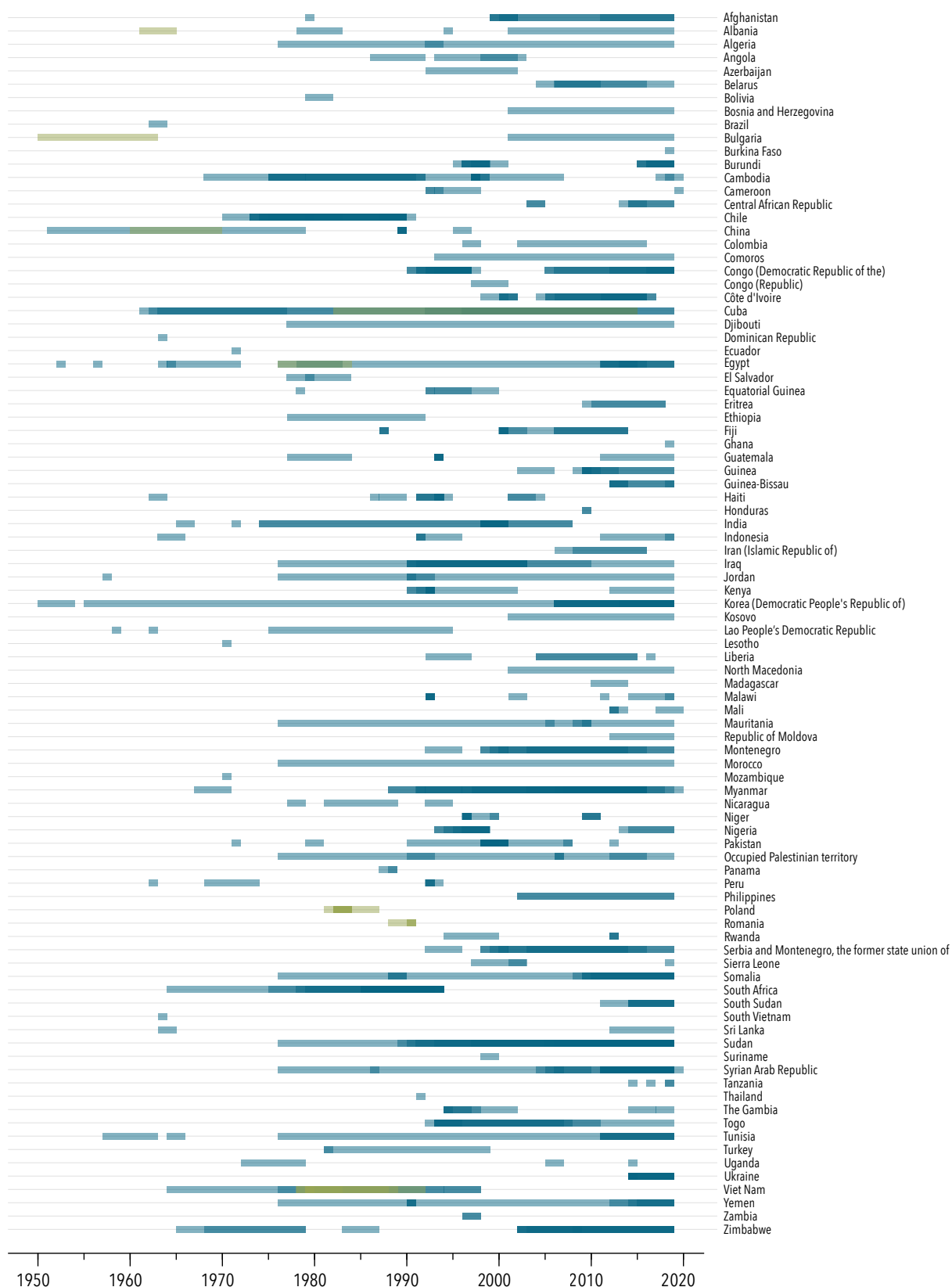


Fig. A1.2. Timeline of arms embargoes in LMICs, 1950–2019

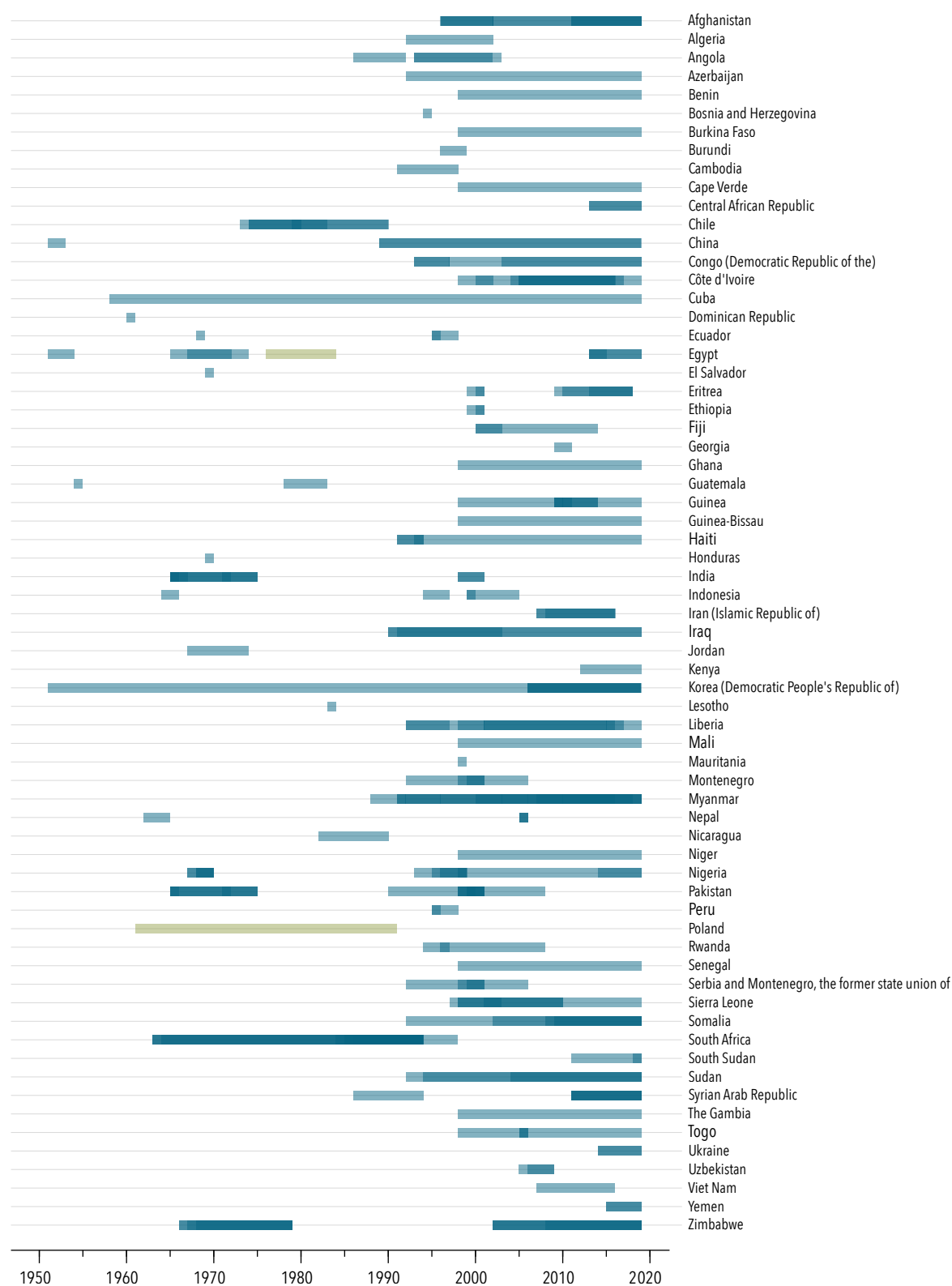


Fig. A1.3. Timeline of limitations to military assistance in LMICs, 1950–2019

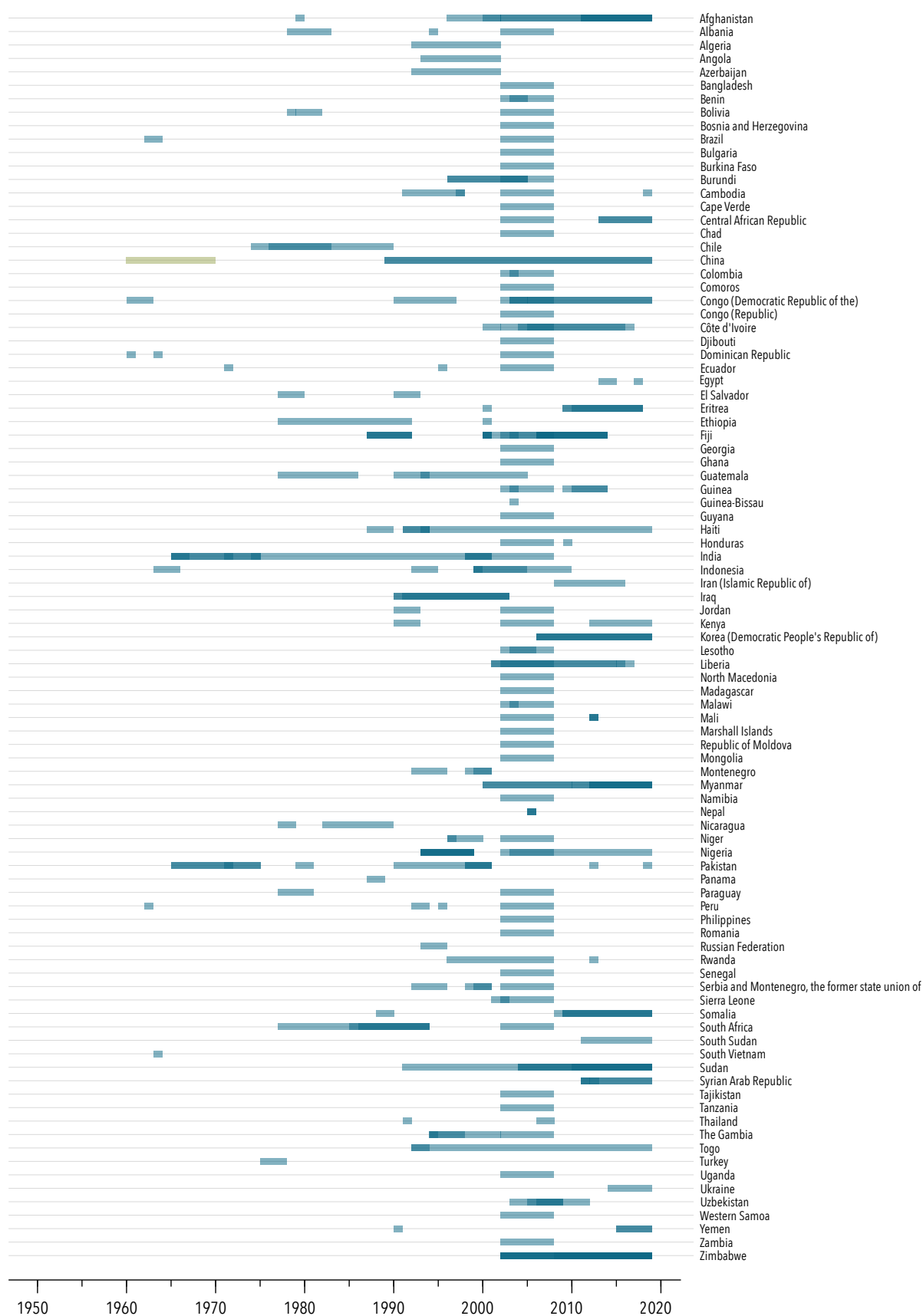


Fig. A1.4. Timeline of travel bans in LMICs, 1950–2019



Fig. A1.5. Timeline of other types of sanctions in LMICs, 1950–2019



Appendix 2. Classification of studies by research method

This appendix defines terms employed to classify included sources according to their research method and define the core and non-core groups of studies. For each study, the classification applies to the *main* approach used to address the *relevant* research question (the impact of sanctions on health and health systems).

We designated **ORIGINAL RESEARCH** any source which reports, discusses and manipulates observations to generate a novel assessment of the research question. We required an element of novelty, be it in the type of evidence provided or in the technique employed to manipulate it, to be clearly identifiable as separate from simple matters of opinion and personal judgement about existing findings. Original research was divided into studies adopting quantitative, qualitative and mixed-method approaches. We classified as **MIXED-METHOD** studies adopting both quantitative and qualitative techniques in a complementary fashion. Given the definition of *core* sources as necessarily including a quantitative element, all *core* studies using qualitative techniques are mixed-method studies.

We defined as **QUALITATIVE** sources reporting and discussing evidence elicited from interested parties by means of interviews, usually but not necessarily in person, and systematic observations and experiences made by the study author(s). To qualify as qualitative, we required sources to include a description of the context in which observations were made, a description of subjects encountered and interviewed, and details of field travel. We excluded memoirs and unstructured reports claiming first-hand, in-person experience.

We defined as **QUANTITATIVE** sources entailing the manipulation of raw numerical data from primary or secondary sources including collations of data from existing literature. We further divided them into **DESCRIPTIVE** studies, in which numerical summaries and sample statistics are used but no estimation or inference is performed, although logical inferences can be found in terms of informed judgements; **UNCONTROLLED COMPARISON** studies, which compare an outcome for two or more groups of study units known to differ in terms of an exposure of interest, without taking into consideration any other potential determinant of the outcome; **CONTROLLED COMPARISON** studies, which perform this comparison conditionally on a series of chosen control variables, by means of techniques such as regression, matching, stratification, standardization and adjustment of variables; **QUASI-EXPERIMENTAL** studies, which perform a controlled comparison by relying, with adequate justification and motivation, on one of the following techniques: regression discontinuity and interrupted time series; instrumental variables; difference studies (before-and-after studies, difference-in-difference and fixed effects estimators). We base our list on recent taxonomies (Bärnighausen et al., 2017; Geldsetzer & Fawzi, 2017; Rockers et al., 2015). We depart from those in excluding natural experiments, as the definition of the term we adopt does not represent, or map to, a specific statistical technique. As emphasized by the literature, the designation of a quasi-experimental study must be partly based on a qualitative judgement about the pertinence of the employed technique and its assumptions. Some studies were not designated as quasi-experimental due to the perceived failure to satisfy this requirement.

We defined a quantitative study as providing an **IMPACT ESTIMATE** when it presented information relating variation in measures of health and health system performance to variation in exposure to sanctions. Some quantitative studies failed to satisfy this criterion because, for example, they compared an outcome at different point in times under sanctions, without any known or documented change in one or more variable aspects of sanctions; or because they performed analyses of outcomes immediately after sanctions were lifted, presenting interpretations related to sanctions. In a small number of limit cases, an impact estimate could be inferred from information reported separately by different studies; or from a strong reason to assume a specific value for missing information – for example, a baseline value of zero for the occurrence of a condition never recorded before sanctions. These limit cases have been conservatively taken not to provide an impact estimate, and therefore excluded from the core sample.

We classified as **REVIEWS** sources reporting results of existing research to generate a comprehensive summary of current knowledge; **SYSTEMATIC REVIEWS** included details about the search strategy originating the list of references, and a prespecified rule about the presentation, assessment and aggregation of findings from reviewed sources. We classified as **COMMENTARIES** sources discussing selective parts of the literature for various reasons (e.g. a comparative perspective, focus on a specific episode) without generating comprehensive summaries of the previous literature or adding an original contribution, but reformulating existing evidence to support specific claims; and as **EDITORIALS, OPINION PIECES AND CORRESPONDENCE** brief expert opinions or exchanges of opinions about a given article or set of articles, with limited referencing and quoting of data.

Appendix 3. Search strategy details

The PubMed searches described in Section 2.2 were carried out on 19 October 2019 and 9 December 2021. Search commands used were:

((Sanctions[Title/Abstract]) AND health[Title/Abstract]) AND ("1970/01/01"[Date - Publication] : "2019/10/19"[Date - Publication])

((Sanctions[Title/Abstract]) AND health[Title/Abstract]) AND ("2020/01/01"[Date - Publication] : "2021/12/9"[Date - Publication])

Google Scholar searches are detailed in Table A3.1, with green shading denoting the searches that have been selected. Table A3.2 lists sources found incidentally while retrieving sources from Google Scholar searches. Such incidental findings occurred for the earlier of the two Google Scholar searches only. Table A3.3 details sources which were first found in an unpublished format, and later found in published format. Green shading indicates which version, according to criteria mentioned in the main text, was chosen. Table A3.4 details sources that were included despite failing to satisfy inclusion criteria, with associated justification for the decision.

Table A3.1. Google Scholar searches

Search terms	Time window	N	Search date
allintitle: sanction sanctions embargoes embargo health mortality humanitarian impact impacts nutrition nutritional malnutrition expectancy survival infection infections noncommunicable incidence prevalence "risk factors"	1970–2019	999	21/10/2019
allintitle: sanction sanctions embargoes embargo health mortality humanitarian nutrition nutritional malnutrition expectancy survival infection infections NCDs incidence prevalence "risk factors" healthcare medicines drugs "chronic conditions"	1970–2019	500	21/10/2019
allintitle: sanction sanctions embargoes embargo health mortality humanitarian nutrition nutritional malnutrition expectancy survival infection infections noncommunicable incidence prevalence "risk factors"	1970–2019	453	21/10/2019
allintitle: sanction sanctions embargoes embargo health mortality morbidity "humanitarian impact" "humanitarian impacts" nutrition malnutrition "life expectancy" survival "death rate" infection	1970–2019	323	21/10/2019
allintitle: sanctions embargoes embargo health mortality morbidity "humanitarian impact" "humanitarian impacts" nutrition malnutrition "life expectancy" survival "death rate" infection	1970–2019	306	21/10/2019
allintitle: sanction sanctions embargoes embargo health mortality humanitarian nutrition nutritional malnutrition expectancy survival infection infections NCDs incidence prevalence "risk factors" healthcare medicines drugs "chronic conditions"	2020–2022	100	18/3/2022

Table A3.2. Incidental findings in Google Scholar searches

Found	While searching for
De Vos et al. (2012) https://doi.org/10.1111/j.1365-3156.2011.02941.x	Data unavailable
Keck & Reed (2012) https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3464859/	
Garfield (2002) https://www.jstor.org/stable/29768138	
https://pcr.uu.se/research/smartsanctions/literature/sanctions-a-bibliographic-manual/	Garfield (1972) https://www.ncbi.nlm.nih.gov/pubmed/9354048
Dyson (2006) https://www.jstor.org/stable/4418840	Bloomfield (1998) https://europepmc.org/abstract/med/9695765
Baram (2000) https://www.jstor.org/stable/4329469	
Eisenberg (1997) https://www.nejm.org/doi/full/10.1056/NEJM199704243361711	Garfield (1999c) http://www.casi.org.uk/info/garfield/dr-garfield.html
Garfield, Zaidi & Lennox (1997) https://www.bmj.com/content/315/7120/1474	
Parnham-Cope (1997) https://www.bmj.com/content/315/7120/1463.2	
Ghalibafian, Hemmati & Bouffet (2018) https://www.thelancet.com/journals/lanonc/article/PIIS1470-2045(18)30751-4/fulltext	Delamothe (1997) https://www.bmj.com/content/315/7120/1393.2
Namazi (2013) http://gozaresh-nakhande.ir/ref/3/27/sanctions_medical_supply_shortages_in_iran.pdf	
Heidari, Akbari qomi & Tavoosidana (2017) https://www.nature.com/articles/d41586-017-08580-z Shahabi (2015) https://www.nature.com/articles/520157b	Batmanghelidj & Hellman (2018) https://www.europeanleadershipnetwork.org/wp-content/uploads/2018/11/FINAL-ELN-BB-HSPV-Policy-Brief-271118-for-ONLINE.pdf
Sharma, Mishra & Kaplan (2017) https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5568715/	
Kokabisaghi et al. (2019) https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6730615/	Aloosh & Aloosh (2015) https://www.nature.com/articles/520623c
Zakavi (2019) https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6352058/	
Maziak, Coutts & Fouad (2013b) https://www.ncbi.nlm.nih.gov/pubmed/23697503	Daponte & Garfield (2000) https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1446193/
Eastman-Abaya (2000) https://www.ncbi.nlm.nih.gov/pubmed/10968469	
Wakai (2000) https://www.ncbi.nlm.nih.gov/pubmed/10968470	Massoumi & Koduri (2015) https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4512265/
Karimi & Haghpanah (2015) https://www.sciencedirect.com/science/article/abs/pii/S0168851014003455	
Rezaee-Zavareh, Karimi-Sari & Alavian (2016) https://www.sciencedirect.com/science/article/pii/S0140673615012957	Al Faisal, Sen & Al Saleh (2012) https://www.ncbi.nlm.nih.gov/pubmed/22864067
Mohammadi (2013) https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(13)60116-6/fulltext	
http://www.cesr.org/sites/default/files/Health_and_Welfare_in_Iraq_after_the_Gulf_Crisis_1991.pdf	Ali & Shah (2000) https://www.ncbi.nlm.nih.gov/pubmed/10866440
Al-Nouri & Al-Raqim (2003) https://adc.bmj.com/content/88/1/92.1	Shahabi et al. (2015) https://www.sciencedirect.com/science/article/abs/pii/S016885101500216X
Al Samaraie (2007) https://www.icrc.org/en/international-review/article/humanitarian-implications-wars-iraq	
Benjamin et al. (2003) https://www.thelancet.com/journals/lancet/article/PIIS0140-6736%2803%2912716-X/fulltext	
Frankish (2003) https://www.thelancet.com/pdfs/journals/lancet/PIIS0140-6736(03)12619-0.pdf	
	Baradaran-Seyed & Majdzadeh (2013) https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(13)61024-7/fulltext
	Found when searching for "Report on the changes in the nutritional status of Iraqi children: one year following the Gulf War and sustained sanctions".
	Found when searching for "niazi al-kubaisi The humanitarian and health impact of war and embargo on Iraq".

Table A3.2. Incidental findings in Google Scholar searches (*continued*)

Found	While searching for
Kirkpatrick, Garfield & Smith (1994) https://www.ncbi.nlm.nih.gov/pubmed/7798873	Found while searching for "AK Kirkpatrick Economic sanctions and health".
Román (1995) https://www.ncbi.nlm.nih.gov/pubmed/7872589	
Kirkpatrick (1997) https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1227827/pdf/cmaj_157_3_281.pdf	
Kirkpatrick (1996) https://www.sciencedirect.com/science/article/pii/S014067369607376X	
The Lancet (1996) https://www.sciencedirect.com/science/article/pii/S0140673605658849	
Román (1995a) https://www.karger.com/Article/Abstract/26161	Found while searching for "carneiro Economic Sanctions, Political Survival, and Human Rights: An Empirical Investigation APSA".
Gutmann et al. (2018) https://www.econstor.eu/bitstream/10419/178615/1/ile-wp-2018-12.pdf	
Maziak, Coutts & Fouad (2013a) https://www.ncbi.nlm.nih.gov/pubmed/23729786	Sen, Al Faisal & AlSaleh (2013) https://www.ncbi.nlm.nih.gov/pubmed/23179240

Table A3.3. Inclusion of sources with multiple versions

Unpublished version	Published version
Bundervoet T, Verwimp P. Civil war and economic sanctions: an analysis of anthropometric outcomes in Burundi. HiCN Working Papers, No. 11, September 2005.	Bundervoet T, Verwimp P, Akresh R. Health and civil war in rural Burundi. <i>Journal of Human Resources</i> . 2009;44(2):536–563.
Garfield R. Morbidity and mortality among Iraqi children from 1990 through 1998: assessing the impact of economic sanctions. Fourth Freedom Forum Occasional Paper Series, No. 16OP3, March 1999.	Garfield R, Leu C. A multivariate method for estimating mortality rates among children under 5 years from health and social indicators in Iraq. <i>International Journal of Epidemiology</i> . 2000;29(3):510–515.
Gutmann J, Neuenkirch M, Neumeier F. Sanctioned to death? the impact of economic sanctions on life expectancy and its gender gap. Universität Trier Research Papers in Economics, Nos. 6–17, 5 September 2018.	Gutmann J, Neuenkirch M, Neumeier F. Sanctioned to death? the impact of economic sanctions on life expectancy and its gender gap. <i>Journal of Development Studies</i> . 2001;57(1):139–162.

Table A3.4. Exceptions to inclusion criteria

Reference	Justification for inclusion
Garfield R (1999b). Suffer the innocents. <i>Sciences</i> . 39(1):19–23.	No peer-review, but authoritative contributor
Garfield R (2000a). The public health impact of sanctions: contrasting responses of Iraq and Cuba. <i>Middle East Rep</i> . 215:16–19.	No peer-review, but authoritative contributor

Appendix 4. Quality assessment criteria and direction-of-effect score

The conceptualization of bias domains for the ROBINS-I tool was used to develop a simple checklist aimed at detecting “bias concerns” in core studies (Sterne et al., 2016: appendix) (Table A4.1). Bias subdomains were developed by iteration and consensus among reviewers, aiming at capturing the most significant aspects of quality in each study. For each reviewed effect of each study, a qualitative judgement was made about whether any of the analyses raised any of the specified problems. An inclusive approach to the effects included in the assessment was followed, as almost no study presented a clear demarcation between primary and secondary outcomes and analyses, and as the main aim of the synthesis is to test for the existence of effects on all health and health system outcomes. However, concerns were not attributed when originating from analyses presented to illustrate an acknowledged problem, preliminary to the presentation of further analyses devised in order to address it. Analyses of effect size modification and mediation performed after a main analysis were only assessed in terms of the modified bias domain referring to them. An additional category was introduced to represent concerns with external validity and data integrity issues.

For each study i we computed the overall quality score

$$Q_i = 7 - n_i$$

where n_i is the number of bias domains in which concerns are identified (excluding the added domain). We do not compute this statistic for studies with data integrity concerns.

To synthesize impact estimates through vote counting, we construct a standardized metric of effect direction. For each study i , we assign to each reported effect δ a score D taking on two possible values:

$$D_\delta = \begin{cases} 1 & \text{if } \delta \text{ harmful} \\ -1 & \text{if } \delta \text{ beneficial} \end{cases}$$

where “harmful” denotes an adverse impact on health or health system performance, with a sign depending on the nature of the outcome. We exclude effects for auxiliary analyses of modification or mediation. In each study, effect scores were merged into a “synthesized effect” based on considerations of homogeneity and complementarity, such as when analyses were presented for a combination of mutually exclusive groups that collectively summed up to (or nearly so) the relevant population (e.g. bilateral and multilateral sanctions, men and women, infant and 1–4 mortality for under-5 mortality). Hence, for each study i and set of synthesizable effects S , the resulting indicator takes on three possible values:

$$D_{S_i} = \begin{cases} 1 & \text{if } D_\delta = 1 \forall \delta \in S_i \\ 0 & \text{if } \exists \delta' \neq \delta'' \mid D_{\delta'} \neq D_{\delta''} \delta', \delta'' \in S_i \\ -1 & \text{if } D_\delta = -1 \forall \delta \in S_i \end{cases}$$

where zero denotes conflicting evidence. For effects without homogeneous counterparts $D_\delta = D_{S_i}$. The same aggregation rule was repeated to obtain an overall study score D_i that was either equal to the scores for synthesized effects in case these were identical, or coded as “conflicting evidence” if otherwise.

$$D_i = \begin{cases} 1 & \text{if } D_{S_i} = 1 \forall S_i \\ 0 & \text{if } \exists S'_i \neq S''_i \mid D_{S'_i} \neq D_{S''_i} \\ -1 & \text{if } D_{S_i} = -1 \forall S_i \end{cases}$$

This conservative aggregation rule safeguards against false positives in studies performing many analyses, and avoids the frequent arbitrariness and poor performance validity of more complex algorithms (McKenzie & Brennan, 2019). In keeping with best practice, we do not consider statistical significance as a criterion in any of these steps.

Following Boon & Thomson (2021), we visualize overall scores with oriented triangles ($\blacktriangle$, $\blacktriangledown$, $\blacktriangleleft\blacktriangleright$), incorporated in the main table of findings and used to sort them. To visualize the distribution of quality

and direction-of-effect scores we construct harvest plots (Ogilvie et al., 2008). Stratification for outcome domains did not uncover relevant patterns, and is thus omitted.

Binomial probability tests for the proportion of studies reporting an overall adverse effect were carried out using the `-bitest-` command in Stata™ 17.0 MP (StataCorp 1985-2021) (Table A4.2). We tested one-sided hypotheses towards an excess of studies reporting adverse effects because we assume that studies are designed to test for adverse effects; and because it has been noted that, in the presence of heterogeneous effects and sample sizes, the power of the test is not monotonically increasing in the proportion of favourable cases, leading to inconsistent test results for two-sided hypotheses (Nikolakopoulos, 2020). The command `-twoway tabulate-` with the `-exact-` option was used to compute Fisher's exact test for whether the proportion of studies reporting an overall adverse effect was different between early and recent studies, and between studies of early and recent sanction episodes (Table A4.3). The command `-ttest-` was used to compute Student's *t*-test for differences in the overall quality score between studies reporting an overall adverse effect of sanctions and all other studies, early and recent studies, and studies of early and recent sanction episodes, allowing for unequal group variances (Table A4.4).

Table A4.1. Bias domains and subdomains for semi-structured risk-of-bias comments

Confounding	Model choice	Does the study contain an acceptable discussion of the analytic method employed and the choice of variables (e.g. regression specification)?
	Model sensitivity	Does the study perform adequate sensitivity analyses to test whether results change after motivated changes in analytic method (e.g. regression specifications, functional forms, transformation of key variables)?
	Omitted control	Has any factor likely to affect the outcome and the probability of exposure to sanctions been omitted from the analysis? Were the factors included in the adjustment procedure adequately measured and operationalized? Was the adjustment procedure correctly implemented?
	Bad control	Are any of the variables used to adjust the estimated impact of exposure to sanctions on the outcome likely to have been affected by exposure to sanctions?
Selection	Registry reporting	If the study uses administrative data, is the probability of reporting information to the administrative body likely to be affected by exposure to sanctions (or one of its causes) and by the outcome (or one of its causes)?
	Facility enrolment	If the study uses facility data, is the probability of enrolment into (or use of) the facility likely to be affected by exposure to sanctions (or one of its causes) and by the outcome (or one of its causes)?
	Outmigration	If the study uses survey data, is the probability of leaving the survey area before being interviewed likely to be affected by exposure to sanctions (or one of its causes) and by the outcome (or one of its causes)?
	Mortality	Is the probability of dying and therefore being excluded from the study sample likely to be affected by exposure to sanctions (or one of its causes) and by the outcome (or one of its causes)?

Table A4.1. Bias domains and subdomains for semi-structured risk-of-bias comments (*continued*)

Error in exposure	Limited information	Is the information used to define groups or variables representing exposure to sanctions reliable and consistent? Does the study provide a sufficient description of the sanction episode or dataset?
	Unclear definition	Is the definition of groups or variables representing exposure to sanctions sufficiently precise in terms of timing and geographical coverage to assess the risk of incorrect classification of exposure status?
	Definition sensitivity	Is there any attempt to test the sensitivity of results to small changes in the definition of groups or variables representing exposure to sanctions?
Modification/mediation	Omitted modifier/mediator	If analyses were performed to identify factors mediating or modifying the impact of sanctions, was any factor likely to exert this role omitted?
	Biased modifier/mediator	If analyses were performed to identify factors mediating or modifying the impact of sanctions, were analytic methods adequate? Could interactions be given a causal interpretation?
Missing data	Sparse data	Are outcomes and additional variables observed only for a small subset of the study period?
	Complete cases only	Are observations with missing information for any of the variables employed in the study excluded from the analysis? If so, is exclusion likely to be associated to exposure to sanctions?
	Imputation issues	Is the method used to impute missing data clearly described, and results adequately discussed?
Error in outcome	Definition comparability	Is the definition of the outcome changing across time or units of observation? Is any change in definitions related to exposure to sanctions?
	Definition sensitivity	Has any attempt been made to test the sensitivity of results to motivated changes to the definition of the outcome (e.g. log-transformations, outcome placebo test)?
	Self-reports only	Were all outcome variables based on information reported by study subjects or other individuals?
Reporting of results	Graph only	Are any of the study analyses discussed verbally but reported only in graphical form?
	Not shown	Are any of the study analyses discussed verbally but reported in neither table nor graphical form?
	Data integrity	Are any of the study analyses based on data from the FAO/NRI or ICMMS surveys?
Other	Unclear population	Is the relation between the study sample and the population it comes from clarified? Does the study provide sufficient information to understand to whom the results should apply, other than to the sampled units?
	No error clustering	If the study uses survey data, are standard errors of sample statistics and estimates clustered at the level of survey cluster to account for the design effect?
	Old sampling frame	If the study uses survey data, is the survey's sampling frame likely to accurately enumerate and locate the study population at the time of the survey?
	Quoted data integrity	Does any quoted material originate from studies based on the FAO/NRI or ICMMS surveys?
	Omitted episodes^a	Is any of the following sanction episodes missing from the dataset? Iraq (1990–2003), the former state union of Serbia and Montenegro (1991–2001), Haiti (1991–1994), Cuba (1992–ongoing), Islamic Republic of Iran (various post-2010)

^a Cross-country studies only.

Table A4.2. One-sided binomial probability tests for excess detection of effects in core studies

	<i>N</i>	π	<i>a</i>	<i>b</i>	<i>a – b</i>
	27	0.5	21	13.5	7.5 ^{***}
	27	0.6	21	16.02	4.98 ^{**}

a: observed number of studies reporting consistent adverse effects.

b: expected number of studies reporting consistent adverse effects under the hypothesis of no adverse effect and a probability of false positive π .

^{***} $P < .01$.

^{**} $P < .05$.

Table A4.3. Fisher's exact test for association between direction of effect and publication or sanction episode period in core studies

		No harm	Harm	<i>P</i> value
Publication period	Early (1992–2005)	2	8	1.000
	Recent (2006–2019)	4	13	
Sanction episode period [†]	Early (before 2010)	3	11	1.000
	Recent (in/after 2010)	1	6	

[†]Cross-country studies omitted.

Table A4.4. Two-sided *t*-tests for differences in quality by direction of effect, publication period and sanction episode period in core studies

	<i>N</i>	<i>a</i>	<i>b</i>	<i>b – a</i>
Direction of effect	27	4	4.42	0.42
Publication period	27	4.2	4.41	0.21
Sanction episode period [†]	21	4.14	5.14	1 ^{**}

a: average overall quality score for (in row order): studies not reporting consistent adverse effects, early studies, studies of early sanction episodes (as in Table A4.2);

b: average overall quality score for: studies reporting consistent adverse effects, recent studies, studies of recent sanction episodes.

[†]Cross-country studies omitted.

^{**} $P < .05$.

Appendix 5. Research reporting guideline checklists

Table A5.1. SWiM checklist. Source: Campbell et al. (2020)

Reporting item	Item description with examples
Methods	
Grouping studies for synthesis	Provide a description of, and rationale for, the groups used in the synthesis (e.g. groupings of populations, interventions, outcomes, study design). "Anticipating a highly heterogeneous set of contributions, we aimed at a two-tiered classification of relevant sources. Studies providing information interpretable as an impact estimate for any outcome domain related to health and health systems – however measured – qualified as core references. This was meant to require numerical measures of, and variability in, health or health system outcomes and exposure to sanctions (see Appendix 2 for definitions). Core sources were inspected in detail, and salient aspects of their analysis were extracted and tabulated. They form the building blocks of the review and were given primary importance in developing our commentary and informing our conclusions. On the other hand, a group of non-core sources was defined in order to preserve content that, despite falling short of providing an impact estimate, was deemed insightful in terms of methodology or subject-matter knowledge. Non-core sources included studies with sparse quantitative information, previous literature reviews, commentaries, editorials and opinion pieces, and qualitative studies of health and sanctions rich in background knowledge about specific aspects of the problem. These sources were used to inform discussion and contextualize core sources, noting points of agreement and disagreement." (p. 6)
Describe the standardized metric and transformation method used	Describe the standardized metric for each outcome. Explain why the metric(s) was chosen, and describe any methods used to transform the intervention effects, as reported in the study, to the standardized metric, citing any methodological guidance used. "To synthesize impact estimates through vote counting, we construct a standardized metric of effect direction [...] This conservative aggregation rule safeguards against false positives in studies performing many analyses, and avoids the frequent arbitrariness and poor performance validity of more complex algorithms (McKenzie & Brennan, 2019). In keeping with best practice, we do not consider statistical significance as a criterion in any of these steps" (Appendix 4).
Describe the synthesis methods	Describe and justify the methods used to synthesize the effects for each outcome when it was not possible to undertake a meta-analysis of effect estimates. "The high heterogeneity of the core studies, and the lack of measures of precision for some of them, precludes meta-analysis and calls for alternative synthesis methods. [...] In developing this two-tiered approach to synthesis, we share the position that mapping methodological gaps and proposing explanatory frameworks is, for emerging literatures, a more realistic objective than ensuring a homogeneous base for meta-analysis (Ogilvie et al., 2020b; Ogilvie et al., 2005)." (p. 8)
Criteria used to prioritize results for summary and synthesis	Where applicable, provide the criteria used, with supporting justification, to select particular studies or a particular study, for the main synthesis or to draw conclusions from the synthesis (e.g. based on study design, risk-of-bias assessments, directness in relation to the review question). Not applicable
Investigation of heterogeneity in reported effects	State the method(s) used to examine heterogeneity in reported effects when it is not possible to undertake a meta-analysis of effect estimates and its extensions to investigate heterogeneity. "Moreover, the nature and current knowledge of the subject suggest that, as far as health-related outcomes are concerned, no intended or typical experience of sanctions can be identified. As the effect of interest is presumed to be harmful, there is no intended course of action conditional on exposure. Hence, notions related to compliance (e.g. adherence, implementation failure, etc.) have no meaningful analogue in this setting. A typical course of events under the exposure might exist, but there is little interest in defining one such benchmark, and doing so would require background information that is currently unavailable. Absent those pre-specified benchmarks, we assess suggestions and analyses for all proposed effect size modifications and mediators (also known as channels), regarding them as relevant components of the effect of interest." (p. 8)

Table A5.1. SWiM checklist. Source: Campbell et al. (2020) (*continued*)

Reporting item	Item description with examples
Certainty of evidence	Describe the methods used to assess certainty of the synthesis findings. "We rely on the seven bias domains of ROBINS-I, augmented by an additional dimension, to present risk-of-bias concerns in a semi-structured way. For each study, a count of the domains for which concerns were identified provides a rough measure of overall study quality." (p. 8) "The conceptualization of bias domains for the ROBINS-I tool was used to develop a simple checklist aimed at detecting 'bias concerns' in core studies (Sterne et al., 2016: appendix) (Table A4.1) [...] We do not compute this statistic for studies with data integrity concerns" (Appendix 4).
Data presentation methods	Describe the graphical and tabular methods used to present the effects (e.g. tables, forest plots, harvest plots) Specify key study characteristics (e.g. study design, risk of bias) used to order the studies, in the text and any tables or graphs, clearly referencing the studies included. "Following Boon & Thomson (2021), we visualize overall scores with oriented triangles (▲, ▼, ◀▶), incorporated in the main table of findings and used to sort them. To visualize the distribution of quality and direction-of-effect scores we construct harvest plots (Ogilvie et al., 2008)" (Appendix 4).
Results	
Reporting results	For each comparison and outcome, provide a description of the synthesized findings, and the certainty of the findings. Describe the result in language that is consistent with the question the synthesis addresses, and indicate which studies contribute to the synthesis. "Excluding four studies with data integrity issues, 21 out of 27 studies consistently reported adverse effects of sanctions on health and health systems (Table 1, Fig. 9). This proportion is significantly higher than what is expected by assuming no adverse effect and an equal likelihood of false positives and negatives, and even by assuming the expected proportion of false positives to be as high as 60%, for example, due to publication bias (Table A4.2). Studies which consistently report adverse effects do not appear to be systematically focused on earlier, or more recent, sanction episodes; nor do they appear to be older, or more recent, in terms of publication period (Table A4.3). Based on the constructed quality score, studies focusing on more recent episodes appear to be of significantly higher quality than studies focusing on earlier episodes, while the improvement in terms of publication period is smaller and not statistically significant. This discrepancy might stem from the fact that determinants of study quality specific to more recent episodes, such as data quality, might be more important than those generally improving with time – such as statistical methods. Finally, no significant difference in quality is apparent between studies consistently reporting adverse effects and all other studies (Fig. 10, Table A4.4)." (p. 14)
Limitations of the synthesis	Report the limitations of the synthesis methods used and/or the groupings used in the synthesis, and how these affect the conclusions that can be drawn in relation to the original review question. "As this quality score is not directly obtained from the construction of target trials as unique benchmarks for assessing reported effects, it is expected to rely more heavily on the reviewers' statistical knowledge. For this reason, each rating was thoroughly discussed and established by consensus among the reviewing authors (MPP, MS). The score is understood as a valuable tool to further characterize the 'high-risk spectrum' occupied by the virtual entirety of our sample of core studies." (p. 8) "The thematic narrative aims to make sense of sanctions as highly complex social events, and should be regarded as an informed proposal of an explanatory framework." (p. 15) "Additional caution in interpreting these findings stems from limitations of the review itself. [...] Finally, systematic reviews, even if adequately implemented, can be fruitfully complemented by other assessments, such as Delphi-method interviews of expert panels – which exceed the scope of this report, but are likely to cast further light on the topic." (p. 64)

Table A5.2. PRISMA 2020 checklist. Source: Page et al. (2021)

Section and topic	Item no.	Checklist item	Location where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	N/A
ABSTRACT			
Abstract	2	See the PRISMA 2020 for abstracts checklist.	p. 102
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	pp. 1–3
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	pp. 1–3
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	pp. 6–7
Information sources	6	Specify all databases, registers, websites, organizations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	pp. 6–7
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	Appendix 3
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	pp. 6–7
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	pp. 6–7; Appendix 3
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	pp. 6–7; Appendix 2
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	p. 7; Appendix 2
Study risk-of-bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	pp. 7–8; Appendix 4
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	Appendix 4
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item no. 5)).	pp. 7–8; Appendix 2
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	Appendix 4
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	Appendix 4

Table A5.2. PRISMA 2020 checklist. Source: Page et al. (2021) (*continued*)

Section and topic	Item no.	Checklist item	Location where item is reported
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	pp. 7–8; Appendix 4
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	p. 8
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	Appendix 4
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	pp. 13–14
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	N/A
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	p. 9
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	Appendix 2 and 3
Study characteristics	17	Cite each included study and present its characteristics.	pp. 16–39, Appendix 6
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	pp. 16–39
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	pp. 16–39
Results of syntheses	20a	For each synthesis, briefly summarize the characteristics and risk of bias among contributing studies.	pp. 12–14
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	pp. 12–15
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	pp. 16–39
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	p. 14
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	pp. 13–14
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	N/A

Table A5.2. PRISMA 2020 checklist. Source: Page et al. (2021) (*continued*)

Section and topic	Item no.	Checklist item	Location where item is reported
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	p. 63
	23b	Discuss any limitations of the evidence included in the review.	pp. 63–65
	23c	Discuss any limitations of the review processes used.	p. 64
	23d	Discuss implications of the results for practice, policy and future research.	pp. 63–65
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	pp. 63–64
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	pp. 63–64
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	N/A
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	p. v
Competing interests	26	Declare any competing interests of review authors.	p. v
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	p. v

Table A5.3. PRISMA 2020 for abstracts checklist. Source: Page et al. (2021)

Section and topic	Item #	Checklist item	Reported (Yes/No)
TITLE			
Title	1	Identify the report as a systematic review.	NO
BACKGROUND			
Objectives	2	Provide an explicit statement of the main objective(s) or question(s) the review addresses.	YES
METHODS			
Eligibility criteria	3	Specify the inclusion and exclusion criteria for the review.	YES
Information sources	4	Specify the information sources (e.g. databases, registers) used to identify studies and the date when each was last searched.	YES
Risk of bias	5	Specify the methods used to assess risk of bias in the included studies.	YES
Synthesis of results	6	Specify the methods used to present and synthesize results.	YES
RESULTS			
Included studies	7	Give the total number of included studies and participants and summarize relevant characteristics of studies.	YES
Synthesis of results	8	Present results for main outcomes, preferably indicating the number of included studies and participants for each. If meta-analysis was done, report the summary estimate and confidence/credible interval. If comparing groups, indicate the direction of the effect (i.e. which group is favoured).	YES
DISCUSSION			
Limitations of evidence	9	Provide a brief summary of the limitations of the evidence included in the review (e.g. study risk of bias, inconsistency and imprecision).	YES
Interpretation	10	Provide a general interpretation of the results and important implications.	YES
OTHER			
Funding	11	Specify the primary source of funding for the review.	YES
Registration	12	Provide the register name and registration number.	NO

Appendix 6. Findings of non-core studies

Table A6.1. Findings of non-core studies

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
1 Abbara et al. (2018)	(Unspecified)	Syrian Arab Republic		Availability of medical equipment	Commentary based on published sources, secondary survey data, official statistics and media reports	No original research findings. Together with weak pre-war policies, armed conflict and counterproductive government policies, sanctions are mentioned as a factor restricting the availability of medical supplies necessary to monitor and mitigate opportunities for antimicrobial resistance to evolve. Mentioned items are: spare parts for autoclaves, reagents, agar plates, various disinfection and diagnostic equipment. Energy shortages related to sanctions are also deemed to have made it more difficult to use existing equipment.		
2 Abbas et al. (2008)	UN sanctions (Aug 1990–May 2003).	Iraq	Body mass index (BMI), haemoglobin count, self-reports (age of menarche, average duration of menstrual flow, consanguinity with future husband, family history of inherited conditions)		Descriptive statistics from facility-based cross-sectional survey in Baghdad, 2001.	Prevalence of anaemia (<12 g/dl) at 63.2%. Prevalence of overweight (BMI ≥ 25) and underweight (BMI ≤ 20) at 24.8% and 6.4%. Mean age of menarche at 13.9 years. Significant positive age trend for weight and BMI, but not height. Significant positive educational trend for weight, BMI, and haemoglobin level.	Findings interpreted as evidence of maternal malnutrition and ascribed to sanctions.	The absence of baseline prevents obtaining an impact estimate. The BMI and anaemia severity thresholds employed in presenting defining conditions are not in line with established WHO definitions.

Table A6.1. Findings of non-core studies (*continued*)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
3 Abdoli (2020)	United States sanctions (Nov 1979–ongoing), esp. measures reintroduced after withdrawal from the Joint Comprehensive Plan of Action (Aug 2018–ongoing)	Islamic Republic of Iran			Short communication	No original research findings. Sanctions are regarded as exacerbating the extraordinary pressure put on the health care system by the ongoing COVID-19 pandemic, by limiting the import of drugs, PCR and X-ray machines, and equipment for CCU/ICU; by shrinking fiscal space to finance health care workforce expansion and medical research; by hampering international research collaborations with Iranian scholars.		Discussion partially based on the ICMMS survey, the reliability of which has been questioned.
4 Afshari & Bhopal (2016)	(unspecified)	Islamic Republic of Iran			Short communication	No original research findings. Starting from negligible levels, the number of PubMed-indexed articles with at least one author affiliated to an Iranian institution began to grow in the mid-1980s. The number of articles published in PubMed-indexed Iranian journals follows a similar trend, with a delay of 15 years.		The authors argue that adverse effects of sanctions on international collaborations might have been avoided by an international professional support and the founding of Iranian research journals. Given that neither the presence of an author affiliated to the Islamic Republic of Iran, nor the nationality of a research journal are sufficient to distinguish between international collaborations and domestically produced research, it is unclear how informative the figure given is on the issue.

Table A6.1. Findings of non-core studies (*continued*)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
5	Ahmad (2001)	UN sanctions (Oct 1999–Jan 2002). Afghanistan (Taliban-occupied territories)	U5MR	Food availability.	Editorial quoting published sources and expert opinions.	No original research findings. The article is an editorial reporting on the publication of a study by the NGO Médecins Sans Frontières. Its main finding, a mortality rate of 5.2 per 10 000 per day among under-5 Afghani children in refugee camps in north-west Pakistan, is mentioned. Facts such as distress sales of ploughing animals by households, unavailability of seeds and general inability to farm are also mentioned. The Médecins Sans Frontières spokesperson is referred to as indicating that food scarcity in Afghanistan forces many people to resort to plant roots. Other sources from UN agencies are quoted or referred expressing concern about deteriorating health conditions in the Afghan population.		No proposed association with sanctions.

Table A6.1. Findings of non-core studies (*continued*)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
6 Ahmadi & Meskarpour-Amiri (2015)					Short communication	No original research findings. Quoting secondary sources, the article expresses the opinion that sanctions, irrespective of exemption policy, can deteriorate population health.		
7 Ahmed et al. (2007)	UN sanctions (Aug. 1990–May 2003).	Baghdad, Iraq	Prevalence of dental caries (DMFT index), sugar consumption		Bivariate and multivariate ANOVA on cross-sectional survey of 392 12-years-old secondary school children.	Prevalence of dental caries of 62%. In multivariate ANOVA, relative to low maternal education, children of mothers with high education had on average 0.7 more filled teeth ($P < .05$) and a lower score of sugar consumption (8.5 vs. 9.6, $P < .05$). Sugar consumption score was also higher among boys (9.5 vs. 8.7, $P < .001$) and among children from a low versus high socioeconomic status (10.5 vs. 8.3, $P < .001$). The opposite sign of the maternal education gradient on dental caries (positive) and sugar consumption (negative) is interpreted as evidence of an inverse U-shaped income elasticity of demand for imported sugary foods consumption, with lagged health effects and learned moderation.	Increase in availability of imported sugary products due to lifting of sanctions, leading to higher consumption and prevalence of dental caries.	Impact of sanctions conjectured as a contextual factor, outside the empirical analysis.
8 Akbariabad et al. (2021)	United States sanctions (Nov 1979–ongoing)	Islamic Republic of Iran			Literature review	No original research findings.		

Table A6.1. Findings of non-core studies (*continued*)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
9 Akbarpour Roshan & Abbasi (2014)	United States embargo (Jul 1963–ongoing), esp. CDA (Oct 1992–ongoing).	Cuba	Infant, child, maternal and general mortality; life expectancy	Aggregate food supply, domestic food production, food imports	Commentary based on published sources and statistics from the World Bank, UN agencies and the United States Census Bureau	No original research findings. After the Soviet trade slump and the CDA, aggregate food supply fluctuated downwards for a few years. The apparent lack of impact on infant and child mortality is attributed to effective food rationing. General mortality increased moderately in the two subsequent decades, and is attributed to shortages of specialized treatment for chronic illness.		Narrative discussion of pre-existing findings. The association with sanctions is often assumed uncritically.
10 Akunjee & Ali (2002)	UN sanctions (Aug 1990–May 2003).	Iraq			Commentary based on published sources and field visit	No original research findings. Salient topics in the narrative include: deteriorating medical education due to shortage of foreign materials and limited scientific exchange; outmigration of trained specialists and nurses during the Gulf crisis; the role of family relatives as substitutes of nurses in hospitals; shortages of pharmaceuticals, laboratory and X-ray equipment; declining drug quality standards due to lower regulation in non-sanctioning exporter countries. It is reported that “over 66%” of chemotherapy medication required by the UKALL97 protocol are found to be unavailable in the country.		No description of conditions under which field observations were made. Discussion partly based on FAO/NRI survey findings (Zaidi & Fawzi, 1995), later partly retracted (Zaidi, 1997), and ICMMS survey, the reliability of which has been questioned.

Table A6.1. Findings of non-core studies (continued)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
11	Al Faisal, Sen & Al Saleh (2012)	Syrian Arab Republic			Descriptive statistics based on government sources, UN agencies and online sources.	In one year after sanctions, the local currency devalued from US\$ 45 to US\$ 70 and a twofold to fourfold increase occurred in the price of essential goods such as gas, heating oil, vegetable ghee, cheese, yogurt, sugar, milk, vegetable oil, rice, eggs, tea and tomatoes. Other adverse consequences attributed to sanctions include: job losses, especially in tourism; energy shortages threatening vaccine refrigeration; heating oil shortages increasing the risk of respiratory tract infections in winter; blocked import of diabetes medication and treatment for cancer and heart disease; disruption to clean water supply.		Before-and-after table of prices lacks precise time references, and no indication is given of how prices are derived or computed. Upon inspection, the quoted source of price data could not be retrieved.
12	Al Faisal, Al Saleh & Sen (2012)	Syrian Arab Republic			Opinion	No original research findings. The authors express concerns over the health of Syrians trapped in the current civil war, underlining the role of the local health care system and its pre-war achievements. Sanctions are claimed to be a cause of currency devaluation, inflation eroding the purchasing power for food and drugs, and decreased capacity to maintain a supply of clean water.		

Table A6.1. Findings of non-core studies (continued)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
13	Al Faisal & Sen (2013)	Syrian Arab Republic			Correspondence	No original research findings. Correspondence on Sen, Al Faisal & Al Saleh (2013). The authors reply to Maziak, Coutts & Fouad (2013a) maintaining that the article's focus on sanctions does not entail a partisan position in the conflict, and that the role of sanctions amplifies existing disruptions.		
14	Al Samarale (2007)	UN sanctions (Aug 1990–May 2003); Iraq			Commentary based on published sources.	No original findings. Sanctions are mentioned as contributing to declines in living standards, health and education.		
15	Albright (2000)	Iraq: UN sanctions (Aug 1990–May 2003). Cuba: United States embargo (Jul 1963–ongoing), esp. CDA (Oct 1992–ongoing) and Helms-Burton Act (Mar 1996–ongoing).	Iraq, Cuba		Opinion	No original research findings. Sanctions are an effective instrument for international enforcement of human rights, but measures such as exemptions of food and medicines must be taken to minimize civilian harm. The United States Government complies with this qualification, and has allowed trade in such items in the case of Cuba and Iraq. Existing health problems are due to the planned economic model of Cuba, and to the Iraqi's regime boycott of international aid such as the OFFP.		The article has no list of references, and no source is quoted for various individual numbers reported.

Table A6.1. Findings of non-core studies (*continued*)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
16	Al-Nouri & Al-Raqim (2003)	UN sanctions (Aug 1990–May 2003).	Iraq		Correspondence	No original research findings. Estimates of rising infant and child mortality, malnutrition and observations on morbidity and hospital conditions are quoted from academic literature and UN reports, and attributed to sanctions.		Some findings quoted from Ascherio et al. (1992), Garfield, Zaidi & Lennox (1997), but also from other published sources which fail to refer to original findings (Dobson, 2000) or which refer to the partially retracted findings of Zaidi & Fawzi (1995).
17	Aloosh & Aloosh (2015)	(unspecified)	Islamic Republic of Iran		Short communication.	No original research findings. The article reports an episode of unexpected permanent vision loss in at least 15 patients after eye surgery in Tehran, attributed to substandard equipment.		The authors conjecture that the reported case exemplifies a way in which sanctions can affect population health.
18	Aloosh, Salvati & Aloosh (2019)	(unspecified)	Islamic Republic of Iran		Commentary based on published sources and official statistics.	No original research findings. Official GDP figures are quoted showing a recession after the strengthening of sanctions in 2011 and 2012, with recovery after their relaxation due to the Joint Cooperative Plan of Action. Increases in death rates due to self-harm and interpersonal violence are mentioned. Published findings are quoted supporting the occurrence of shortages of essential pharmaceuticals		

Table A6.1. Findings of non-core studies (*continued*)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
19	Ameri et al. (2018)	Islamic Republic of Iran		Number, operational status; spatial distribution of facilities; number of staff; available equipment	Descriptive statistics from cross-sectional survey of 94 radiotherapy facilities in 2015	The number of operational cobalt-60 machines in the country declined from 25 in 2010 to 8 in 2015.		Impact of sanctions conjectured as a contextual factor, outside the empirical analysis.
20	Andrews et al. (1997)	United States embargo (Jul 1963–ongoing), esp. CDA (Oct 1992–ongoing) and Helms–Burton Act (Mar 1996–ongoing).	Cuba	Self-inflicted injuries	Cases series report from one health facility	Between summer 1994 and late 1995, among detained asylum-seekers in Guantanamo Bay United States military base (30 000 in September 1994), the following cases of self-injury were reported: injection of fuel diesel in the leg and scrotum; burns due to molten plastic; haematuria due to urethral trauma; haemorrhoids due to rectal trauma; laceration of Achilles tendon; asthma due to ingestion of irritants; intestinal obstruction due to ingestion of rocks, metal rings and other objects; uncontrolled hypertension and diabetes mellitus due to noncompliance of treatment abuse. Cases of malingering were also reported, including alleged cases of angina, brain tumour, chronic pain and other conditions, which later investigation by competent personnel could not verify. Self-mutilations ceased after United States immigration policy changed, granting refugee status to all detainees. Average outpatient visits fell from 53 per 1000 at the peak of the epidemic (Jan 1995) to 25 from mid-May to Sep 1995.	Motivation to attain refugee status in the USA on medical grounds, given the existing restrictive United States refugee policy (later reversed) and deteriorating economic conditions in Cuba.	The authors mention United States sanctions among the factors contributing to the wave of asylum-seekers constituting the population in which the epidemic of self-injuries occurred.

Table A6.1. Findings of non-core studies (*continued*)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
21	Appleyard (1998)				Correspondence	No original research findings. The letter reports a resolution by the World Medical Association, urging national professional bodies in sanctioning countries to lobby for effective implementation of exemption systems.		
22	Arab-Zozani & Ghoddoosi-Nejad (2021)	United States sanctions (Nov 1979–ongoing), esp. measures reintroduced after withdrawal from the Joint Comprehensive Plan of Action (Aug 2018–ongoing).	Islamic Republic of Iran		Short communication	No original research findings. Sanctions are mentioned as a factor contributing to shortages of personal protective equipment, ventilators, and computed tomography scanners in ICUs.		
23	Aziz (2003)	UN sanctions (Aug 1990–May 2003).	Iraq		Correspondence	No original research findings. Interviewed Iraqi health professionals are quoted emphasizing the unprecedented severity of injuries presented by patients hit by cluster bombs, the need to ration medications, delays in the treatment of congenital malformations in children, the reliance on superseded pharmaceuticals, and the need to repair basic infrastructure and equipment. Reported shortages of health system inputs and financial resources are attributed to sanctions and government policy before the United-States-led invasion.		

Table A6.1. Findings of non-core studies (*continued*)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
24	Baradaran-Seyed & Majdzadeh (2013)	Islamic Republic of Iran			Correspondence	No original research findings. Comment on Mohammadi (2013), arguing that sanction-induced shortages affect not only pharmaceuticals but also "materials for health services, even sutures and vaccines".	The authors discount currency devaluation and overcompliance by foreign exporters, arguing that shortages are due to financial sanctions, preventing Iranian companies performing international payments.	
25	Baram (2000)	UN sanctions (Aug 1990–May 2003); Iraq			Commentary based on official statistics, survey data, UN documents and published literature	No original research findings. Iraq census data and UN fertility estimates are shown to be inconsistent with claims by Iraqi authorities of 1.5 mln. Deaths attributable to sanctions, but consistent with a population loss due to war and sanctions comparable with the Iran–Iraq War (250 000 to 500 000 deaths). Claims by the Iraqi government and various international organizations on child mortality attributable to sanctions are contrasted with substantially lower available estimates. Data on malnutrition suggests improvements under the OFFP, but frequent absence of nationally representative sampling or disaggregation by governorate level prevents systematic assessment of regional inequalities, which might in part be due to intentional neglect by the Government. Available evidence suggests higher prevalence in southern, mainly Shia districts. The selective focus of some field visits is noted. Opportunities to increase imports of food and medicine with the OFFP were not fully exploited by the government until UN pressure ensued. Bias against primary care and breastfeeding in rationing policies and import orders are mentioned.	Discussion partially based on the ICMMS survey, the reliability of which has been questioned.	

Table A6.1. Findings of non-core studies (*continued*)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
26	Barnouti (1996)	UN sanctions (Aug 1990–May 2003), Iraq		Supply of surgical equipment	Correspondence	No original research findings. The letter characterize surgical practice in Iraq as “far below minimally acceptable standards”, and mentions shortages of antimicrobials, anaesthetics, antiseptics, protective equipment, spare parts for cauterizing devices, and suture material, with associated increased risks of mortality and postoperative morbidity.		
27	Barry (2000a)	United States embargo (Jul 1963–ongoing), esp. CDA (Oct 1992–ongoing) and Helms-Burton Act (Mar 1996–ongoing).	Cuba		Commentary based on field visits and published sources	No original research findings. Previous findings are discussed, including documented epidemics of neuropathy due to B-group vitamin deficiency; child intoxication with liquid lye; cases of Guillain-Barré syndrome due to underchlorinated water. The importance of exemption systems and monitoring of civilian welfare in sanctioned countries is emphasized.		
28	Barry (2000b)	Embargo by OAS (Oct 1991–Aug 1993) and UN (Jun–Aug 1993, Oct 1993–Oct 1994).	Haiti		Commented abstract	No original research findings. The article is a brief summary of Gibbons and Garfield (1999), arguing that only an effective exemption enforcement system with continuous monitoring of processes and outcomes can prevent sanctions to damage population health.		

Table A6.1. Findings of non-core studies (*continued*)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
29 Bastani et al. (2021a)	United States sanctions (Nov 1979–ongoing), esp. measures reintroduced after withdrawal from the Joint Comprehensive Plan of Action (Aug 2018–ongoing)	Islamic Republic of Iran		Policies to improve the pharmaceutical supply chain under sanctions	Thematic analysis on records of semi-structured face-to-face interviews with President, Vice-Presidents, managers of Iran's Food and Drug Administration and other experts (sample: 18 individuals after pilot interviews)	Minimum interview length was 50 minutes. Nine themes and 26 sub-themes were identified. The themes were: health policy considerations, including stronger oversight and less interference vis-à-vis private companies, the introduction of clinical guidelines and reform of GP referral system; leveraging on local conditions via public-private partnerships, collaboration with the media and religious authority; cooperation with neighbouring countries; higher procurement prices for domestic companies to stimulate import substitution; health insurance reform to target resources on expanding basic coverage; efficiency gains in health care by introducing electronic records and prescribing; implementing a tracking and monitoring system for distribution and sale; stronger quality control; better information on alternatives to imported pharmaceuticals for physicians and patients.		

Table A6.1. Findings of non-core studies (*continued*)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
30 Bastani et al. (2021b)	United States sanctions (Nov 1979–ongoing), esp. measures reintroduced after withdrawal from the Joint Comprehensive Plan of Action (Aug 2018–ongoing)	Islamic Republic of Iran		Policies to achieve universal health coverage under sanctions	Thematic analysis on results of 3-round Delphi method (via online survey) from 30 policy themes pre-selected via comparative analysis of 10 countries (Sample: 20 experts in health care management, health economics and insurance)	Comparative analysis generated 30 policy themes, organized in three groups. Consensus was reached for 18. For “health technology assessment to select essential health services”, consensus was achieved on: avoiding premature assessments, consideration of non-economic factors, consideration of cost-effectiveness, potential limits to cost-effectiveness, use of cost-effectiveness in health insurance. For “For whom to buy interventions and who should receive the most benefits from financing for health services”, consensus was achieved on: basic universal coverage, the elderly, pregnant women, the under-18 and low-income as priority groups, targeted demand-side subsidies, regressive effects of unrestricted access to free health care in low-income countries, importance of geographical/economic/cultural accessibility. On “payment mechanisms” consensus was achieved on: direct payment to providers, tailoring payment to country health insurance system.	Unclear role of the topic of sanctions and associated impacts in the expert consensus process.	

Table A6.1. Findings of non-core studies (*continued*)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
31	Batmanghelidj & Heydari (2014)	United States sanctions (unspecified)	Islamic Republic of Iran		Commentary based on published sources	No original research findings. The authors argue that United States tobacco companies are granted a high number of licenses to export to the Islamic Republic of Iran. Quoting figures on the prevalence, tax revenue stream, and health costs of smoking, it is argued that stronger enforcement of border controls against smuggling and higher taxes on tobacco products are needed to improve population health and increase state capacity.		
32	Benjamin et al. (2003)	UN sanctions (Aug 1990–May 2003).	Iraq	Operational status of sites, availability of health care inputs	Operational status of sites, availability of health care inputs	Of 12 hospitals surveyed, 11 reported shortages of basic equipment, and 10 drug shortages; only 2 could perform basic resuscitations, and only one could perform intensive care ventilator support, cardiac monitoring and pulse oximetry. Child infections were found to be “under reasonable control”, although outbreaks in the recent past are interpreted as signs of vulnerability. All 8 water, sewage treatment and electricity plants were found to operate “by the flimsiest of means”.	Fieldwork is described as assessing “the health effect of economic sanctions”, but no attempt is made to document this association.	
33	Bessler, Garfield & McHugh (2004a)				Literature review	No original research findings.		

Table A6.1. Findings of non-core studies (*continued*)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
34	Bessler, Garfield & McHugh (2004b)				Literature review	No original research findings.		
35	Black (1993)	The former state union of Serbia and Montenegro	Cases of TB, tetanus, weight	Availability of food, pharmaceuticals and medical equipment; health expenditure per capita	Report based on field observations and interviews	Field observations include: queues to purchase milk; adequate supply of fresh farm produce in urban markets; a group of refugee mothers and children housed in a hospital basement; a "clear deterioration" in hospital conditions relative to the previous year. Local staff of UN agencies are quoted reporting a large decline in health care expenditure; shortage of pharmaceuticals and medical equipment due to war, sanctions and economic decline. In different facilities, doctors are quoted reporting suspension of most elective surgery; increases in diagnosed cases of tetanus; shortage and black market circulation of antimicrobials leading to an increase in multiresistant infections. Observations in a psychiatric hospital include a 10-fold decline in recorded drug supplies vis-à-vis before the war; a 90% budget cut in the previous 2 years; an increase in diagnosed TB cases from 2/3 in 1991 to 25 in 1993; lack of soap and tampons; an average 1.9 kg weight loss apparent from the records for 27 underweight patients; good patient-staff relations. The author concludes that "sanctions are clearly damaging the health of the population, affecting the poorest and most vulnerable groups most of all".	Currency devaluation; shipment delays due to imperfect exemption system; no exemption on intermediate inputs for pharmaceuticals.	Sanctions are regarded as contributing to declines in population health, together with state breakup, war and counterproductive government policies.

Table A6.1. Findings of non-core studies (*continued*)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
36 Blacker, Ali & Jones (2007)	UN sanctions (Aug 1990–May 2003).	Iraq	Under-5 mortality rates, birth interval		Descriptive statistics from cross-sectional survey and administrative data	Estimates of under-5 mortality rates from the ICMMS of 1999, once computed with the indirect method used by the Iraq population census of 1997, are comparable to the latter's unadjusted estimates. Non-response is likely to stem from obsolete question format, and should not be adjusted for by assuming it stems from absence of child death in respondent's birth history. If the relevant section of the survey is backdated by a decade, it is comparable with the census of 1987. The abnormally low ratio of 1–4 to infant mortality in the ICMMS data in the sanction period reflects disproportional increase in infant-specific risks such as low birthweight and decreased exclusive breastfeeding. Discrepancy between direct estimates from ICMMS and census data, and changes in the age composition of under-5 mortality under sanctions, are thus explained without questioning the integrity of the ICMMS.	Reply to objections raised against estimates based on ICMMS survey (Ali et al. 2003). Findings based on UNICEF's ICMMS survey, the reliability of which was later questioned.	

Table A6.1. Findings of non-core studies (continued)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
37	Centres for Disease Control (1994)	United States embargo (Jul 1963–ongoing), esp. CDA (Oct 1992–ongoing).	Cuba	Cases of epidemic neuropathy	Report based on Cuban official statistics and case-control studies	No original research findings. Reported characteristics of the epidemic include: a total number of cases around 50 000; the presence of an optic and a peripheral form; higher incidence among men, in the 45–65 age group, in the tobacco-growing region of Pinar del Rio; eventual remission of symptoms and decrease of incidence after mass administration of B-complex vitamin supplements. Quoted risk factors from case-control studies conducted by Cuban authorities include: low BMI, tobacco smoking, low intake of animal proteins, fat and sources of B-vitamins.	The discussion section of the report suggests that a causal factor in the condition is B-vitamins deficiency, itself associated with "economic difficulties in Cuba since 1989", for example due to increases in physically demanding commuting induced by fuel scarcity depleting vitamin reserves in the population.	No explicit mention is made of the United States embargo.
38	Chelala (1994)	Embargo by OAS (Oct 1991–Aug 1993) and UN (Jun–Aug 1993, Oct 1993–Oct 1994).	Haiti		Correspondence	No original research findings. The letter quotes population health indicators for the pre-sanction period; argues that HIV/AIDS prevalence has increased under sanctions due to urban violence and unemployment causing internal displacement and high-risk behaviours; and argues that the oil embargo prevents the use of fuel to distribute exempted humanitarian goods.		

Table A6.1. Findings of non-core studies (*continued*)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
39	Chelala (1996)	United States embargo (Jul 1963–ongoing), esp. CDA (Oct 1992–ongoing).	Cuba		Editorial	No original research findings. The commentary proposes the relaxing of the United States embargo and the organization of diplomatic talks, led by medical practitioners and focused on health issues, as alternatives to the existing United States policy on Cuba. Quoting Cuban official statistics, the author expresses the opinion that the United States embargo contributes to adverse health outcomes among Cuban citizens.		
40	Chelala (1998)	United States embargo (Jul 1963–ongoing), esp. CDA (Oct 1992–ongoing) and Helms-Burton Act (Mar 1996–ongoing).	Cuba	IMR, MMR	Short communication	No original research findings. Figures for IMR (7.2 per 1000) and MMR (22 per 100 000) in 1997 are quoted, and emphasis is given to the fact that the values are historical lows for the second consecutive year – despite the recent economic crisis which affected the country.		
41	Cheraghali (2013)	UN, United States, EU sanctions (unspecified)	Islamic Republic of Iran		Commentary based on published sources	No original research findings. Sanctions are deemed responsible for shortages of finished and intermediate pharmaceutical products, due to higher transaction costs and restrictions on banking and insurance.		

Table A6.1. Findings of non-core studies (*continued*)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
42	Choonara (2013)	Iraq: UN sanctions (Aug 1990–May 2003). Cuba: United States embargo (Jul 1963–ongoing), esp. CDA (Oct 1992–ongoing). Occupied Palestinian territory: sanctions by UN, USA, EU and Russian Federation (unspecified) and blockade by Israel and Egypt (unspecified)	Iraq, Cuba, occupied Palestinian territory		Commentary based on published sources	No original research findings. For Iraq, published estimates of infant and under-5 mortality estimates under sanctions, and reports of rising prevalence of low birthweight and malnutrition, are quoted. For Cuba, reports of delayed and blocked shipments of medical equipment are mentioned, and good population health in the country is associated to its primary care model. For the occupied Palestinian territory, reports of shortages of essential medicines and equipment, electricity, and declines in access to potable water, are quoted, with associated evidence of rising anaemia among school-age children, prevalence of diarrhoea in under-3 children and underweight in infants between 9 to 12 months. The author advocates the extension of the Geneva Conventions to protect civilians under sanctions.	Discussion partly based on FAO/NRI survey findings (Zaidi & Fawzi, 1995), later partly retracted (Zaidi, 1997), and ICMMS survey, the reliability of which has been questioned.	
43	Cohen (2018)	UN and United States sanctions (unspecified)	Democratic People's Republic of Korea	Delivery of health inputs as humanitarian aid	Commentary based on UN documents and other published sources	No original research findings. The author argues that UN and United States sanctions contributed to hampering effective humanitarian aid in the country, including the sourcing of medical equipment. However, the author concludes that obstructive policies by the Government of the Democratic People's Republic of Korea play a larger role in preventing basic population health conditions to be achieved in the country.	Overcompliance with financial sanctions by banks, preventing transactions for exempted items; time costs of licensing monitoring and licensing for exemptions; deterrence of shipping companies due to fear of reputational costs; mobility restrictions on aid workers due to travel ban.	

Table A6.1. Findings of non-core studies (*continued*)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
44	Coovadia (1999)	UN arms and oil embargo (Nov 1962–May 1994), United States sanctions (Oct 1986–Nov 1993)	South Africa		Commentary based on recollection of personal experience and published sources	No original research findings. While “great controversy” on trade sanctions is said to have occurred, the African National Congress position is characterized as supportive, as economic distress was seen as a “necessary condition for liberation”. This position was based on the belief that economic growth would not have resulted in the abolition of apartheid, while sanction’s adverse impact on black people’s incomes was deemed negligible relative to that of continuing segregation. The possibility that sanctions worsened the incomes and thus health of the poor, largely black South Africans, is acknowledged, but is seen as exacerbating existing problems, against which little progress was made under previous diplomatic stances: and as a cost to be weighted against the contribution to abolishing apartheid.		
45	Cotton (1993)	USA embargo (Jul 1963–ongoing), esp. CDA (Oct 1992–ongoing).	Cuba	Cases of epidemic neuropathy	Editorial	No original research findings. The article reports on epidemiological studies on the epidemic of neuropathy in Cuba – which was by then ongoing. The opinions of various United States field investigators and experts are quoted over possible causal factors, including the probable role of nutrition and the potential role of United States sanctions in triggering nutritional deprivation in Cuba.		

Table A6.1. Findings of non-core studies (*continued*)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
46	The Cuba Neuropathy Field Investigation Team (1995)	United States embargo (Jul 1963–ongoing), esp. CDA (Oct 1992–ongoing)	Cuba	Cases of neuropathy (optic form)	Adjusted odds ratios (logistic regression) on case-control pairs matched by sex, age and municipality, randomly selected in five municipalities of the Pinar del Rio province	Univariate risk factors include any tobacco use (6.6;95%CI: 3.2–13.9), daily consumption of 1 to 3 (8.7;95%CI: 2.5–30.7) and above 3 (22.8;95%CI: 4–131) cigars (relative to no consumption); share of energy intake from cassava (3;95%CI: 1.3–6.6) (highest-to-lowest quartile). Protective factors include higher (highest-to-lowest quartile) share of energy intake from animal proteins (0.3;95%CI: 0.1–0.6), rearing poultry (0.4;95%CI: 0.2–0.7); having relatives abroad (0.4;95%CI: 0.2–0.6), animal fat (0.2;95%CI: 0.1–0.5), methionine (0.3;95%CI: 0.1–0.6), B12 vitamin (0.2;95%CI: 0.1–0.4), riboflavin (0.3;95%CI: 0.2–0.7); higher serum density of Lycopene (0.05;95%CI: 0.02–0.2), δ -carotene (0.2;95%CI: 0.1–0.4), Selenium (0.3;95%CI: 0.1–0.6). In multivariable models (not shown), cigar smoking, cassava consumption, serum Lycopene, total energy intake, methionine share in total energy, and poultry rearing reportedly remained significant, although other factors could be substituted with little loss of explanatory power.	Damages to the optic nerve due to impaired cyanide detoxification, caused by B-complex vitamin deficiency. This deficiency is in turn deemed associated to adverse economic conditions, including "the loss of Cuba's major trading partners and a severe storm".	Sampling limited to severe cases. The study strongly suggests a nutritional origin of the epidemic, consistent with a contributory role of barriers to food imports, including the collapse of the Soviet Union, the pre-existing United States embargo and its subsequent tightening. However, its design does not allow separate quantification of these factors.
47	Cuellar (2015)	United States embargo (Jul 1963–ongoing), esp. CDA (Oct 1992–ongoing) and Helms-Burton Act (Mar 1996–ongoing).	Cuba		Short communication	No original research findings. The article quotes selected facts about the record of population health, the performance of the health care system in Cuba, and argues that sanctions severely restrict access to drugs for chronic conditions.		

Table A6.1. Findings of non-core studies (*continued*)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
48 Danaei et al. (2019)	United States sanctions (Nov 1979–ongoing), esp. measures reintroduced after withdrawal from the Joint Comprehensive Plan of Action (Aug 2018–ongoing).	Islamic Republic of Iran			Correspondence	No original research findings. Exclusion from international payment circuits is claimed to have slowed down the receipt of international aid during the floods of Spring 2019, requiring the establishment of ad hoc accounts by UNICEF to facilitate inflow of resources from Europe.		
49 Dehghani et al. (2021)	United States sanctions (Nov 1979–ongoing), esp. measures reintroduced after withdrawal from the Joint Comprehensive Plan of Action (Aug 2018–ongoing)	Islamic Republic of Iran (city of Tabriz, Tabriz University of Medical Science)		Elicited opinions on three guideline questions: “How have sanctions affected the health research system in [the Islamic Republic of] Iran?”; “Do you have any personal experience about the impact of sanctions on your research projects?”; “Which research sections have been most affected by sanctions?”	Thematic analysis on records of semi-structured interviews with managers, faculty members, postdoctoral and doctoral students (Sample: 24 individuals)	Length of interviews ranged between 31 and 47 minutes. Five themes concerning channels of impact on health research were identified. Financial issues, including lower funding due to inflation and changes in budgetary priorities, delays in grant payments and allocation of foreign currency for international payments. Difficulties in sourcing laboratory materials and other equipment, due to reluctance of foreign firms leading to higher prices and transaction costs with associated delays, and cash-in-advance terms when contracting Iranian companies: counterfeit or low-quality items; unavailability of maintenance services and spare parts, shortening the lifespan of equipment. Stress due to increased workload, including correction of errors due to malfunctioning equipment, and risk of failure of projects. Disruption of international collaborations due to increased visa issuing problems, currency devaluation, difficulties in obtaining international scholarships, biased rejection of articles by foreign journals, lack of access to online research resources and software.	Sample limited in size and homogeneous institutional affiliation of subjects.	

Table A6.1. Findings of non-core studies (*continued*)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
50 Destafkan et al. (2020)	(unspecified)	Islamic Republic of Iran			Commentary based on published literature and legal documents	No original research findings. Sources of duty in international law that institute accountability for human rights violations due to sanctions include fundamental principles of the UN Charter for the UN Security Council, and the right to health as stated in the WHO constitution, the Covenant on Economic, Social and Cultural Rights and the Convention on the Rights of the Child. The cases of Iraq and Cuba illustrate possible health impacts of sanctions, and possible mitigating policies by target stages. In the case of Iran, ambiguous terminology and the treatment of dual-use items in the exemption system, the macroeconomic effects of barriers to oil exports, and the blocking of banking services associated with financial sanctions, all potentially impact civilians and their human rights.		Discussion partially based on the ICMIMS survey, the reliability of which has been questioned.

Table A6.1. Findings of non-core studies (continued)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
51 De Vos et al. (2012)	United States embargo (Jul 1963–ongoing), esp. CDA (Oct 1992–ongoing).	Cuba	IMR, incidence of low birthweight and TB, life expectancy	Public health expenditure, number of various types of health facilities, hospital beds, physician density	Commentary based on published sources, descriptive statistics and pairwise correlations between them.	No original research findings. The authors show that, while GDP fell during the <i>período especial</i> crisis, public health expenditure, the number of health care facilities and professionals all increased. Hospitalizations and hospital beds were constant, before eventually declining in the postcrisis years. Previously published figures documenting the limited and temporary extent of health deteriorations (incidence of low birthweight and TB) are cited.	The authors claim that “given the importance of GDP decrease, one might have expected a dramatic deterioration of the Cuba’s health”. This decoupling is deemed due to the fact that “social and health services policies limited social consequences of the crisis” (p. 474).	No discussion of the specific role of sanctions vis-à-vis the Soviet trade slump, and of the relative importance of government policy responses – e.g. economic liberalization vs. public health interventions.
52 Delamothe (1997)					Editorial	No original research findings. The article is an editorial quoting published studies on Iraq and Cuba expressing the opinion that doctors should oppose sanctions “whenever these are likely to endanger health”.		
53 Dobson (2000)	UN sanctions (Aug 1990–May 2003).	Iraq			Editorial	No original research findings. Estimate of under-5 mortality increasing from 56 in 1984–89 to 131 in 1994–99 from unreferenced source.		Source of reported finding not quoted, but likely based on the ICMMS survey, the reliability of which has been questioned.
54 Drain (2015)	United States embargo (Jul 1963–ongoing), esp. CDA (Oct 1992–ongoing) and Helms-Burton Act (Mar 1996–ongoing).	Cuba			Commentary based on published sources	No original research findings. The article expresses the opinion that a potential for medical research collaborations exists between Cuba and the USA, in fields such as vaccine development, medical education and global health, and that this potential can be realized by lifting the embargo.		

Table A6.1. Findings of non-core studies (continued)

	Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
55	Drain & Barry (2010)	United States embargo (Jul 1963–ongoing), esp. CDA (Oct 1992–ongoing) and Helms-Burton Act (Mar 1996–ongoing).	Cuba			Commentary based on published sources	No original research findings. The article summarizes information about the impact of the embargo. It states that “during the embargo’s first 30 years, Cuban’s average life expectancy increased 12.2 years, comparable to Caribbean and South American regions”; that the CDA “altered the medication supply and likely had focal, serious consequences on Cuban’s health”; and that those adverse consequences were temporary, and Cuba’s population health continued to improve afterwards.		

Table A6.1. Findings of non-core studies (*continued*)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
56 Drèze & Gazdar (1992)	UN sanctions (Aug 1990–May 2003).	Iraq	Food intake (assessed indirectly through food prices and availability)		Descriptive statistics from household survey; narrative from field observations and interviews	Between Aug 1990 and Aug 1991, food prices increased by a factor of 15 to 20, while nominal earnings stagnated. Food import prices “can be expected to have risen about 25 times” (p. 928). In Aug 1991, the unskilled monthly real wage was 7% of the previous year level. The cost of the average monthly food basket for a family of six with one infant rose from 66 to 1000 Iraqi Dinars in the same period (800 if food rations are included). The average monthly wage over the same period fell within the range of 120–250 Dinars. Food rationing collapsed during wartime. Speaking of their hardest period, households reported giving up meat for staples, eating a single daily meal, consuming “famine foods”, selling household assets and fights within the family for the allocation of food. Poorer households reported persistent hardship after the war.	The large increase in food prices is deemed due to speculation during wartime; quantity constraints due to de facto food embargo until April 1991; the end of subsidized food import prices and the associated currency devaluation due to general sanctions. The rationing system is deemed to have been key in preventing starvation in the immediate post-war period.	Field observations consistent with other studies.

Table A6.1. Findings of non-core studies (*continued*)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
57 Dyson (2009)	UN sanctions (Aug 1990–May 2003).	Iraq	Under-5 mortality rates		Descriptive statistics from household surveys and population census	Estimates of under-5 mortality from the Multiple Indicator Cluster Survey of 2006 (MICS3) agree with the Iraq Living Condition Survey of 2004 (ILCS) and fail to show the sharp and prolonged increase depicted by the 1999 ICMMS. Inspection of first differences of the time series reveal agreement in patterns of annual variability across the three surveys, except for the sharp increase after the imposition of sanctions in the ICMMS data, which must be regarded as suspicious.		
58 Dyson & Cetorelli (2017)	UN sanctions (Aug 1990–May 2003).	Iraq			Commentary based on published literature and survey data	Three surveys (ILCS, MICS3, MICS4) implemented after the 2003 United-States-led invasion depict a pattern of under-5 mortality showing no sharp increase after the imposition of sanctions, in contrast with data from the 1999 ICMMS. This fact supports the view that the ICMMS was manipulated to inflate mortality estimates for the centre/south region of the country. A temporary increase in mortality in 1991 is likely to have occurred, but of a smaller scale than depicted by the IST survey of Ascherio et al. (1992) and the ICMMS.		

Table A6.1. Findings of non-core studies (continued)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
59	Eastman-Abaya (2000)	UN sanctions (Aug 1990–May 2003). Iraq			Correspondence	No original research findings. The letter mentions findings from Ali & Shah (2000), and disputes the view that increased mortality is attributable to the Iraqi government rather than to UN sanctions.		Findings quoted are based on UNICEF ICMMS survey, the reliability of which has been questioned
60	Eisenberg (1997)	United States embargo (Jul 1963–ongoing), esp. Helms-Burton Act (Mar 1996–ongoing). Cuba	Self-inflicted injuries		Editorial quoting published sources	No original research findings. The article comments on Andrews et al. (1997), linking findings to worsening economic conditions in Cuba and citing both the collapse of the former Soviet Union and the United States embargo as contributing factors.	Worsening economic conditions leading to outmigration and concomitant United States immigration policy change towards Cuba.	
61	Fakheran (2019)	United States sanctions (Nov 1979–ongoing), esp. measures reintroduced after withdrawal from the Joint Comprehensive Plan of Action (Aug 2018–ongoing). Islamic Republic of Iran			Short communication	No original research findings. The article argues that, in light of evidence on the health effects of sanction and economic crises, the newly re-imposed United States sanctions are likely to decrease oral health care use in the Islamic Republic of Iran. As a way to mitigate this impact, the author suggests wider adoption of cost-effective preventive interventions.		

Table A6.1. Findings of non-core studies (continued)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
62 Farmer, Smith Fawzi & Nevil (2003)	United States blocking Inter-American Development Bank loan by United States veto (2002).	Haiti	Cases of anthrax, polio, drug-resistant TB and road traffic injuries	Annual outpatient visits in ambulatory facility	Commentary based on personal experience as field workers and published sources	The commentary reports on the United States vetoing of US\$ 164 million in humanitarian aid at the Inter-American Development Bank, in response to alleged irregularities in the May 2000 parliamentary elections. Based on their observation as practicing clinicians, the authors report a steady increase in annual outpatient visits at their ambulatory, from around 10 000 in the first three trimesters of 2001 to 200 000 in the second trimester of 2002 – significantly above the stated nominal staff capacity of 35 000. Unquantified increases in road traffic injuries, the reappearance of polio, anthrax and drug-resistant TB cases are also noted.	The authors stress the dependence of the country on external humanitarian aid. However, they acknowledge that “the noxious effects of a leaky embargo and the consequences of military rule cannot be disentangled”, further noticing the lack of government commitment in the area of health.	
63 Farsad et al. (2019)	United States sanctions (Nov 1979–ongoing), esp. measures reintroduced after withdrawal from the Joint Comprehensive Plan of Action (Aug 2018–ongoing).	Iran			Statement from professional body	No original research findings. The article is a statement from the Network of Iranian Nuclear Medicine Scientists. It claims that, despite exemptions for essential drugs, sanctions hamper the provision of intermediate inputs for domestic producers of radiopharmaceuticals. As a consequence, “the activities of Nuclear Medicine Departments are greatly reduced and most probably, in the near future, will be completely stopped.”		

Table A6.1. Findings of non-core studies (*continued*)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
64 Field & Russell (1992)	UN sanctions (Aug 1990–May 2003).	Iraq	Prevalence of malnutrition (underweight, stunting, wasting), anaemia, vitamin A deficiency	Food prices, interviews with doctors and mothers	Descriptive statistics from administrative records, interviews and cross-sectional survey	Prevalence of moderate malnutrition at 22% for height-for-age, 20% for weight-for-age, 4% for weight-for-height ($-3 < Z < -2$); at 18% for mid-upper arm circumference (135 mm $< X < 125$ mm). Prevalence of severe malnutrition at 17% for height-for-age, 6% for weight-for-age, <i>nil</i> for weight-for-height ($Z < -3$); at 8% for mid-upper arm circumference ($X < 125$ mm). Z scores declined with age: from -0.74 (0–6 months) to -2.04 (above 3 years) for height-for-age; from -0.57 (0–6 months) to -1.48 (2–3 years) and -1.47 (above 3 years) for weight-for-age. No significant differences across gender and rural/urban lines.	Relying on field interviews of mothers and observations about food prices, the authors write: “the cumulative effect of embargo, war, civil unrest, and sanctions had left poorer people in greater Basrah in a food scarcity and price squeeze, reflecting the country’s prior reliance on food imports [...]. In sum, the child malnutrition documented [...] reflects a crisis of consumption as well as a crisis of infectious disease” (p. 44).	The absence of a pre-sanction baseline prevents the obtaining of an impact estimate. No adjustment for mortality selection. No random sampling.

Table A6.1. Findings of non-core studies (*continued*)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
65	Frankish (2003)	UN sanctions (Aug 1990–May 2003); Iraq			Commentary based on published academic and UN sources	No original research findings. Declining living standards in Iraq during the 1990s are discussed and linked to war and sanctions, with the latter characterized as impediment to recovery, while the OFFP is taken as a cause of later improvement. Figures on child malnutrition, infant and child mortality, cases of selected diseases, are mentioned and related to reported shortages of energy and spare parts preventing adequate water treatment, sewage and garbage collection.		Extensive mention of sources, but no list of references.
66	Garfield (1999a)				Literature review	No original research findings.		

Table A6.1. Findings of non-core studies (*continued*)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
67	Garfield (1999b) Iraq: UN sanctions (Aug 1990–May 2003). Cuba: United States embargo (Jul 1963–ongoing), esp. CDA (Oct 1992–ongoing). Haiti: embargo by OAS (Oct 1991–Aug 1993) and UN (Jun–Aug 1993, Oct 1993–Oct 1994).	Iraq, Cuba, Haiti	Prevalence of low birthweight, child (under-5) mortality rate	Available calories per capita	Commentary based on published sources	No original research findings. Sanctions increased in frequency during the 1990s as partial substitute to armed conflict. Technical flaws and politicized implementation led to health and welfare impacts in line with observed trends in civilian exposure to warfare. Impacts on health operate through supply constraints on health inputs and macroeconomic effects. Impacts are often greater on children, pregnant women, the elderly and chronically ill. Mitigation policies are available, for example to protect infants, based on prevention and faster adoption of low-cost technologies. Introducing standards to implement exemption systems and to monitor civilian population in target countries, jointly with greater reliance on targeted sanctions, can enhance the humanitarian potential of sanctions.		Tabulation of descriptive outcomes as before–after comparisons is provided, but lack of any information on data sources and methodology prevents their being considered an impact estimate.

Table A6.1. Findings of non-core studies (*continued*)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
68	Garfield (2000a)	Iraq: UN sanctions (Aug 1990–May 2003). Cuba: United States embargo (Jul 1963–ongoing), esp. CDA (Oct 1992–ongoing).	Iraq, Cuba		Commentary based on published sources.	No original research findings. Government policies in Iraq and Cuba are discussed as a contributory factor behind differences in the severity of adverse health consequences of sanctions. In Iraq, which experienced larger, more sustained increases in under-5 mortality, baseline 6-months exclusive breastfeeding was low, and the government introduced infant formula in the rationing system against UNICEF advice. Limited decline in malnutrition under the OFFP is related to Iraq's curative health care system model, with few staff trained in primary care and community health. The “pro-curative bias” was reflected in the use of Programme funds. In Cuba, secular decline in infant and under-5 mortality was sustained under sanctions, despite economic decline and declines in child and maternal nutrition. Government responses included promotion of breastfeeding, targeted food supplementation for mothers and children, health promotion activities.	Different policy responses are associated to differences in health system models, despite other similarities in terms of form of government and trade structure. It is recognized, however, that differences in outcomes also reflect the greater damage inflicted by armed conflict and sanctions in Iraq.	Discussion partly based on findings from ICMMS survey, the reliability of which has been questioned.

Table A6.1. Findings of non-core studies (*continued*)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
69	Garfield (2000b)	UN sanctions (Aug 1990–May 2003); Iraq	Prevalence of malnutrition (underweight, stunting, wasting)		Descriptive statistics based on survey data.	According to five nationally representative or nearly-representative surveys the prevalence of malnutrition went from 9.2 (underweight), 3 (stunting) and 18.7 (wasting) in 1991 to 23.4, 11 and 31.2 in 1996; 24.7, 8.9, 27.5 in 1997; 21.8, 8.3, 26.5 in 1998; 21, 8.5, 20.1 in 1999. The comparison suggests rapid increase in malnutrition under sanctions, and little decrease after the implementation of exemptions under the OFFP.	Increase in food prices due to decline in food imports. Low level of exclusive breastfeeding.	Comparison from repeated cross-sections with potential lack of comparability. No baseline to estimate the impact of armed conflict and initial imposition of sanctions, and no clear baseline for the implementation of the OFFP
70	Garfield (2001b)	Sanctions by UN, EU and USA (May 1991–Jan 2001, with gaps). The former state union of Serbia and Montenegro			Brief communication	No original research findings. The article summarizes main findings of Garfield (2001a).		

Table A6.1. Findings of non-core studies (*continued*)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
71	Garfield (2002)	Iraq: UN sanctions (Aug 1990–May 2003). Cuba: United States embargo (Jul 1963–ongoing), esp. CDA (Oct 1992–ongoing). Haiti: embargo by OAS (Oct 1991–Aug 1993) and UN (Jun–Aug 1993, Oct 1993–Oct 1994). The former state union of Serbia and Montenegro: sanctions by UN, EU and USA (May 1991–Jan 2001, with gaps).	Iraq, Cuba, Haiti, the former state union of Serbia and Montenegro		Commentary based on published sources.	No original research findings. Reliance upon sanctions increased after the Cold War due to greater potential effectiveness and lower perceived costs vis-à-vis open war. Evidence was gathered that in key episodes, sanctions adversely affect the health of populations in sanctioned countries, casting doubt on their legitimacy in a UN framework and with respect to international law customs. The presence of exemption clauses does not guarantee that civilians will not be affected. The literature suggests rising mortality and morbidity, with greater effect on heavily import-dependent countries and for more comprehensive and multilateral sanctions – with Iraq as a leading case. Responses to sanctions by governments and households in sanctioned countries can mediate the effect, Cuba being the major example of successful mitigation. Prevention of these adverse effects on health requires baseline data collection and follow-up, preparedness to timely identify vulnerabilities based on previous experiences, development of codified procedures for effective exemption systems.		
72	Garfield, Devin & Fausey (1995)				Literature review	No original research findings.		

Table A6.1. Findings of non-core studies (*continued*)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
73 Garfield, Zaidi & Lennox (1997)	UN sanctions (Aug 1990–May 2003).	Iraq	Case fatality of burn injuries, postoperative infection rate	Operational status of sites, availability of health care inputs	Field observations in selected hospitals (20% of Iraq's civilian hospital beds)	Approximately one third of hospital beds visited were closed. Average length of stay "more than halved" relative to pre-war period. Observations in hospitals included: patients bringing their own blankets, kerosene and electric stoves; leaking sewage pipes; in a hospital's radiology department "expiry date of the barium they were using was 1990", approximately 7 years earlier. Reported scarcity of disinfectants and antiseptics, spare parts for diagnostic and therapeutic equipment, anaesthetics and surgical materials, wound dressings, burn ointment, antibiotics, inhalers for asthma patients, materials for X-rays. Increase in case fatality for burns covering between 40% and 70% of skin surface (one hospital). Postoperative infection rate in patients with clean wounds rose from 5% to 25–30% (some hospitals). The authors conclude that the collected experiences "suggest a remarkable decline in what was until recently a medically advanced country".	Authors report that most information reported could not be verified.	

Table A6.1. Findings of non-core studies (continued)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
74 Ghalibafian, Hemmati, & Bouffet (2018)	United States sanctions (Nov 1979–ongoing), esp. measures reintroduced after withdrawal from the Joint Comprehensive Plan of Action (Aug 2018–ongoing).	Islamic Republic of Iran			Short communication.	No original research findings. The article reports drug scarcities from a paediatric hospital in Teheran. Drugs to treat leukaemia are reported to be a month out of stock, while other cancer drugs and antimicrobials are reported to be on a 3-month stock. The authors report that “during the previous embargo, radiation treatments in our hospital were interrupted for 2 months, until spare parts could be imported”.		
75 Gharebaghi & Heidary (2020)	United States and EU sanctions (unspecified)	Islamic Republic of Iran			Opinion piece	No original research findings. The article comments on salient early phases of the COVID-19 outbreak in the Islamic Republic of Iran, expressing the opinion that “the important issue is lifting sanctions against [the Islamic Republic of] Iran, at least in the area of lifesaving medical supplies, which could decrease the extent of the tragedy and help prevent a second wave of the disease”.		

Table A6.1. Findings of non-core studies (*continued*)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
76	Gibbons & Garfield (1999)	Embargo by OAS (Oct 1991–Aug 1993) and UN (Jun–Aug 1993, Oct 1993–Oct 1994).	Haiti	Prevalence of moderate-to-severe malnutrition (unspecified, wasting); IMR, 1–4 mortality rate	Descriptive statistics from health facilities, household surveys and published literature (Sample: epidemiological surveillance, 42 facilities; nutritional surveys: unspecified) Observations and interviews with affected women, governmental representatives, diplomats, relief workers	Under-5 prevalence of moderate-to-severe malnutrition in surveillance stations rose from 18% in 1993 to 24% in September 1994, while according to nationally representative surveys it rose from 3.4% in 1990 to 7.8% in 1994–1995. Between 1987 and 1994 IMR declined from 101 to 74 per 1000, while 1–4 mortality rose from 56 to 61. The following coping strategies were observed among large section of the population: urban-to-rural migration to seek cheaper food, reliance upon remittances, dissaving and sale of household assets, cohabitation, informal sector employment, black market, prostitution, changed dietary habits, increased informal unions among couples, decreased school attendance and indentured servitude among children.	Change in assembly industry employment declined from -7.5% 1986–1991 to -80% in 1991–1994. GDP per capita decreased by 30% in the 3 years following the coup. The price of rice and corn rose 137% and 184%, respectively, between September 1991 and September 1994. The price of infant formula increased 283% from November 1991 to September 1994. Fuel shortages, closure of health facilities and severing of ties between international agencies and public sector staff caused a decline in measles immunization coverage and a measles epidemic from June 1991 to November 1993. In the capital Port-au-Prince, access to potable water declined from 53% in 1990 to 35% in 1994.	Survey-based estimates for the prevalence of malnutrition (wasting) and 1-to-4 mortality already employed in Mulder-Sibanda (1998). The comparison between surveillance-based and survey prevalence estimates for undernutrition suggest that the former sample is selective on child nutritional status.
77	Gorji (2013)	Sanctions by the USA, UN and EU before the Joint Comprehensive Plan of Action (unspecified).	Islamic Republic of Iran		Correspondence	No original research findings. The article is a letter arguing that, despite formal exemptions, sanctions against the Islamic Republic of Iran hampered the delivery and manufacture of pharmaceuticals for chronic conditions that affect about 6 million people, by blocking trading services such as licensing and shipping, and by general deterrence of foreign companies.		Discussion partly based on findings from ICMMS survey, the reliability of which has been questioned.

Table A6.1. Findings of non-core studies (continued)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
78 Gorji (2014)	Sanctions by the USA, UN and EU before the Joint Comprehensive Plan of Action (unspecified).	Islamic Republic of Iran			Correspondence	No original research findings. (same as previous entry)		Discussion partly based on findings from ICMMS survey, the reliability of which has been questioned. Wrong excess death estimate (300 000 instead of 46 900) attributed to Ascherio et al. (1992)
79 Habibzadeh (2016)	United States sanctions (unspecified)	Islamic Republic of Iran		Access to medical education	Correspondence	No original research findings. The letter reports the case of an Iran-based medical student who was denied enrolment to an online medical education course by a United States university, reportedly due to the institution's need to comply with United States sanctions.		

Table A6.1. Findings of non-core studies (*continued*)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
80	Harvard Study Team (1991)	UN sanctions (Aug 1990–May 2003). Iraq	Prevalence and incidence of child infections, malnutrition	Energy supply, operational status of visited sites, availability of selected health care inputs	Field visits to health care facilities, power plants, water and sewage treatment plants, on-site interviews, site-level administrative data	In April–May 1991, prevalence of severe gastroenteritis among hospitalized children was 91% (Irbil), 78% (Kirkuk), 84% (Sulaymaniyah), and 38% (Baghdad). For the latter site, incidence increased from 17% to 35% relative to previous year. Prevalence of child malnutrition was found to be 32% (Baghdad), 57% (Irbil), 52% (Kirkuk) and 48% (Sulaymaniyah). Reported two- to threefold increase in hospital mortality. In health centres, consultations for gastroenteritis rose from 4 to 42 per day relative to previous year (Kirkuk). The share of patients with gastroenteritis rose from 18% to 55% in Kirkuk, from 3.6% to 17.7% in Baghdad. Visited hospitals (16) reported complete or partial lack of running water (8), major sanitation problems (11), electrical failures (5). Local authorities reported closure of 14 of 19 health centres in Basra, 37 of 42 in Irbil, 14 of 20 in Sulaymaniyah. All hospitals reported lack of laboratory reagents, materials for radiology, damage to associated equipment. All facilities reported drug shortages, allegedly started in the second half of 1990, including antimicrobials, anti-parasitic, anaesthetics, vaccines, intravenous fluids, insulin.	Destruction of energy generation capacity by bombings (23% of pre-war level in May 1991) and shutdown or destruction of water and sewage treatment systems, leading to polluted water supply. Both armed conflict (including post-war civilian uprising) and sanctions are mentioned as upstream causes.	

Table A6.1. Findings of non-core studies (*continued*)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
81 Heidari, Akbari qomi & Tavoosidana (2017)	UN sanctions (Jul 2006–Jan 2016), esp. Security Council Resolution 2231 (Jan 2016).	Islamic Republic of Iran			Short communication	No original research findings. The article refers changes in per capita use of the blood-clotting protein factor VIII, a treatment for haemophilia: mean per capita use was 1.6 international units (UI) before 2006; it decreased to 0.5 UI after sanctions were imposed, to then increase again at 2.7 when sanctions were lifted.		The numbers given are not clearly presented and related to the timing of sanctions.
82 Hosseini (2013)	Sanctions by the USA, UN and EU before the Joint Comprehensive Plan of Action (unspecified).	Islamic Republic of Iran			Report based on official data, government reports and published literature	Imported products constitute less than 4% of pharmaceutical sector output, but ~40% of its value. These include anaesthetics, plasma-derived anti-coagulants, treatments for cancers, emergency hypertension, heart failure. The number of pharmaceuticals reported as being in short supply increased from 88–78 in July–September 2012 to 147–160 in October–November, not falling below 120 for the whole period (ending September 2013). An SMS-based system providing public information on local drug availability receives approximately 20 000 monthly queries.	Shortages caused by higher transaction costs and administrative delays in approving international payments; overcompliance by international firms, fearing United States prosecution despite licensing.	No date on the figure for import shares of volume and value of pharmaceutical output.

Table A6.1. Findings of non-core studies (*continued*)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
83	Huertás et al. (1996)	United States embargo (Jul 1963–ongoing), esp. CDA (Oct 1992–ongoing)	Cuba		Correspondence	No original research findings. Huertás argues that, to achieve desirable political improvements in Cuba, the United States embargo is needed and should not be relaxed. Martin argues that adverse health outcomes in Cuba are due to Cuba's collectivist agricultural policies and excessive military spending, not to the United States embargo, which does not prevent Cuba from importing medical supplies from non-United States companies such as those in Europe and Japan. Kirkpatrick argues that the United States embargo restricts access to pharmaceuticals for Cuba, pointing out that half of newly patented pharmaceuticals that attained world-class status after 1975 are United States-made; quoting the case of 1 year waiting for an export licence to Cuba by a Belgian subsidiary of a United States company; the denial of a licence for X-ray replacement parts; and mentions WHO sources reporting higher prices for Cuba by non-United States vis-à-vis United States companies, suggesting higher costs or reluctance to give prices due to fear of reprisals by the United States Government. Chelala replies stressing the multiplicity of factors involved in Cuba's health problems, of which the United States embargo is a significant one.		Comments on Chelala (1996)

Table A6.1. Findings of non-core studies (continued)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
84	Kandela (1997a)	UN sanctions (Aug 1990–May 2003)	Iraq		Editorial	No original research findings. Salient observations in the narrative include shortages of pharmaceutical and medical equipment, supplementary employment among medical professionals, deteriorating quality of medical education due to lack of access to international literature, rise in infections due to disrupted garbage collection.		
85	Kandela (1997b)	UN sanctions (Aug 1990–May 2003)	Iraq		Editorial	No original research findings. The article mentions the release of a report by the Iraqi Government claiming 800 000 deaths attributable to sanctions since their imposition. The opinion of Iraqi health authorities is referred that, besides the lifting of sanctions, allowance of medical tourism by air travel would improve the situation.		The mentioned Government source is not referenced.
86	Karimi & Turkamani (2021)	United States sanctions (Nov 1979–ongoing), esp. measures reintroduced after withdrawal from the Joint Comprehensive Plan of Action (Aug 2018–ongoing)	Islamic Republic of Iran		Short communication	No original research findings. In the context of the current COVID-19 pandemic, sanctions are regarded as limiting imports and causing shortages or ventilators, protection and other exempted medical equipment, due to lack of access to financing facilities.		

Table A6.1. Findings of non-core studies (*continued*)

	Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
87	Keck & Reed (2012)	United States embargo (Jul 1963–ongoing), esp. CDA (Oct 1992–ongoing) and Helms-Burton Act (Mar 1996–ongoing)	Cuba			Commentary based on published sources	No original research findings. Health care policies in post-revolutionary Cuba are described, emphasizing the role of community-level primary health care. Together with the collapse of the former Soviet Union, the CDA is mentioned as a factor behind a temporary setback in population health. The authors stress continued policy commitment to population health under sanctions.		
88	Khanal, Mishra & DeYoung (2016)	India–Nepal border blockade (Sep 2015–Feb 2016)	Nepal			Correspondence	No original research findings. The letter expresses concerns over the cumulative effects of two earthquakes and a blockade at the Indian Border for population health in Nepal, which is imposing delays on imports of fuel and pharmaceuticals. A reply by Garfield stresses the known potential for mobilizing internal resources to ensure primary health care under sanctions, even at low income levels.		

Table A6.1. Findings of non-core studies (*continued*)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
89	Kheirandish, Rashidian & Bigdeli (2015)	United States, EU and UN sanctions targeting the Islamic Republic of Iran's banking system (unspecified)	Islamic Republic of Iran	Media-reported access to pharmaceutical	Descriptive statistics from time series of news media items.	Out of 371 included news media items, those classified as reporting a shortage were 145 (39%); those classified as raising concerns about availability without reporting a shortage were 129 (35%); and those classified as reporting no shortages or improved availability were 97 (26%). The number of relevant media reports increased throughout the observation period (2011–2013).	Despite the acknowledged possibility of reporting bias, the increase in reported shortages and concerns is deemed to be accurate and reflect shortages caused by sanctions.	No clear exposure period or variable is related to the outcome data presented. No search words and screening statistics are presented.
90	Kheirandish et al. (2015)				Literature review	No original research findings.		
91	Kirkpatrick (1996)	United States embargo (Jul 1963–ongoing), esp. CDA (Oct 1992–ongoing)	Cuba	Non-legal determinants of the availability of medicinal products	Report based on oral and written interviews with civil servants and staff of involved companies in 1993–1996	On-site inspections prescribed by the exemption system are reported to raise transaction costs for United States companies willing to export on Cuba. Companies also report administrative difficulties in obtaining licenses, and very serious legal penalties for terms violations. The risk of retaliation due to United States extraterritorial clauses is reported to have raised export prices of non-United States companies.		

Table A6.1. Findings of non-core studies (*continued*)

	Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
92	Kirkpatrick (1997)	United States embargo (Jul 1963–ongoing), esp. CDA (Oct 1992–ongoing)	Cuba			Commentary based on published sources	No original research findings. The article counters various claims made by the United States State Department about the health effects of the United States embargo. In particular, it is claimed that, due to implementation factors, exemptions for essentials fail to prevent significant additional costs – current and expected, monetary and non-monetary – for United States companies and subsidiaries willing to trade in food and drugs with Cuba.		
93	Kokabisaghi (2018)		Islamic Republic of Iran			Literature review	No original research findings.		
94	Kokabisaghi et al. (2019)	UN sanctions (Jul 2006–Jan 2016)	Islamic Republic of Iran	Share of research publications with foreign collaborator, annual number of publications		Pairwise correlation and Mann-Kendal trend test on time series of bibliometric indices	Between 2010 and 2017, the share of manuscript with international collaborators increased, after having declined from 1996 onwards. An insignificant correlation with GDP is interpreted as rejecting the hypothesis that the increase is only caused by efforts to access foreign funds due to declining domestic resources under sanctions. A statistically significant positive trend was also detected in annual number of publications in 1996–2018, but was reported to be absent for annual visibility of publications.		No definition of exposure period. Analysis of the determinants of international collaborations limited to univariate association. GDP likely a poor proxy for domestic research funds.

Table A6.1. Findings of non-core studies (*continued*)

	Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
95	Kumar (1998a)	United States sanctions against India (May–Nov 1998)	India			Short communications	No original research findings. Published in short sequence, the articles report on announced increases in public expenditure for health and welfare, but also for military purposes, after the imposition of sanctions; and on the deferred decision on three World Bank loans, eventually approved “thanks to a liberal interpretation of these loans as humanitarian aid” (Kumar, 1998b).		The figures quoted for public spending are all percentages and are thus insufficient to evaluate the real nature of these changes. It is also unclear whether they can be plausibly interpreted as a response to the sanction themselves. If accurate, the reported event highlights the role of definitions of concepts such as “humanitarian” and “essential” in creating room for bargaining over exemptions, and thus variation in the severity of sanctions.
96	Kumar (1998b)	See previous entry							
97	Kuntz (1994)	United States embargo (Jul 1963–ongoing), esp. CDA (Oct 1992–ongoing)	Cuba		Availability and price of food, basic commodities, pharmaceuticals and medical equipment	Report based on field observations, interviews with government and UN officials, health workers, ordinary citizens	The synergistic impact of the Soviet trade slump and the United States embargo led to rising import prices and shortages of hard currency, food, fuel, intermediate inputs for farming and pharmaceuticals, and medical equipment. Extensive adjustments at all levels of society and government, including food and health care rationing and promotion of breastfeeding, ensured adequate diet and health care provision. However, evidence of rising incidence of common infections, anaemia and low-birthweight children suggests a vulnerable situation and limited room for further coping.	Higher import prices due to higher transport costs; higher mark-ups; greater quality risks and inventory costs associated to larger shipments; licensing costs and retaliation risks faced by foreign companies.	No description of ethnographic context; only narrative reporting of observations. Concerning the relative contribution of sanctions and the Soviet trade slump on health outcomes, the authors write that “the embargo is not the only, or perhaps even the major, factor”.

Table A6.1. Findings of non-core studies (*continued*)

	Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
98	Lafta & Al-Nuaiimi (2019)	UN sanctions (Aug 1990–May 2003)	Iraq			Literature review	No original research findings.		Discussion partly based on FAO/NRI survey findings (Zaidi & Fawzi, 1995), later partly retracted (Zaidi, 1997), and ICMMS survey, the reliability of which has been questioned.
99	The Lancet (1995)	UN sanctions (Aug 1990–May 2003).	Iraq			Editorial	No original research findings. Findings in Zaidi & Fawzi (1995) are consistent with UN sources and field reports, pointing to shortages of medicines, rising morbidity and mortality, and decline in vaccine coverage. Attribution to war versus sanctions is difficult, and Iraqi civil servants may be deterred from revealing accurate information.		Discussion partly based on FAO/NRI survey findings (Zaidi & Fawzi, 1995), later partly retracted (Zaidi, 1997).
100	The Lancet (1996)	United States embargo (Jul 1963–ongoing), esp. CDA (Oct 1992–ongoing)	Cuba			Editorial	No original research findings. Brief note linked to Kirkpatrick (1996).		

Table A6.1. Findings of non-core studies (*continued*)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
101 Larijani (2016)	Sanctions by the USA, UN and EU before the Joint Comprehensive Plan of Action (unspecified)	Islamic Republic of Iran			Commentary based on published sources and official statistics	No original research findings. Unlike other noncommunicable diseases, diabetes care was not substantially impacted by sanctions. Higher transaction costs and currency devaluation increased import prices, consistent with observed increases in pharmaceutical expenditure in 2009–2013. However, unlike chemotherapy and immunosuppressants, diabetes medications were domestically produced, and local firms bypassed financial sanctions, ensuring continuing supply of intermediate inputs. Lifting of sanctions might facilitate transfer of medical technology, but also increase population exposure to dietary risks.		
102 Lee & Haines (1991)	UN sanctions (Aug 1990–May 2003).	Iraq			Commentary based on published sources	No original research findings. Having reviewed available evidence on post-war trends in mortality and risk factors, the authors conjecture that the share of civilian deaths will increase relative to the figure based only on direct warfare mortality.		

Table A6.1. Findings of non-core studies (*continued*)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
103	Legetic et al. (1996)	Sanctions by UN, EU and USA (May 1991– Jan 2001, with gaps)	The former state union of Serbia and Montenegro	Health-related outcomes	Hospitalization rate, annual primary health care visits	Descriptive statistics and uncontrolled comparisons from administrative data and cross-sectional household surveys	Between 1990 and 1992, in the former state union of Serbia and Montenegro hospitalizations per 1000 population declined by 15.68, annual primary health care visits per capita declined 3.52 to 2.07 for adults, 1.36 to 0.88 for women and 6.5 to 4.25 for children. Under sanctions (1994), in the two surveyed regions, 87.3% and 98.5% of households lived within 4km to the closest health facility, but 80% and 81.4% of households reported difficulties in obtaining some type of care, including treatment, diagnostics, emergency services and surgery. Main reported causes of difficulties were: lack of materials, lack of financial resources, lack of proximate facility.	Lack of pre-sanction baseline prevents obtaining an impact estimate.
104	Lyme (2012)	Sanctions by USA (Dec 2003 –ongoing), esp. Executive Order 13527 (Apr 2011) and followings; EU (May 2011 – ongoing); League of Arab States (Nov 2011); Turkey (unspecified)	Syrian Arab Republic	Prices and availability of essential goods, including food and pharmaceuticals	Qualitative analysis based on official documents, published sources, and interviews with diplomats, international and national development aid workers, and academics at distance or during field visits in Brussels, Damascus, Beirut and Ankara	Quoting primary sources, sanctions are deemed a contributing factor in documented shortages of medical equipment and pharmaceuticals, and in raising the price of basic staples such as wheat. Moreover, sanctions are thought to have contributed to a contraction of economic activity and higher inflation, leading to lower incomes in the general population.	Overcompliance with financial sanctions raising import costs of (otherwise exempted) food and medical items; trade sanctions leading to lower macroeconomic activity and higher inflation due to lower export demand.	Both the direct and macroeconomic effect of sanctions are confounded by the effects of armed conflict and modified by governmental decisions. In particular, “the indirect effects of the sanctions are highly intertwined with the conflict’s direct repercussions and thus highly difficult to isolate”.

Table A6.1. Findings of non-core studies (continued)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
105 Madani-Lavassani (2020)	United States sanctions (Nov 1979–ongoing), esp. measures reintroduced after withdrawal from the Joint Comprehensive Plan of Action (Aug 2018–ongoing)	Islamic Republic of Iran			Commentary based on published sources	No original research findings. Past episodes such as Iraq show that sanctions can have adverse impacts on population health, and motivate assessment of current episodes, including the Islamic Republic of Iran. Ambiguity of key terms in exemption systems create uncertainty that deters legitimate trade of exempted items. These effects, in addition to the ban from international banking infrastructure, are deemed responsible of documented shortages of pharmaceuticals, medical equipment and obstacles to international collaborations in medical research. Some reports focus on the impact of shortages of medication for haemophilia, anaesthetics and asthma on children. However, rigorous evidence on the causes of shortages is limited, and possible alternative factors must be considered, including misplaced government policies and biased reporting. International efforts to improve the exemption system are advocated.		Discussion partially based on the ICMIMS survey, the reliability of which has been questioned.

Table A6.1. Findings of non-core studies (*continued*)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
106	Marks (1999)				Commentary	No original research findings. Legal aspects of sanctions are discussed in light of the evidence of adverse health impacts and a low success rate. This body of evidence disputes both the effectiveness and "proportionality principle" of sanctions – whereby goals have to be measured expected undesirable side-effects. Neither the UN nor states have direct legal responsibility to protect foreigners who reside in their own countries from threats to their human rights stemming from sanctions. Responsibility also implies wilful intent, which is not easy to establish. Nevertheless, the evidence does point to sanctions being conducive to human rights violations, and steps are being made by some international actors to reform the instrument – consistent with some assumption of responsibility.		

Table A6.1. Findings of non-core studies (*continued*)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
107 Massoumi & Koduri (2015)	Sanctions by the USA, UN and EU before the Joint Comprehensive Plan of Action (unspecified).	Islamic Republic of Iran			Commentary based on published sources and interviews to medical professionals	No original research findings. Sanctions are held responsible for shortages of pharmaceuticals and medical equipment, with reallocation to alternative import markets associated with declines in product quality and limited by the exclusive holding of licenses of United States and European patented product by United States and European manufacturers. Quoted opinions of interviewed doctors include: the role of restricted international payments in causing drug shortages; lower quality of suturing material imported from non-sanctioning countries and manufactured domestically; reliance upon cheaper but older and riskier products; shortages of chemotherapy, anaesthetics and PET scanners.	Restrictions on international payments and overcompliance by foreign companies.	

Table A6.1. Findings of non-core studies (*continued*)

	Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
108	Maziak, Coutts & Fouad (2013a)	(unspecified)	Syrian Arab Republic			Correspondence	No original research findings. Comment on Sen et al. (2013). The authors criticize the study for presenting "a skewed analysis of threats to the health and wellbeing of Syrians", as the designation of sanctions as the cause of adverse outcomes mentioned in the article (currency devaluation, scarcity of electricity and essential drugs) is confounded by "a situation of all-out civil war". The targeting of health care facilities and workers by government military forces is mentioned as an overlooked factor.		
109	Maziak, Coutts & Fouad (2013b)	(unspecified)	Syrian Arab Republic			Correspondence	No original research findings. Correspondence on Al Faisal, Sen & Al Saleh (2012). The authors criticize the article claiming that no evidence and plausible mechanism is provided to ascribe a causal role to sanctions in the deterioration of population health in the Syrian Arab Republic. The omission of the role of Syrian government military forces is criticized.		
110	McCarthy (2000)					Short communication	No original research findings. The article is a brief summary of Morin & Miles (2000).		

Table A6.1. Findings of non-core studies (continued)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
111 Mehtarpour et al. (2020)	United States sanctions (Nov 1979–ongoing), esp. measures reintroduced after withdrawal from the Joint Comprehensive Plan of Action (Aug 2018–ongoing)	Islamic Republic of Iran		Elicited opinion on 5 guideline questions: "What do you think are the important international and external determinants that have influenced antimicrobial resistance in our country?"; "How did these factors affect (decrease or increase) AMR?"; "Have there been any that influenced the policies developed to combat AMR?"; "Has it been positive or helpful or has it had a detrimental effect on the policies that have been formed? How?"; "Which international actors and stakeholders have had a positive or negative impact on the AMR in our country? How?"	Thematic analysis on records of semi-structured face-to-face interviews with policy-makers, managers and academics from seven institutions working on antimicrobial resistance (Sample: 24 individuals)	Average length of interviews was 55 minutes. Interviewees were 13 men and 11 women. Seven sub-themes were identified on the two themes of international factors facilitating or hampering the control of antimicrobial resistance. Barriers to antimicrobial resistance attributed to sanctions include: a decline in international purchasing power to import laboratory supplies, and higher transaction costs on international orders; increased production, smuggling and black-market supply of low-quality and counterfeit equipment, raw materials and pharmaceuticals; higher production costs in meat production, incentivizing antimicrobials overuse in combination with government price controls; macroeconomic decline exerting pressure on safety standards; lower funding for control activities and research, in part due to de-prioritized prevention, disruption of international collaborations.		

Table A6.1. Findings of non-core studies (*continued*)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
112	Mohammadi (2013)	Islamic Republic of Iran			Short communication	No original research findings. The article reports opinions by Iranian professionals, including a former Health Minister, on the increase in prices and decrease in quantity of drugs for many chronic conditions. It is claimed that, while the Islamic Republic of Iran produces 90% of its drugs domestically, sanctions impede provision of intermediate inputs.		
113	Moret (2014)	(unspecified)	Islamic Republic of Iran, Syrian Arab Republic		Report based on interviews with EU, UN, and EU member state officials, analysis of EU documents and published sources	UN officials involved in aid delivery to the Syrian Arab Republic quoted stating that EU sanctions made it "more complicated, often more expensive [...] to procure hardware and supplies for essential services such as medical equipment and drugs".		Association between sanctions and adverse health outcomes mostly based on analogy from past episodes and media sources.

Table A6.1. Findings of non-core studies (continued)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
114	Morin & Miles (2000)				Editorial	No original research findings. Statement by the American College of Physicians – American Society of Internal Medicine. The statement recognizes difficulties in attributing adverse health impacts to sanctions; interprets existing studies as plausible evidence of morbidity and mortality that is preventable by modifying or lifting sanctions; suggests that harmful sanctions are contrary to the spirit of the International Covenant on Economic, Social and Cultural Rights; that law of warfare should apply to sanctions, including prohibition to target medical facilities and to obstruct supply of food and medicines. The statement supports the establishment of exemption systems, their management by competent third parties, the active provision of health-related goods if required, and continuous monitoring and assessment of sanction regimes.		Discussion partly based on FAO/NRI survey findings (Zaidi & Fawzi, 1995), later partly retracted (Zaidi, 1997).

Table A6.1. Findings of non-core studies (*continued*)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
115	Namazi (2013)	(unspecified)	Islamic Republic of Iran	Availability of pharmaceuticals and medical equipment	Interviews with import-export operators, manufacturers and distributors of pharmaceuticals and medical equipment	Sanctions lead to import shortages in these health inputs due to limited availability of trade services and of international currency. Diversion to China and India in addition to existing volumes is unfeasible for the patented products produced only by western companies, or prohibited by restrictions on input quality for domestic producers operating under licensing agreements with western companies. When diversion is feasible, anecdotal evidence suggests reduced product quality (lower effectiveness, greater side-consequences). Illegal smuggling and black market sales of drugs has emerged, increasing the circulation of counterfeited, damaged or expired medicinal products. The authors conclude that the "pronounced role of sanctions in creating shortages of life-saving medical supplies and drugs in Iran may have been unintentional, but it is also irrefutable".	Sanctions led to the exclusion of major Iranian trade banks from the Interbank Financial Telecommunication Society. The lack of legal certainty over exempted items and high penalties associated to violations deter many western providers of banking, insurance and shipping services from supporting western companies who applied for a licence to export exempted items into the Islamic Republic of Iran. As a result, trade is constrained by the limited capacity to handle orders by existing arrangements. Sanctions exacerbate international currency shortages in the Islamic Republic of Iran. Penalizing oil trade terms prevent the Islamic Republic of Iran to generate international currency from oil revenues. Western exporters respond to bottlenecks in trade services by curtailing credit lines to Iranian importers, so that current orders are mostly processed on cash-advance terms. The resulting increase in operating capital requirements of Iranian importers of finished products and intermediate inputs cannot be passed on consumers by raising prices, due to price cap policies for drugs. As a consequence, many companies have failed, while others have survived by cutting product quality. Surviving companies are either more productive, or better connected to gain preferential access to capital from the Government.	Only narrative reporting of qualitative findings.

Table A6.1. Findings of non-core studies (*continued*)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
116	Nasheit (2003)	UN sanctions (Aug 1990–May 2003); Iraq	IMR, MMR and neonatal mortality rate, prevalence of low birthweight	Average monthly number of laboratory examination and major surgical operations	Commentary based on published sources	No original research findings. In the 1990s, IMR, MMR, neonatal mortality rate and the prevalence of low birthweight all increased, while the average monthly number of laboratory examinations and major surgical operations declined.	Trends ascribed to sanctions.	Missing references for quoted data. Two other sources are mentioned, without its data being discussed: the surveys of Ascherio et al. (1992) and the UNICEF ICMMS survey (the reliability of the latter has been questioned).
117	Ogbonna (2017)	United States sanctions (Dec 2001–ongoing) and EU restrictive measures (Feb 2002–ongoing)	Zimbabwe	Development aid, public expenditure for health care and education	Long commentary based on published sources	No original research findings. The article argues that sanctions led to decreased health and educational expenditure by obstructing multilateral and bilateral aid, and by worsening macroeconomic performance. Rejections of loan applications by the International Monetary Fund and the African Development Bank, and discontinuation of aid programmes by selected EU countries, are mentioned.	Decrease in export earnings and international reserves contributing to worse macroeconomic performance and associated fiscal consolidation through social spending cuts. Reduced access to development finance and aid.	Virtually no evidence is provided to support the empirical claims about the impact of sanctions on macroeconomic activity. In particular, the hypothesis that any macroeconomic impact of sanctions “forced” the government to cut social expenditure is not assessed against the alternative hypothesis that the government did in fact enjoy sufficient room to pursue alternative fiscal consolidation policies not involving those cuts, but chose not to.
118	Parnham-Cope (1997)	United States embargo (Jul 1963–ongoing), esp. Helms-Burton Act (Mar 1996–ongoing)	Cuba	Self-inflicted injuries	Editorial quoting published sources	No original research findings. The article comments on the epidemic of self-inflicted injuries among Cuba detainees in Guantanamo Bay (Andrews et al., 1997), linking the strengthening of United States sanctions brought about by the Helms-Burton Act to worsened economic conditions in Cuba.	Worsening economic conditions leading to outmigration and concomitant United States immigration policy change towards Cuba	Concurs with Eisenberg (1997) in conjecturing a contribution of United States sanctions to the episode.

Table A6.1. Findings of non-core studies (continued)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
119	Peyravi & Ahmadi Marzaleh (2019)	United States sanctions (Nov 1979–ongoing), esp. measures reintroduced after withdrawal from the Joint Comprehensive Plan of Action (Aug 2018–ongoing)	Islamic Republic of Iran		Correspondence	No original research findings. The letter identifies sanctions as a factor limiting the transfer of financial resources during the flood that occurred in Mar 2019, affecting about 2 million people. Constraints mentioned include purchases by the Red Crescent Society, UN cash transfers to its field personnel, and in-kind contributions of dual-use items such as rescue vehicles.		
120	Popal (2000)	UN sanctions (Aug 1990–May 2003)	Iraq	Average daily nutritional intake; infant and under-5 mortality rates	Descriptive statistics based on administrative and survey data	Relative to average intake before sanctions (1988/1990), the daily ration has 65% less calories (from 3120 to 1093 kcal), 67.4% less protein (from 82.5 to 26.9 g), 10.8% less fats (from 75.3 to 22 g), 83.1% less calcium (from 467 to 79 g), and 68.5% less iron (from 26 to 8.2 g). A secular increase of infant and under-5 mortality under sanctions is reported.		No pre-sanction baseline for point estimates quoted. Some data is presented only in graphical forms and cannot be extracted. Data from the Ministry of Health is facility-based, subject to changes in facility use patterns and thus unlikely to be nationally representative. No source quoted for baseline nutrient intake and no time reference for nutrients intake from daily ration under sanctions. The quoted infant and under-5 mortality figures come from the UNICEF ICMMS survey, the reliability of which has been questioned.

Table A6.1. Findings of non-core studies (*continued*)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
121 Rezaee-Zavareh, Karimi-Sari & Alavian (2016)	(unspecified)	Islamic Republic of Iran			Short communication	No original research findings. Among Middle Eastern countries over the 1996–2014 period, the Islamic Republic of Iran ranks third for number of research papers and total citations in medicine, and fifth for h-index (data from a SCImago search). In light of these statistics, the performance of the Islamic Republic of Iran in terms of international collaborations in medical research is deemed poor, and ascribed to a multiplicity of factors – including sanctions. It is concluded that the lifting of sanctions could improve the situation.	According to the figures given in the article, the Islamic Republic of Iran ranks fourth in research collaborations in the sample, a result that is hardly different, and is in fact fully in line, with performance in terms of research output and impact. It is therefore unclear in what way the figures support the claim about the potential effects of sanctions.	
122 Román (1995a)	United States embargo (Jul 1963–ongoing), esp. CDA (Oct 1992–ongoing)	Cuba	Cases of neuropathy		Commentary based on published sources	No original research findings. The figures quoted point to an epidemic of neuropathy in Cuba in 1992–1993, with a total of 50 862 certified cases in Jan 1994. It is reported that the study was able to rule out exposure to neurotoxic and infectious agents as potential confounders, and that the most likely cause was identified in a deficiency of B vitamins, mainly thiamine. Vitamin B supplementation was found to be highly effective and, once scaled up to population, brought the epidemic to an end.	Dietary changes, mainly consisting in increased cane sugar consumption, are thought to be the likely mediator between, on the one hand, the economic crisis and embargo and, on the other hand, vitamin B deficiency leading to epidemic neuropathy. Suggested channels for the effect of sanctions are: higher import prices for feed and grains, laboratory equipment and reagents, materials for vitamin laboratory synthesis; severing of medical research collaborations and access to United States medical information.	The author writes: ‘Although the US economic embargo may not have been the primary cause of the epidemic in Cuba, it has contributed to its development, complicated its investigation and treatment, and continues to hamper its prevention’.

Table A6.1. Findings of non-core studies (*continued*)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
123	Román (1995b)	United States embargo (Jul 1963–ongoing), esp. CDA (Oct 1992–ongoing)	Cuba	Cases of neuropathy	Commentary based on published sources	No original research findings. The article summarizes evidence from published studies on the epidemiology, symptomatology and likely etiology of the epidemic. From the discovery of early cases in late 1991 to the eventual epidemic outbreak and remission after B-group vitamin supplementation in 1993 and 1994, total cases summed over 50 000. Patients displayed hearing and vision loss, “burning feet”, fatigue, weight loss, difficulties in locomotion, sleeping and concentration. Similar symptoms were observed among prisoner of war populations in the past.	Both analyses and successful treatment point to nutritional causes. These are in turn associated by the author to the double shock of Cuba’s “special period” crisis. The role of the United States embargo is evaluated as in Román (1995a): a contribution adding to existing adverse conditions.	
124	Román (1998)	United States embargo (Jul 1963–ongoing), esp. CDA (Oct 1992–ongoing)	Cuba	Cases of neuropathy	Commentary based on published sources	No original research findings. The article reports findings from published research about an epidemic of peripheral neuropathy in Cuba during 1992 and 1993, linking it with the economic crisis of the period and implicating the tightening of the United States embargo as a contributing factor.		The source closely tracks Román (1995a, 1995b).

Table A6.1. Findings of non-core studies (*continued*)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
125	Sahraian et al. (2021)	United States sanctions (Nov 1979–ongoing), esp. measures reintroduced after withdrawal from the Joint Comprehensive Plan of Action (Aug 2018–ongoing)	Islamic Republic of Iran	Self-reports on concerns on availability of treatment, treatment costs and clinical status.	Unadjusted odd ratios (logistic regression) on cross-sectional survey from 2 facilities (Sample: 1039 multiple sclerosis patients)	Among the 998 respondents for which an income figure is given, more than 73% had a monthly income below US\$ 250, contrasted with US\$ 55 of monthly treatment. The following percentages of respondents reported: concerns for past and future treatment availability (85.8, 93.6), the former significantly larger among women (OR 1.55, 95%CI: 1.04–2.33); concerns for past and future supply and purchase of foreign medicine (86, 89.2), for the effectiveness of domestic vs. foreign medicines (82%), for future replacement of international with domestic medicines (72.8), and more expensive with cheaper medicine (70.3) – the latter significantly higher among those with monthly income below US\$ 250 (OR 2.04, 95%CI: 1.50–2.77); unwillingness to continue treatment due to economic or psychological burden (41.4%, 42.9%), both significantly lower among women OR 0.54, 95%CI: 0.40–0.73; OR 0.73, 95%CI: 0.53–0.93 and the former significantly higher among those with monthly income below US\$ 250 (OR 2.02, 95%CI: 1.49–2.73); cost increases in laboratory services (81.3%), hospitalization (64%), facility physiotherapy (51.89%), home rehabilitation (38.52%), transport to facility (67.63%), psychological/psychiatric counselling (52.22), living costs (93.53%), and mobility aid (38.65) – the latter significantly less among women (OR 0.70, 95%CI: 0.51–0.96); stopping or diminishing own social (60.11%) or physical activities (66.82%); loss of job insurance (47.95%), significantly less among women (OR 0.45, 95%CI: 0.39–0.73); reduced nutrition quality (68.82%), significantly less among women (OR 0.69, 95%CI: 0.49–0.98) and among those with monthly income below US\$ 250 (OR 2.68, 95%CI: 1.99–3.60).	The absence of a pre-sanction baseline prevents obtaining an impact estimate. No information on sampling criteria.	

Table A6.1. Findings of non-core studies (*continued*)

	Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
126	Sansom (2004)	UN sanctions (Aug 1990–May 2003).	Iraq			Correspondence	No original research findings. Interviewed Iraqi health professionals are quoted mentioning shortcomings of health care, including the existence of only two cobalt machines for radiotherapy and no linear accelerator in the country, leading to 2–3 month-long queues; a Government policy of potentially arbitrary hoarding and testing of imported pharmaceuticals under sanctions; an increase in mortality from treatable cancers as a result of shortages in chemotherapy among patients who could not afford medical tourism in neighbouring countries; a decrease in the age of diagnosis for certain types of cancer. The report attributes the state of health care to sanctions and Government policy under sanctions, but also mentions a weak nursing culture reflected in insufficient resources and training. Improvements in drug availability after the 2003 United States-led invasion are attributed to initiatives by international nongovernmental organizations.		
127	Sato, Obeid & Brun (1991)	UN sanctions (Aug 1990–May 2003).	Iraq	Prevalence of underweight, stunting, wasting		Descriptive statistics from cross-sectional survey	11 months after the imposition of sanctions and 5 months after the end of armed conflict, prevalence of moderate-to-severe ($Z \leq -2$) and severe ($Z \leq -3$) malnutrition was 20.7% and 7.8% for stunting, 22.4% and 6.8% for underweight, 6.9% and 1.5% for wasting.		Absence of baseline data prevents obtaining an impact estimate. Unclear treatment of outliers; no adjustment for mortality selection.

Table A61. Findings of non-core studies (*continued*)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
128 Sen (2014)	(unspecified)	Syrian Arab Republic			Correspondence	No original research findings. The letter argues that credible reports of child deaths due to malnutrition in conflict-affected areas, together with a sceptical literature on the effectiveness of sanctions, call into question the current foreign policy stance of western countries.		
129 Sen, Al Faisal & AlSaleh (2013)	(unspecified)	Syrian Arab Republic			Descriptive statistics based on government sources, UN agencies and online sources	Similar content to Al Faisal, Sen & Al Saleh (2012). See entry.		
130 Setayesh & Mackey (2016)	Sanctions by the USA, UN and EU before the Joint Comprehensive Plan of Action (unspecified)	Islamic Republic of Iran		Reported shortages of pharmaceuticals	Descriptive statistics from published sources	Reports of shortages were found for 73 pharmaceuticals; 32 were included in the WHO essential list in 2015; 65 were primarily indicated for noncommunicable diseases, the main cause of death in the country; three were not covered by exemptions to United States sanctions.	Shortages attributed to imperfect exemption systems, including restrictions on shipping and trade insurance.	No clear time period attached to the figures. No comparison of reported shortages across time. No comparison of characteristics with pharmaceuticals not in shortage.
131 Shahabi (2015)	(unspecified)	Islamic Republic of Iran			Short communication	No original research findings. The article is a letter expressing concerns about the adverse impact of sanctions on the Islamic Republic of Iran's National Cancer Control Program. It points to "a serious shortage of cancer drugs in the nation" and argues that "there can be no improvement in the status of the NCCP" until sanctions are lifted.		

Table A6.1. Findings of non-core studies (*continued*)

	Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
132	Shahabi et al. (2015)	United States and EU sanctions against Central Bank of Iran (unspecified).	Islamic Republic of Iran			Commentary	No original research findings. Sanctions, especially those targeting banking and oil exports, imposed by the USA, EU and other countries, led to accelerating inflation and subsequent macroeconomic contraction. Large currency devaluation worsened terms of trade in pharmaceutical imports and led to higher pharmaceutical prices, even as the consumer price index declined during recession. Given the large share of health expenditure met out-of-pocket, rising prices of pharmaceuticals, especially for chronic diseases, directly affect the ability of households to use medications. Sanctions against the oil trade might also have increased reliance on low-quality fuel for cooking and vehicles, leading to greater exposure to carcinogenic pollutants.	Declines in purchasing power for pharmaceuticals due to macroeconomic contraction and supply constraints on the pharmaceutical market due to currency devaluation.	

Table A6.1. Findings of non-core studies (continued)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
133 Shahabi et al. (2020)	United States sanctions (Nov 1979–ongoing), esp. measures reintroduced after withdrawal from the Joint Comprehensive Plan of Action (Aug 2018–ongoing)	Islamic Republic of Iran		Expert opinion on the status of physical rehabilitation services	Thematic analysis on records of semi-structured face-to-face or telephone interviews with health policy-makers, researchers and registered practitioners with prolonged experience on physical rehabilitation (Sample: 37 individuals)	Four themes and 12 sub-themes were identified. Socioeconomic challenges, including: shrinking government revenues and expenditures; higher inflation, pushing up costs and leading insurance companies to remove services; higher unemployment, reducing insurance premiums, increasing reimbursement delays, and increasing the risk of catastrophic expenditures; precarious employment situation of practitioners. Educational challenges, including: barriers to international collaborations, events and publications; shortages of funding for training materials. Service delivery challenges, including: shortage or quality decline of raw materials and spare parts for prostheses and medical equipment; lack of maintenance of infrastructure; limited access to foreign financial assistance; declining third sector activity. Mentioned mitigating responses included innovations by indigenous knowledge-based companies.		

Table A6.1. Findings of non-core studies (*continued*)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
134	Sidel (1999)				Commentary based on published sources and UN documents	No original research findings. The author argues that, to the extent that fundamental human rights constitute obligations towards the international community, measures to enforce them against violations are only legitimate if, in addition to UN authorization, they do not themselves violate those rights. This principle requires that economic sanctions be designed to safeguard trade in essential goods, target political elites and operate continuous monitoring of living standards in target countries.		
135	Smith & Zaidi (1993)	UN sanctions (Aug 1990–May 2003).	Iraq	Prevalence of malnutrition (underweight, stunting, wasting).	Descriptive statistics from cross-sectional survey	Prevalence of moderate and severe malnutrition ($Z < -2$) at 21.8% for stunting, 11.9% for underweight, 3.4% for wasting. Prevalence of severe malnutrition ($Z < -3$) at 7.3% for stunting, 2.3% for underweight, 0.4% for wasting. Inverse U-shaped age distribution of moderate and severe malnutrition: stunting peaks among children 18–23 months (38.5%), underweight and wasting among children 12–17 months (18.4% and 6.1%). Malnutrition inversely correlated with maternal education, highest in northern region. No significant differences across gender and urban/rural lines. Reported presence of diarrhoea associated with stunting (RR: 1.8, 95% CI: 1.5, 2.2); underweight (RR: 2.1, 95% CI: 1.6, 2.7) and wasting (RR: 1.5, 95% CI: 0.9, 2.4).	The authors note that the prevalence of stunting peaks among children who were 6–11 months old when sanctions were imposed, and suggest the peak might reflect acute malnutrition during weaning for the cohort, due to sanctions.	Data from subsample of Ascherio et al. (1992). Absence of baseline data prevents obtaining an impact estimate. Uncertain adjustment of sampling frame for population displacement. No clustering of standard errors. No adjustment for mortality selection on both children and mothers.

Table A6.1. Findings of non-core studies (*continued*)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
136 Spagat (2010)	UN sanctions (Aug 1990–May 2003).	Iraq	Under-5 mortality		Commentary based on published sources and secondary survey data	No original research findings. Partial retraction after on-site verification, and stark contrast with surveys fielded after the fall of the Iraqi regime are suggestive of survey fraud for the FAO/NRI and ICMMS surveys respectively. Often quoted claims of half-million excess child deaths due to sanctions, based on those surveys, are thus unsupported.		
137 Sponeck (2002)	UN sanctions (Aug 1990–May 2003).	Iraq			Commentary based on published sources	No original findings. The author traces the failure to prevent adverse health outcomes of sanctions to lack of clarity on UN legal accountability, vagueness in sanctions resolutions, and the absence of a sanctions monitoring system. Measures to remedy those gaps are proposed.		
138 Stix (1995)	United States embargo (Jul 1963–ongoing), esp. CDA (Oct 1992–ongoing)	Cuba			Editorial	No original research findings. The article discusses the outbreak of neuropathy in Cuba during 1992–1993 and the following campaign to advocate the lifting of sanctions on food and medicines by various health workers and organizations.		
139 Takian et al. (2020)	United States and EU sanctions (unspecified)	Islamic Republic of Iran			Correspondence	No original findings. The letter argues that, in the current COVID-19 epidemic, “the detrimental effects of sanctions have reduced access to life-saving medicines and equipment”.		

Table A6.1. Findings of non-core studies (*continued*)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
140	Velayati, Jamaati & Hashemian (2015)	United States sanctions (unspecified)	Islamic Republic of Iran		Correspondence	No original research findings. The letter announces the establishment of a non-profit organization to seek opportunities for procurements of chemotherapy drugs that are in short supply in the Islamic Republic of Iran.		
141	Wakai (2000)	UN sanctions (Aug 1990–May 2003).	Iraq		Correspondence	No original research findings. The letter mentions findings from Ali & Shah (2000), and advocates the lifting or relaxation of sanctions.		Findings quoted are based on UNICEF ICMMS survey, the reliability of which has been questioned.
142	Wareham (2000)	UN sanctions (Aug 1990–May 2003).	Iraq		Editorial	No original research findings. Personal recollection of field visit in Iraq. Salient observations include: shortage of drugs and surgical supplies in visited hospitals; an increase in cases of major infections reported by doctors at Saddam Paediatric Hospital in Baghdad; blocked and broken sewerage pipes in visited hospitals; lack of access to foreign handbooks reported by doctors at Baghdad's University College of Medicine; an increase in the incidence of child leukaemia and congenital abnormalities, especially in southern Iraq, reported by various doctors.		Discussion partly based on UNICEF's ICMMS survey, the reliability of which has been questioned.

Table A6.1. Findings of non-core studies *(continued)*

Reference		Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
143	Weeramanthri et al. (2001)	United States embargo (Jul 1963–ongoing), esp. CDA (Oct 1992–ongoing)	Cuba			Short communication	No original research findings. The article is a letter that relies on secondary sources to argue that the United States embargo adversely impacts population health in Cuba, although the resilience allowed by the local health care system is also mentioned.		
144	WHO (2002)		Various countries	Child mortality, prevalence of chronic child malnutrition.	Availability of health care inputs, restriction of travel for health care workers and patients.	Commentary based on published sources, national statistics and reports by UN agencies.	No original research findings. In Iraq, the Gulf War and the parallel UN sanctions led to a deterioration in many health indicators, including child mortality and the prevalence of child malnutrition as measured by multiple anthropometric indicators. In Afghanistan, the freezing of government assets and the ban on flights of the national company implemented by UN sanctions in 1999 had repercussions on the wider society. Humanitarian efforts were restricted due to rioting after the imposition of sanctions. The Indira Ghandi Paediatric Hospital in Kabul had its air-based drug supply channel cut due to the flight ban. Sanctions contributed to currency devaluation. Isolating the contribution of sanctions is made difficult by the coexistence of long-standing armed conflict and instability, a picture further compounded by a devastating drought in 2000. UN sanctions imposed against Libya in 1992 froze government assets and banned travel. A UN mission later reported shortages of essential drugs and vaccines, spare parts, denial of transportation abroad for the critically ill; delays in sourcing blood products, serums, laboratory reagents and termination of contracts or entry denials for health workers. No quantification of the impact has been made.	It is suggested that, in Iraq, the impact of sanctions worked both through supply constraints to essential health inputs such as drugs and vaccines, and through general-purposes goods and services with important applications in health systems such as fuel, energy, mechanical spare parts and chemicals of various type.	

Table A6.1. Findings of non-core studies (continued)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
145 Yamada et al. (2006)	UN sanctions (Aug 1990–May 2003);	Iraq			Commentary based on published academic and media sources	No original research findings. Discussing the role of the media in communicating the impact of war and sanctions on civilians, the findings of Harvard Study Team (1991), Ascherio et al. (1992), and Ali & Shah (2000) are quoted.		Discussion partly based on UNICEF's ICMMS survey, the reliability of which was later questioned.
146 Yoon et al. (2019)	Sanctions by UN and USA (unspecified)	Democratic People's Republic of Korea		Characteristics of medical research articles	Chi-square and Mann-Whitney U test on time series of bibliographic data (Sample: 775 articles from 28 issues of one medical journal, selected at 5-years interval from 1985 to 2005)	The proportion of articles classified as "conventional therapies: medication" decreased from 25.3% in the two years 2000 and 2005 to 15.6% ($p < .05$); articles classified as "diagnosis" decreased from 41.3% to 13.9% ($p < .001$); articles classified as "nonconventional therapies: alternative medicine" increased from 6.7% to 57.2% ($p < .001$). No significant change for categories "conventional therapies: surgery", "nonconventional therapies: traditional medicine".	Shortages of pharmaceuticals are proposed as a potential cause of changes in research on medication and alternative medicine, while the decrease in focus on traditional medicine is taken to reflect long-run policies to integrate traditional medicine in the health care system.	Both descriptive statistics and significance tests are reported only for some of the categories, and no justification is provided for this choice. An additional comparison is reported for international aid volume, but the study contain no clear discussion of aid, nor hypotheses about aid. Hence, the result is not considered.

Table A6.1. Findings of non-core studies (*continued*)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
147	Younis & Aswad (2018)	UN sanctions (Aug 1990–May 2003)	Iraq	Prevalence of PTSD, anxiety and depressive disorders	Attendance in outpatient clinics, psychiatrist density	Descriptive statistics from published literature in the 1990–2003 period.	Retrieved findings include: shortage of psychiatric drugs, closure of a facility, and cases of deaths due to neglect and lack of staff in psychiatric hospitals; an increase in attendees of outpatient clinics from 197 000 to 220 000 to 507 000 in 1990, 1994 and 1998, respectively; a prevalence of PTSD of 10% in the general population (2005 and 2006 sources), between 24% and 57% in a 2003 sample of Baghdad schoolchildren exposed to bombing in 1991; 87% and 20% in two samples of Kurdish children exposed to military operations; in a facility in Baghdad, a prevalence of anxiety and depressive disorders of 18.9% and 16% (10 101 patients) in 1993, rising to 33.4% and 22.2% (1315 patients) in 2003; an estimated decrease in psychiatrists per 100 000 population from 0.5 'before sanctions' to 0.1 in 1998.	No baseline reporting of key characteristics for many studies, and ambiguous relationship with sanctions for all findings reported.
148	Yousefi et al. (2019)	United States, UN, EU sanctions before the Joint Comprehensive Plan of Action, especially National Defense Authorization Act (Jan 2013) and Iran Threat Reduction and Syria Human Rights Act (Aug 2012)	Islamic Republic of Iran	Inflation in pharmaceuticals and health commodities. Reported pharmaceuticals in shortage	Focus group on policies to improve access to pharmaceuticals (Sample: 5 operators at Iran Federal Drug Administration) and descriptive statistics from administrative data	In 2014 and 2015, average annual inflation in pharmaceutical commodities was, respectively, 19% and 13% lower than in overall health commodities. Price reductions in pharmaceuticals in the 2 years is reported to have led to US\$ 350 million. Out-of-pocket expenditure in pharmaceuticals targeted by insurance subsidies decreased 45% during 2013–2015. Reported number of pharmaceuticals in shortage declined from 270 (2012) to 170 (2013) and 30 (2014, 2015, 2016).	Declines in prices and shortages attributed to mitigation policies, including simplified custom clearance for medicines; priority to IFDA in central bank foreign currency allocations; health insurance subsidies for selected conditions and patients at risk of catastrophic expenditure; tariffs and quotas on imported items with domestic counterpart; reformed inventory management; price controls based on parallel imports and tendering.	No baseline give for the reported price reduction. No policy implementation time.

Table A6.1. Findings of non-core studies (*continued*)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
149 Yazdi-Feyzabadi et al. (2020)	United States sanctions (Nov 1979–ongoing), esp. measures reintroduced after withdrawal from the Joint Comprehensive Plan of Action (Aug 2018–ongoing).	Islamic Republic of Iran			Commentary based on published sources	No original research findings. Channels of the health impact of sanctions are mentioned, including macroeconomic effects on currency exchange, inflation and unemployment, lowering the availability of, and public and private expenditure on, health care services, pharmaceuticals, and medical imports. These effects are related to the Social Determinants of Health framework, and deemed to impact all its three main components: socioeconomic-political context, structural factors and intermediary factors. A health diplomacy approach is proposed as a mechanism of dispute resolution alternative to sanctions.		

Table A6.1. Findings of non-core studies (*continued*)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
150 Zadeh-Cummings & Harris (2020)	Sanctions by the UN (Oct 2006–ongoing) and the USA (unspecified)	Democratic People's Republic of Korea		Expert opinion on operational outcomes in humanitarian action	Report based on UN documents and reports by nongovernmental organizations, local and international media sources, and semi-structured interviews with operators from 8 relief agencies (Sample: eight individuals)	Four themes are identified from the interviews. Problems with exemption systems. For United States sanctions, these included large legal costs, and long/unreliable processing times in licensing, and ambiguity of rules such as prohibition of collaboration with government personnel. For UN sanctions, uncertainty over the extent of disclosure of non-sanctioned items in licence applications. Problems with third parties under United States secondary sanctions, including blocked international bank transfers, refusal of banking services due to overcompliance, higher transaction costs charged by suppliers. Problems with sanctioning governments, including sequestering of exempted items at customs, evidence of political influence on licensing. Distorted incentives and deterrence on humanitarian action, as some agencies adapt programmes to minimize the mentioned barriers, while others are discouraged into expanding operations in the country.		

Table A6.1. Findings of non-core studies (*continued*)

Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
151 Zaidi (1994)	UN sanctions (Aug 1990–May 2003)	Iraq (Baghdad, Saddam City district)	Prevalence of under-5 malnutrition (underweight, stunting, wasting).		Descriptive statistics from panel survey.	Between baseline (August 1991) and follow-up (Nov 1993), moderate-to-severe malnutrition increased 16% to 30% (stunting), 9% to 35% (underweight), and 2.2% to 16% (wasting).	Effect attributed to sanctions; independent of previous armed conflict.	Follow-up of a subset of eight clusters of Ascherio et al. (1992). Uncertain adjustment of sampling frame for population displacement. No clustering of standard errors. Unexplained limitation of comparison to six of the eight clusters sampled. No pre-sanction baseline, or measure of cumulative exposure. Attribution of impact to sanctions assumes cumulative exposure and no lagged confounding or effect modification due to armed conflict.
152 Zakavi (2019)	United States sanctions (Nov 1979–ongoing), esp. measures reintroduced after withdrawal from the Joint Comprehensive Plan of Action (Aug 2018–ongoing)	Islamic Republic of Iran			Short communication	No original research findings. The article argues that newly imposed United States sanctions are likely to affect adversely the provision of nuclear medicine diagnostics and treatment, through an increase in the risks and costs associated with the import of intermediate inputs in the production of radiopharmaceuticals.		

Table A6.1. Findings of non-core studies (*continued*)

	Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
153	Zartab et al. (2020)	(unspecified)	Islamic Republic of Iran		Health expenditure, market shares of pharmaceutical companies, pharmaceutical sales and import volumes	Descriptive statistics from government sources	Health expenditure as a share of GDP remained constant over the 2001–2016 period, despite large GDP fluctuations. The out-of-pocket component increased after 2012, mirroring a falling Government share. Among the top six holding groups in the pharmaceutical sector, three were private and three state-owned, with market shares going from 17.5% to 5.3%. Among the top 10 domestic pharmaceutical producers in 2016, four were private and six state-owned, and none had a marked share above 5%, adding up to 34.98%. Among the top 10 importers, all private, market share ranges from 18.83 to 2.31, adding up to 70.76%. Pharmaceutical sales grew from 2008 to 2012, declined in 2013 and recovered in 2016, with recovery driven by consumption of domestic products. The annual and compound growth of the market were 48.67% and 21.93% before and 20.49% and 9.77% after sanctions, respectively. The analogous rates for imports were 45.79% and 20.75% before and 9.54% and 4.66% after sanctions.		No definition of exposure period for the outcome presented.

Table A6.1. Findings of non-core studies (*continued*)

	Reference	Type of economic sanctions	Country focus	Health-related outcomes	Health system outcomes	Methods	Main findings	Evidence (or suggestion) of modification or mediation	Comments
154	Zolotarev et al. (2020)			Annual medical publications; clusters in networks of authors; research institutions and countries	Annual medical publications; clusters in networks of authors; research institutions and countries	Descriptive statistics and network maps on bibliometric data (Sample: not shown)	Publications retrieved for dimensions searches "Sanctions of Iranian Scientists" and "Economic Sanctions of Iranian Medicine and Health Science" show a positive time trend, and an anomalous peak in 2014. Mental maps of selected sub-samples of publications from the latter search show a high degree of fragmentation and isolation of scholars, little overlap in quoted sources, five country clusters of research collaborations, and six organization clusters. Publications retrieved for a PubMed search of Iran-affiliated authors show a growing trend until 2011, followed by large decline and subsequent stagnation. Publications retrieved for a PubMed search "Economic Sanctions" show a first wave of sources in the 1990s and a second wave of sources from the mid-2000s onwards. A mental map of the last search included 54 terms organized in five clusters.		The 2014 peak in items retrieved in two searches is attributed to relaxed United States sanctions, but no reference to a specific measure is given.

