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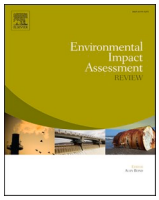

Quantitative health impact assessment methodology for societal initiatives: A scoping review

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ABSTRACT

Health initiatives are increasingly situated outside the institutionalised public health sector. The intersectoral character of societal initiatives, along with indirect relationships between initiatives and health, makes making projections of reach, impact and goal achievement complex. This scoping review of the peer-reviewed literature searches for appropriate methods to conduct quantitative health impact assessment for such initiatives. Database searches were done in PubMed and Web of Science, as well as a reference list search. Studies were then selected in a systematic manner. The review includes 64 studies. Most studies made estimates using simulation methods, notably with Monte Carlo, Markov and system dynamics modelling. Inputs for the models such as transition probabilities and price elasticities were taken from census, register and survey data, evidence from previous (scientific) studies and sometimes outcomes from stakeholder participation. Of different health outcome measures, the number of deaths was most frequently used, followed by QALYs and DALYs and life years. Health effect distribution is frequently mentioned, but not often estimated. Scientific methodological publications on HIAs focusing on civil society initiatives are relatively sparse, indicating possibilities for further methodological advancement. Estimating health effect distributions and incorporating stakeholder participation could make meaningful additions to standard practice.

1. Introduction

The World Health Organization's (WHO) Adelaide statement from 2010 (World Health Organization and the Government of South Australia, 2010) explicitly emphasises that health effects do not originate exclusively from the institutionalised public health policy sector, but are instead very dependent on activities from almost all other sectors. There is growing awareness and knowledge that health and health problems are inextricably connected to social, environmental and structural conditions in society and in the direct settings where people live, work, study and play (Wilkinson and Marmot, 2003). This is also illustrated by Dahlgren and Whitehead's 'rainbow model' (Dahlgren and Whitehead, 1991). However, understanding of the (often indirect) interactions between health and social issues is still limited. To effectively influence these settings and conditions in favour of health, insight into other kinds of collective action additional to governmental policies and health service interventions is needed. In the past decade, across different countries, we have witnessed the rise of programmes and platforms enhancing collective initiatives for health. Sometimes these receive financial grants under public, private philanthropy, or public-private schemes, such as '*Investir pour l'avenir*' (Quebec en forme, 2002–2017; now privatised as 'M361') (M361, 2020), '*Building Healthy Communities*' (The California Endowment, 2010–2020) (Rosen et al., 2018), the '*Healthy Carolinians Micro-Grant Project*' (US Department Of Health and the State of Northern-Carolina, 1991-2001-now) (Bobbitt-Cooke, 2005), the UK '*Public Health Responsibility Deal*' Programme (2012–2016) (Bryden et al., 2013), and the Dutch governmental programme '*All about Health*' (2014-now) (Bekker et al., 2017).

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In this review, we focus on a particular sort of activities to which we refer with the term *societal initiatives*, which comprises a wide range of interventionist policies, programmes and activities. We define 'societal initiatives' as: 'bottom-up social innovations taken by civil society actors and organisations to enhance the health of their constituents in collaborative networks across domains and sectors, in non-hierarchical partnership, and with a focus towards experimenting, learning and adapting their practice to improve health'. This definition is derived from the concept of civil society organisations as organisations "that are autonomous, that are not wholly of the state, market, or family, and that work with or for a given constituency that can be identified" (Greer et al., 2017, p. 10). Social innovations result from network explorations of interdependencies, contextual needs and capacities, or by a general discomfort with existing systems of regulation, funding and fragmented responsibilities that do not address the complex interrelatedness of health problems. They often start up small scale. Examples of the societal initiatives we study are schools and employers that implement voluntary lifestyle and vitality programmes into their operational processes that go beyond directly work or study related health problems, health services and financial debt assistance programmes that join efforts to relief chronic stress in families, and nature organisations and urban planning developing tiny forests and other green facilities in urban neighbourhoods (Bekker et al., 2018).

Although there is a continued call for accountability on effectiveness and efficiency in these programmes, evaluation is difficult due to the long-term scope and complex interconnectedness of health initiatives. Especially in earlier stages of development, when initiators and network partners are still exploring issues, commonalities, capacities, ideas and interdependencies (Bekker et al., 2017), health impact assessment of potential benefits seems more appropriate and feasible than retrospective or concurrent evaluation. The goal of this paper is to provide input for the methodological development for quantitative assessment of health impacts from societal initiatives as defined here. The research question of a scoping review should be broad and open and is meant to help identify as much of the relevant scientific literature as possible (Arksey and O'Malley, 2005). This paper does not aim to reflect the scope of the HIA practice area but rather zooms in on the scientific literature on innovative methods and techniques for the prospective assessment of health impacts from societal initiatives on determinants outside the scope of the regular healthcare system. As such, our resulting research question can be formulated as: *which methods are suited to quantitatively assess the health impact of societal initiatives?*

1.1. What is health impact assessment?

HIA began to attain popularity in the 1990s. Early mentions originate from environmental studies, which started to include health impacts that resulted from environmental determinants (Case et al., 1977; Hamilton and Manne, 1978). Today, the term 'health impact assessment' comprises a broad range of methods and it can be and has been done in myriad ways. It is typically, but not exclusively, conducted for interventions outside the health sector (Veerman, 2007), which is also the domain of societal initiatives. HIA can be done as a standalone assessment or as part of a broader assessment, such as environmental and/or social impact assessment. The International Association for Impact Assessment states that "[t]he main objective of HIA is to apply existing knowledge and evidence about health impacts, to specific social and community contexts in order to develop evidence-based recommendations that inform decision-making. This is done in order to protect and improve community health and wellbeing" (International Association for Impact Assessment, 2020).

In the early days of HIA, Scott-Samuel described it as "the estimation of the effects of a specified action on the health of a defined population" (Scott-Samuel, 1998, p. 704). One of the most commonly-used definitions is the consensus definition formulated by the WHO, defining HIA as "a combination of procedures, methods and tools by which a policy, programme or project may be judged as to its potential effects on the health of a population, and the distribution of those effects within the population" (World Health Organization, 1999, p. 4). Following this definition, an HIA includes at least a substantiated appraisal – not necessarily a quantified one – of potential health effects of some kind of policy or other intervention on a chosen population. However, this definition is too broad to be clear on what precise set of procedures, methods and tools is meant and does seem to leave some room for discussion on what HIA is and what it is not. Often several distinct procedural steps are mentioned, usually along the lines of "screening, scoping, assessment, decision-making and recommendations, and follow-up" (Harris-Roxas and Harris, 2011, pp. 396–397).

HIA is intended to estimate positive and negative health impacts from (not necessarily health) policies and projects and is meant to inform and facilitate policy makers, with the goal of providing evidence to improve their decision-making (International Association for Impact Assessment, 2020; Bekker, 2007). This is done in a prospective manner (Birley, 2013); as it is only possible to make decisions on future actions. HIA has to make projections regarding *future* health consequences of possible decisions, for "where there is no decision to be made there is no HIA" (Kemm, 2013, p. 5). An HIA in this view does not have to be explicitly called HIA in order to qualify as such, as long as it adheres to the requirements.

Bhatia et al. (2014) maintain a stricter view and propose a list of eight minimum elements that a study must contain in order to be called HIA. This view is partly very similar to the requirements mentioned above, but also requires a study to include stakeholder involvement and to consider impacts on health equity in order to qualify as HIA. O'Mullane and Harris-Roxas (2015) consider these minimum elements and regard them as being meant as minimum elements, but also as guidance of good practice. They also stress the importance of not evaluating HIA based on unrealistic standards. Furthermore, they themselves present a list of six essential components, which do not include stakeholder involvement or health outcome distributions, but are more focused on practical standards, good documentation, clarity, and transparency.

For the purpose of conducting this review, we used a broad view of HIA, as prospective research that projects health impacts that can help policy makers with making a decision. We have done so in order to not exclude studies based on the ongoing discussion of what constitutes HIA. Our approach to HIA in this review is consistent with the 'social view on HIA' as proposed by Harris-Roxas and Harris (2011).

In more general research-methodological terms, HIA can be done both in a qualitative and quantitative way. The distinction between the two lies not in the inputs that a study uses, but in its outputs. Both qualitative and quantitative HIA can make use of qualitative methods and data (for example stakeholder input), but quantitative HIA generates estimations of the magnitude of impacts (Bhatia and Seto, 2011), whereas qualitative HIA offers an intersubjective narrative interpretation of the assessed impacts in context. They can be and are both used to help decision makers make informed choices. By estimating impact sizes, policy makers are provided with information that can help them discern main issues from details and make judgments about how resources can be best used in order to improve public health (Veerman, 2007). Such information often receives more attention from policy makers (O'Connell and Hurley, 2009). In this review, as we wish to explore methods that are used to estimate impact sizes for societal initiatives, we focus on quantitative HIA. This does not exclude the use of qualitative methods.

1.2. Developments in quantifying HIA

Since 2000, the attention for quantitative HIA has been steadily growing. Two reviews have been conducted, one by Veerman et al. (2005) and one by Bhatia and Seto (2011). Veerman et al. (2005) specifically note that there are opportunities in the development of methods

for quantitative HIA for both socioeconomic and behavioural determinants. Similarly, more user-friendly simulation models, summary measures, expert opinions, and validity and reliability checks could strengthen methodological practice. In their review on quantitative HIA in the US, Bhatia and Seto (2011), partly building on the review by Veerman et al. (2005), concurred that research on the impacts from economic instruments (such as taxes and subsidies) present distinct opportunities. They also noted that even though "HIA is concerned with the distribution of health impacts and impacts on health equity (…) no HIA examined in our review provided quantitative estimates of the distribution of health impacts" (Bhatia and Seto, 2011, p. 307). Both reviews agree that in predictive models there is inherent uncertainty and it is often not feasible to validate estimated outcomes with real outcomes. Also, in some cases in which quantification is not feasible it may best to rely on robust qualitative HIA instead, but that quantified HIA methodology still has much room for improvement (Bhatia and Seto, 2011; Veerman et al., 2005). Our scoping review differs from the other reviews as its main focus is on societal initiatives and it has special attention for the different sorts of methodological approaches that are used for building simulation models on different levels.

Quantitative HIA can be seen as having two parts: the first focuses on the relationship between the (proposed) policy changes and the determinant(s) of interest, the second on the relationship between determinant(s) and health outcomes (Veerman et al., 2005). In some cases, researchers and decision makers are also interested in the economic outcomes of a considered policy option. Different methods for estimating economic outcomes can be used, but all these methods share the necessity of having to estimate quantitative health outcomes first (Lorgelly et al., 2010). Economic evaluation could subsequently add a third part connecting the expected health outcomes to economic outcomes. In some instances, HIA could in practice be the same as economic evaluation without the economic component (Veerman, 2007). Note that this would apply only to economic evaluations that are done prospectively, as HIA is a prospective approach. Lhachimi et al. (2010) and Fehr et al. (2016) have compiled overviews of practical modelling software tools that are being or have been used. This is beyond the scope of our article, but researchers who wish to explore HIA modelling software should find these reviews very interesting.

2. Methods

In conducting this study, we built on scoping review methodology as proposed by Arksey and O'Malley (2005), Levac et al. (2010) and Peters et al. (2015) in order to show existing approaches and problems in an attempt to illustrate the current state of the field. We have extended the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram from Moher et al. (2009) so it allows for the extra step of selecting literature based on article titles and abstracts separately.

2.1. Systematic search

We established search queries (Table 1) to identify possibly relevant studies in PubMed and Web of Science in an iterative fashion. Search results were not limited by year of publication and run until the date of extraction (7 May 2020). As the search queries with 'quantitative health impact assessment' yielded but a small sample of eligible publications, we have decided to allow a broader selection of studies. A brief expert consultation focused our attention to prospective economic evaluations and system dynamics as potentially useful methods for HIA. The rationale behind adding these is that impact assessment, especially when it concerns more indirect health determinants, only makes sense if embedded in coherent yet complex and dynamic logic model, also taking in to account benefits and drawbacks indirectly related to health. Including these terms exclusively expanded search results.

We have done a check of the grey literature using search terms ("quantitative health impact assessment" and either "report", "methods", "societal" or "social") and manual navigation of websites of institutes that conduct or catalogue HIA studies. As there is no systematic way of searching the grey literature, this comes with limitations and an unknown and unknowable number of possibly relevant single HIA reports. Our finding, however, was that the sample our search yielded did not produce the kind of innovative methodologies for quantification and simulation we are looking for. This led us to conclude that additional searches of the grey literature would not bring additional insights that help us provide input for methodological development of quantification techniques for the assessment of health impacts from societal initiatives as defined here. The scientific environment, with research grants that allow for more fundamental scientific exploration, experimentation and validation of methods and techniques, seems a more appropriate resource for such methodological advancement.

Finally, several terms that were specifically found in the titles of clinical trials were entered as exclusion terms. Doing so targeted and excluded thousands of medical studies that were not relevant to the topic of this review.

Table 1
Database search queries.

Search query in PubMed. 'Found in title' is denoted by "[ti]", 'found in title or abstract' by "[tiab]" and 'found in MeSH term' (categories made by PuBMed) by "[mesh]".	
	((health impact assessment[mesh] OR "health impact"[ti]) AND (quanti* [tiab] OR (model*[tiab] AND estimat*[tiab]))) OR ((health impact assessment[mesh]) OR ("impact assessment"[title]) OR (cost-benefit analysis [mesh] AND (outcom*[tiab] OR evaluat*[tiab] OR valuat*[tiab]) OR ((Systems Analysis[mesh] AND dynamic*[tiab]) OR "system dynamics"[tiab] OR "systems thinking"[tiab] OR "system thinking"[tiab]))
AND	(Method*[tiab] OR methods[mesh])
AND	("public health"[tiab])
AND	(societ*[tiab] OR program*[tiab] OR intervent*[tiab] OR polic*[tiab] OR project*[tiab] OR organisati*[tiab] OR organizati*[tiab] OR action*[tiab])
NOT	(vaccin*[ti] OR "randomised controlled"[ti] OR "randomized controlled"[ti] OR screening[ti] OR clinical[tiab])
Number of results: 1031	
Search query in Web of Science. 'Found in title' is denoted by "TI=", 'found in topic' (searches for the terms in an array of fields) by "TS=".	
	(((TS = ("health impact assessment") OR TI = (("health impact"))) AND (TI = (quanti* OR (model* AND estimat*))))) OR ((TS = ("health impact assessment")) OR (TI = ("impact assessment")) OR (TS = (("cost-benefit analysis" OR "cost-effectiveness analysis" OR "economic evaluation") AND (outcom* OR evaluat* OR valuat*))) OR ((TS = ("Systems Analysis" AND dynamic*)) OR TS = ("system dynamics")))
AND	(TS = (method*))
AND	(TS = ("public health"))
AND	(TS = (program* OR intervent* OR polic* OR project* OR organisati* OR organizati* OR action*))
NOT	(TI = (vaccin* OR "randomised controlled" OR "randomized controlled" OR screening OR clinical))
Number of results: 795	
Total number of results from both databases: 1826	
Total number of unique results (duplicates removed): 1594	

2.2. Selection criteria

Decisions regarding whether to include studies were directly based on a list of inclusion and exclusion criteria, which was made in an iterative fashion and can be found in Table 2. Some of the criteria, to our reckoning, warrant some additional elucidation.

Furthermore, criterion eight was formulated in order to exclude studies that *only* use micro-level data – such as clinical trial or survey data – in conducting HIA. For societal initiatives, micro-level data will not always be available and prospective studies need other inputs beside such data in order to make projections. Given the exploratory and specifically targeted methodological focus of this review, literature only describing randomised controlled trials or large retrospective dataset

Table 2
Literature selection criteria.

Number	Inclusion criterion
The study:	
1	Elaborates on methodology: describes methods and/or outcome indicators
2	holds a detailed description of how HIA has been done in at least one particular instance or how it should be done
3	Involves estimating health outcomes from at least one (considered) activity
4	Is prospective in nature: it considers potential impacts in the future
5	Is written in English

Number	Exclusion criterion
The study:	
6	Examines an activity of interest whose focus is (bio-)medical in character
7	Examines an activity of interest that is primarily concerned with health care delivery or health services and systems
8	Is a micro-level trial or solely relies upon micro-level data
9	Is focused on policy on HIA or implementation of HIA
10	Employs or proposes exclusively qualitative research methods
11	Exclusively considers specific toxicological health determinants that have their own specific methodologies, such as air pollution and water pollution
12	Considers the number of hospitalisations as sole health outcome

analysis has little to add to the methodology and is therefore not included in the final selection. Using micro-level data in itself was not an exclusion criterion and can be very useful, among other things, for estimating differential impacts.

Studies that exclusively rely on qualitative methods were also excluded, as this review focuses on quantitative HIA. Qualitative methods can be used, but a study also had to feature quantitative methodology in order to be eligible for inclusion.

Similarly, as we focus on assessment methods of societal initiatives that aim to benefit health, we have excluded risk assessment studies whose *only* determinants are concerned with toxicological aspects that have their own specific methodologies, such as air pollution (small particulate matter, $PM_{2,5}$ and PM_{10}), as was also done in Bhatia and Seto's review (Bhatia and Seto, 2011). The methods that are used in such studies are tailored to very specific fields and therefore not well-suited for use with other determinants.

We also excluded studies which took the number of hospitalisations as their sole health outcome measure. The number of hospitalisations does not only depend on a population's health, but on other factors as well, such as resources of the population and hospital capacity. For instance, a population that is largely too poor to afford any health care will likely see fewer hospitalisations than an affluent one, but will not necessarily turn out to be healthier. Also, the number of hospitalisations can in some cases be a good indicator for health (outcomes), but it can be argued that it is either a cause or a result of them.

2.3. Selection process

The first step in the literature selection process was assessing the titles of the articles that were identified in our search strategy for relevance, which was done by two researchers (LR and MB) independently. Disagreements were solved by consensus and whenever any doubt remained, we chose to include the study at this stage. After title screening, article abstracts of the remaining texts were examined for eligibility. From this stage on, LR and MB iteratively compared the results of independent screening of samples until agreement on over 80% of studies was reached, after which LR completed the abstract selection. Then, all of the remaining studies were assessed full-text. We subsequently used the articles that were selected in this process to find additional literature. The reference lists of all articles that were included so far were examined to check for other studies that possibly met the selection criteria. These articles were put through the same selection process as the rest of the literature. The final literature selection was also checked by all authors of this review.

3. Results

3.1. General characteristics

The database searches returned 1594 unique studies, which are visualised in a PRISMA flow chart in Fig. 1. Of these, 43 peer-reviewed articles were included in this review. A reference list search yielded another 21 studies to be included, making for a total of 64 articles (a full reference list and an overview of these studies can be found in the online supplementary material). Seven of these studies are mainly or fully methodological in character and the remaining 57 conducted HIA, in a broad meaning of the concept: they prospectively estimated health effects of policy or an initiative (Kemm, 2013). This is not to say that this review includes every quantitative HIA, as the search terms and selection criteria were designed to only include articles that were likely to aid in answering our research question.

Table 3 displays some general characteristics of the included studies. Most of the studies were conducted in North America or Europe. No fewer than 23 studies focus on 'nutrition, physical activity and weight', making that the most common of our topic categories (Fig. 2). The vast majority of studies – 41 out of 53 for which it was applicable – concerned governmental policy, while only nine assessed interventions outside governmental policy and three included both. Activities related to tax or subsidy policy were found in 21 of the studies. Most studies were conducted on a national scale: in 34 of the studies, outcomes were estimated for the population of one country. Lastly, 37 studies mentioned the time horizon of the projection period. These periods ranged between five and 100 years, with a mean of 45 years and a median of 40 years.

3.2. Health outcomes

In the literature, we found six types of health outcome units, shown in Table 4. Most frequently used are units concerning mortality, which could be the total number of deaths in different scenarios, number of deaths averted, lives saved per time period or the number of life years won or lost because of an intervention. Quality-adjusted life years (QALYs) and disability-adjusted life years (DALYs) are often used, in order to take into account morbidity and quality of life as well. In our sample of studies, thirteen of the eighteen studies that expressed projected health outcomes in life years also reported outcomes in QALYs gained or DALYs saved. Other, more straightforward morbidity measures are also used, such as the estimated number of cases of certain diseases. Body weight-related measures – number of cases of overweight and/or obesity, BMI, and also simply body weight – are also used as outcomes.

3.3. Estimation methods

In 43 of 57 studies that conducted HIA, the application of at least one of three types of simulation methods that are used for the estimation of health outcomes is reported. These are Monte Carlo (Harrison, 2010), Markov (Tolver, 2016) and system dynamics models (Homer and Hirsch, 2006; Sterman, 2001). They are distinct from each other in their basics, but also have some similarities, so it is not always immediately apparent which method was used (Homer and Hirsch, 2006). Monte Carlo simulation, most simply put, makes use of (usually many) samples of inputs generating a range of outcomes, deriving probability distributions empirically. It is often used to simulate sensitivity analyses and to model uncertainties. This can be done both on a micro or macro level and can use different sorts of input. It can also be conducted in conjunction with a Markov model, which is referred to as Markov Chain Monte Carlo. A micro-level Markov model is a stochastic and dynamic model: it works

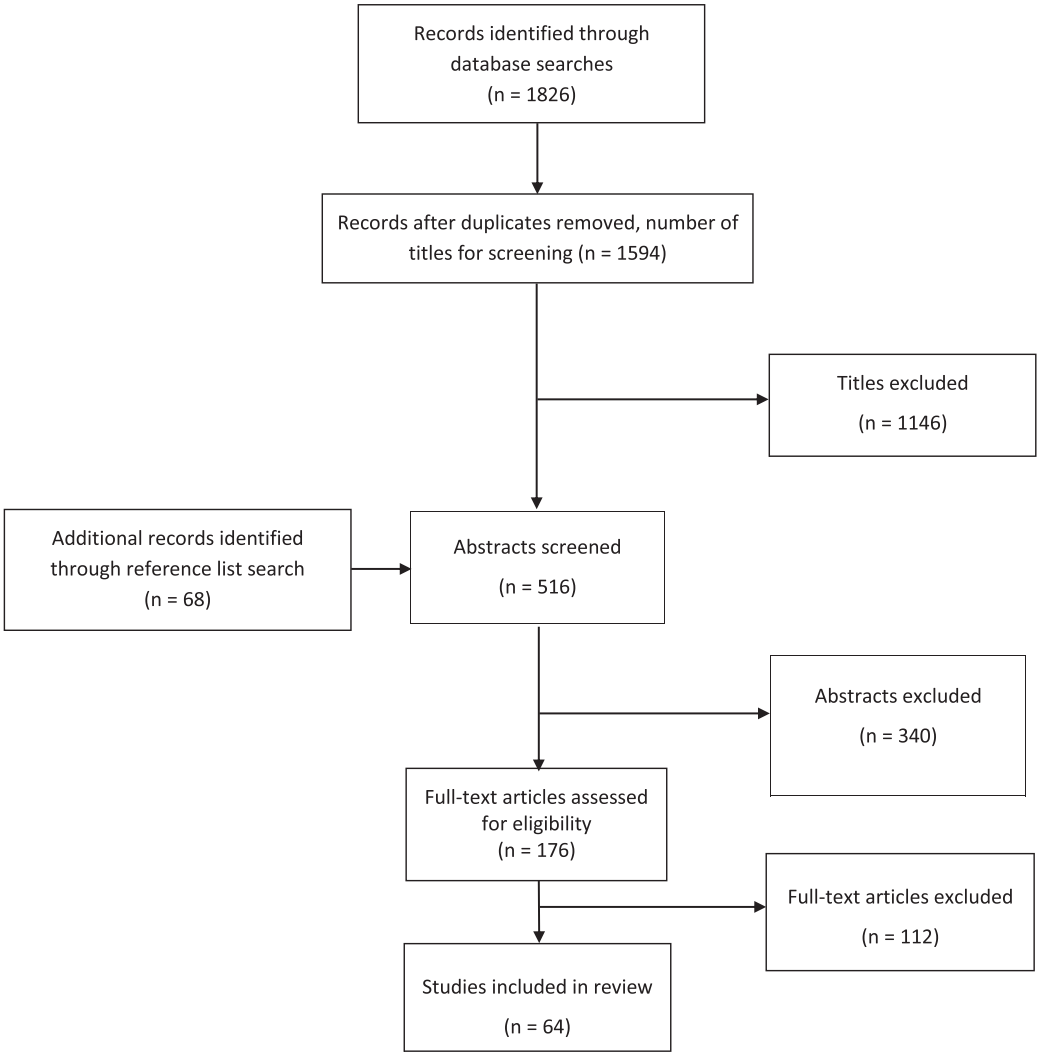

Fig. 1. Adjusted PRISMA flow diagram.

with probabilities and changes over discrete time points. At each time point, the state of an object may change (with often multiple change options) or may stay the same. The probability that an object is in a certain state at a time point is solely determined by the state it was in at the previous time point. The transition probabilities from each state to each other state have to be entered into the model. DYNAMO-HIA (found in six of the included studies) is an example of a tool that uses Markov modelling. An aggregated-level Markov model would involve interpreting probabilities as proportions, by splitting up the population so that parts of the populations make different transitions. This is in fact what a (quantitative) system dynamics model does – the general principles behind system dynamics models and aggregated Markov models are the same. System dynamics models often have dynamic ratios – 'ratios' are comparable to 'transition probabilities' – whereas these are usually static in Markov models. Additionally, system dynamics "tend to have broader boundaries than other types of models and accordingly tend to admit more variables on the basis of logic or expert opinion and for which solid statistical estimates may not be available" (Homer and Hirsch, 2006, p. 453). The focus of system dynamics lies with how the elements of a system behave and change over time, which makes it well suited for aggregated-level analyses of systems with changing parameters. The method is less suited for cases in which one is interested in the individual or in effect distributions, as it cannot utilise the level of detail of micro-level information and has to aggregate it.

3.4. Other methodological tools

Table 5 gives an overview of the different methods that were found in the literature. Studies that did not use simulation methods used other tools such as regression and/or price elasticities to directly estimate health outcomes. Studies that did employ simulation methods often used such tools to obtain inputs for their models. The simulation methods have in common that they all use transition probabilities or similar ways of defining relationships between variables within a model – 43 of the studies in our review report using them. Some of these relationships are quantified by using evidence from previous studies and others by conducting regression analyses. The data used for these regressions can come from any source – survey data (e.g. from the Canadian National Population Health Survey (Statistics Canada, 2020)), census data (e.g. from the US population census (US Census Bureau, 2020)) and register data (e.g. from Dutch social statistical datasets (Bakker et al., 2014)) are all frequently used. Price elasticities, a specific sort of relationship between variables (for example used for estimating change in use of sugar-sweetened soft drinks with an increase in price (Veerman et al., 2016)), are used as a standard tool to approach health effects caused by tax and subsidy policy.

Although health effect distributions are frequently mentioned, often in the form of health equity and disparities, relatively few studies include effect distributions or any kind of quantitative equity outcome measures (see Manuel et al. (2014) for an example of a study that does).

Table 3
Overview of included studies with characteristics.

Authors	Continent	Research topic	Population
Adam et al., 2013	Europe	Smoking	National
Ahmad and Billimek, 2005	North America	Smoking	National
Ahmad and Billimek, 2007	North America	Smoking	National
Ahmad et al., 2008	North America	Smoking	National
Ahmad, 2005	North America	Smoking	Regional
Ahmad, 2005	North America	Smoking	National
Apostolopoulos et al., 2018	North America	Methodology	N/A
Beale et al., 2012	Europe	Nutrition, PA, weight	National
Bhatia and Seto, 2011	North America	Methodology	N/A
Boshuizen et al., 2012	N/A	Methodology	N/A
Briggs et al., 2019	Europe	Multiple	National
Briggs et al., 2013	Europe	Nutrition, PA, weight	National
Brown et al., 2019	Australasia	Transport	City
Cash et al., 2005	North America	Nutrition, PA, weight	National
Cherrie et al., 2017	Europe	Workplace safety	International
Cobiac et al., 2019	Australasia	Transport	National
Cobiac et al., 2017	Australasia	Nutrition, PA, weight	National
Cole et al., 2005	North America	Multiple	City
Dallongeville et al., 2011	Europe	Nutrition, PA, weight	National
Dhont et al., 2013	Europe	Transport	National
Ekwaru et al., 2017	North America	Nutrition, PA, weight	Local group
Feenstra et al., 2005	Europe	Smoking	National
Haby et al., 2006	Australasia	Nutrition, PA, weight	National
Holm et al., 2014	Europe	Smoking	City
Homer and Hirsch, 2006	North America	Methodology	N/A
Jacobs-Van der Bruggen et al., 2007	Europe	Nutrition, PA, weight	National
James et al., 2014	North America	Transport	City
Kaplan et al., 2001	North America	Smoking	Regional
Kaur et al., 2019	Europe	Nutrition, PA, weight	National
Kolovos et al., 2020	Europe	Nutrition, PA, weight	International
Kristensen et al., 2014	North America	Nutrition, PA, weight	National
Lhachimi et al., 2012	Europe	Alcohol	International
Lhachimi et al., 2016	Europe	Multiple	International
Lhachimi et al., 2012	N/A	Methodology	N/A
Lich et al., 2017	North America	Methodology	N/A
Lorgelly et al., 2010	N/A	Methodology	N/A
Macmillan et al., 2014	Australasia	Transport	City
Mahamoud et al., 2013	North America	Social determinants	City
Mahendra and Rajagopalan, 2015	Asia	Transport	City
Mansfield and MacDonald Gibson, 2015	North America	Multiple	Regional
Manuel et al., 2014	North America	Methodology	National
McClure et al., 2015	Multiple	Transport	International
Meier et al., 2016	Europe	Alcohol	National
Moodie et al., 2009	Australasia	Nutrition, PA, weight	Local group
Mooy and Gunning-Schepers, 2001	Europe	Multiple	National
Mueller et al., 2018	Europe	Transport	City
Nnoaham et al., 2009	Europe	Nutrition, PA, weight	National
Powell et al., 2017	North America	Nutrition, PA, weight	Regional
Rojas-Rueda et al., 2011	Europe	Transport	City
Roux et al., 2008	North America	Nutrition, PA, weight	National
Sacks et al., 2011	Australasia	Nutrition, PA, weight	National
Saramago et al., 2014	Europe	Workplace safety	National
Stockwell et al., 2018	Europe	Alcohol	National
Tengs et al., 2001	North America	Smoking	National
Tengs et al., 2005	North America	Smoking	National
Tran et al., 2014	North America	Nutrition, PA, weight	Local group
Urwannachotima et al., 2020	Asia	Nutrition, PA, weight	National
Van den Berg et al., 2008	Europe	Alcohol	National
Veerman et al., 2006	Europe	Nutrition, PA, weight	National
Veerman et al., 2009	North America	Nutrition, PA, weight	National
Veerman et al., 2016	Australasia	Nutrition, PA, weight	National
Verguet et al., 2015	Asia	Smoking	National
Woodcock et al., 2013	Europe	Transport	National
Zapata-Diomedi et al., 2019	Australasia	Nutrition, PA, weight	City

Only eight of the included studies have displayed estimated differences in outcomes in any form. In each of these studies, this was done by displaying outcomes for different groups separately. Differentiated health outcomes based on socio-economic status are found in six of these studies.

Quantitative HIA can use input from experts or other stakeholders for informing model structure, for data triangulation or, if carefully done, providing informed estimates where quantitative data is lacking or incomplete. Eight of the selected studies included such stakeholder participation. As mentioned above, system dynamics is known for admitting variables based on logic and expert opinion. In our literature selection, it indeed turned out that five of the studies that employed participatory methods also used a system dynamics simulation approach and none of them used another simulation method.

Lastly, 49 of the studies are explicitly concerned with the validity or sensitivity of their presented models and the uncertainties that lie within them, but how this is done varies widely. Some studies compared model behaviour to real-world data in order to check the model fit; others changed parameter values to check how outcomes would be affected.

3.5. Health economic evaluation

We found 32 studies that include an economic evaluation aspect. There are distinct methods for doing economic evaluation, which can broadly be divided into cost-effectiveness analyses (including cost-utility analysis and cost-minimisation analysis) and cost-benefit analyses (including cost-consequence analysis). Whereas the first compares monetary costs directly to health gains (for example as cost per life year or QALY gained), the second converts health outcomes into monetary terms before making a comparison between costs and monetary benefits. In our literature selection, these approaches are found 19 and 12 times, respectively.

4. Discussion

This review is explicitly focused on methodology concerning

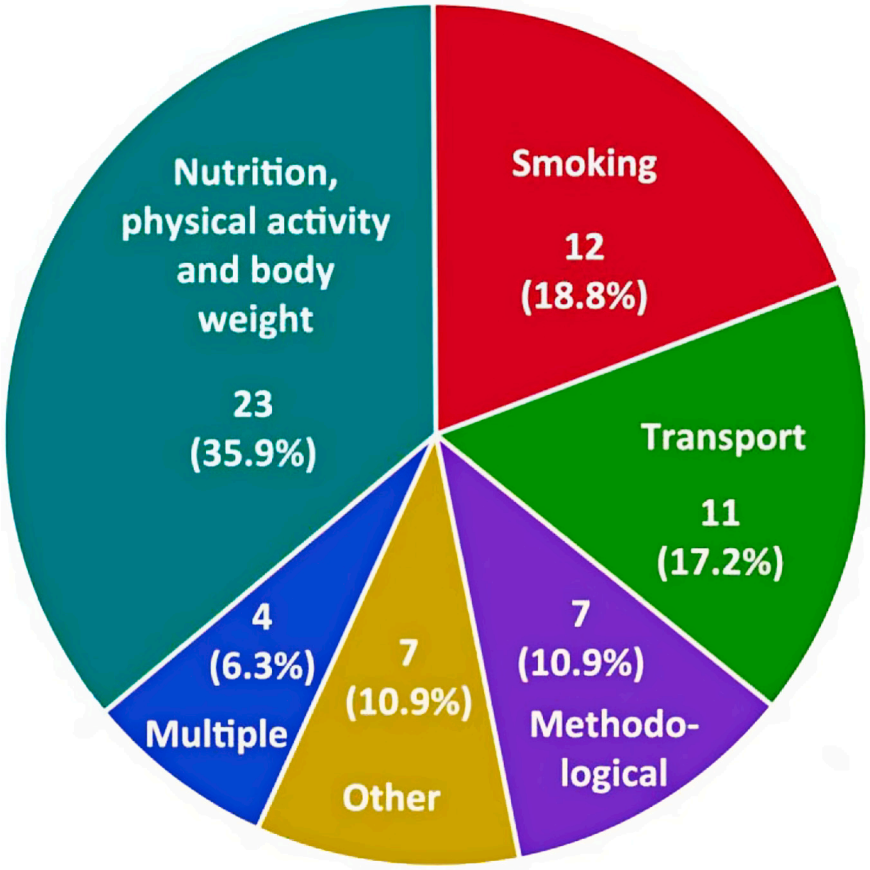

Fig. 2. Pie chart of area of focus of included studies.

Table 4
Reported use of health outcome measures (multiple may be used in a study).

Measure	Frequency
Deaths averted or deaths total	34
Quality-adjusted life years (QALYs)	10
Life years	18
Morbidity measures	16
Disability-adjusted life years (DALYs)	14
Body weight-related measures	13

Table 5
Reported use of methodological tools (multiple may be used in a study).

Methodological tool	Frequency
Relative risks and/or transition probabilities	43
Monte Carlo	26
Discounting	24
Price elasticity	22
Markov	18
Regression	17
System dynamics	15
Multi-state life tables	13
Equity/distribution of health outcomes	8
Participatory methods	8

quantitative HIA for societal initiatives. Given the finding that within this area some types of HIA are relatively rare, opportunities for methodological advancements for those types seem more likely. In our sample of peer-reviewed literature, quantitative HIAs for societal initiatives are mostly conducted for governmental policy options. This may be explained by the logic that governmental bodies often have the incentive, in the form of public justification, but also the means to finance HIAs. In the sample, quantitative HIAs on initiatives from outside the governmental domain by comparison are rare and HIA methods specifically designed for governmental policy seem to be currently further developed for this area. Impacts related to tax or subsidy policy, assessed in 21 of the studies, use methods that are of limited application to non-governmental initiatives.

Distribution of health outcomes is frequently mentioned in studies (and in the WHO definition of HIA (World Health Organization, 1999)), but these distributions are not often estimated. An explanation for this may be that they require more data on human populations and are therefore more demanding than giving just one aggregated estimate. Health effects are however unlikely to have a perfectly uniform distribution, even if there are no reasons to expect unequal effects between groups, and it is important to know how many individuals are affected and how strongly they are affected. Efforts that are meant to increase overall population health by focusing on exposure to causes of positive or negative health effects do not fully – and sometimes at all – translate to the individual level. The reasons why health status differs between individuals within a population and between populations are not the same (Rose, 2001). However, methods that can operate on the micro-level (such as Monte Carlo or Markov models) should be especially well suited for displaying health effects stratified by other characteristics. Increasing possibilities for combining large datasets should make the estimation of effect distributions easier as well.

Likewise, stakeholder participation is equally rare in our sample. It may be that modellers are generally unfamiliar with participatory methods. However, societal initiatives, by their nature, usually aim to tackle complex, 'wicked' problems. They tend to be intersectoral and (sometimes *due to* this intersectoral character) contain indirect links

between initiatives and health outcomes, which produce complexity. Participatory methods are specifically designed to capture this sort of complexity. These methods are embraced in system dynamics practice (Rouwette and Vennix, 2006) and in our sample, use of participatory methods is indeed almost exclusively (with one exception) found in combination with a system dynamics approach and not with the other simulation approaches. While Monte Carlo and Markov models could in theory use participatory methods, system dynamics can much more easily be made visually intuitive to people with no experience with the method and is therefore an appropriate choice for use with stakeholder participation.

In our literature review, we have included studies that conducted or reflected upon prospective estimation of health impacts of a decision, with an intention to underpin or influence that decision. Over half of the studies in this review conducted some sort of economic evaluation. The economic aspect can provide useful additional information on comparative efficiency and costs, which decision makers will consider as well (Kemm, 2006; Parry and Kemm, 2005).

Bhatia et al. (2014) formulated a set of 'minimum elements' for HIA that is much stricter than other views of HIA, in particular concerning the demand for estimation of effects on equity and stakeholder participation. These are elements that, if commonly incorporated, would indeed constitute a substantial improvement of HIA research, but we have only discovered them in a minority of studies. The 'minimum elements' were formulated in 2014 and both the literature review by Bhatia and Seto (2011) and most of the literature in this review were published before that. Still, neither that previous review nor this one has found any study that contains all 'minimum elements'. This underscores the importance of the question of what HIA is and what it should be. In any case, accepting the 'minimum elements' as guidelines for good practice could help to strengthen the field of quantitative HIA.

We did find that simulation in the selected literature usually spans a relatively long period of time, with a mean of 45 and median of 40 years. This indicates that quantitative HIA is often used for informing decisions based on long-term projections. As changes in public health may result from slow mechanisms, considering long-term outcomes seems suitable in many HIAs.

This scoping review explored the peer-reviewed literature on methodology for quantitative HIA of societal initiatives. The results of this review, as in every literature review, are inevitably affected by the search strategy and selection process, and are particularly likely to influence general statistics. Our exploration indicated that the grey literature seems more concerned with practical application of HIA and practical guidelines, rather than methodological development. However, within this grey literature, as with the peer-reviewed literature, there is of course a possibility that there are relevant, applicable methods that exist outside the formulated scope of this review.

5. Conclusion

This review study has been guided by the broad scoping question of "*which methods are suited to quantitatively assess the health impact of societal initiatives?*"

First of all, we conclude that quantitative HIAs on potential benefits of civil society initiatives are still rare. There are, however, methods and techniques available for the further methodological advancement of such HIAs. Quantitative HIA is a prospective exercise that uses simulation models in order to estimate health effects and inform future policy decisions. The modelling methods are similar, not mutually exclusive and each have their own advantages and limitations. Micro-level Markov and Monte Carlo models have an advantage regarding estimating health effect distributions, while system dynamics is better suited for use in conjunction with stakeholder participation. Which method to use depends on these considerations, but also on other factors. The sort of intervention that is contemplated, the level on which the health determinants are interacted with and idiosyncratic features such as data availability and the complexity of underlying mechanisms are such factors.

Additionally, putting more emphasis on generating and validating models with stakeholders and including effect distributions across different groups in society among the outputs could decidedly benefit the value of quantitative HIA, because this will contribute to better, more appropriate, and more tailored policies.

Author contributions

Laurens Reumers: Conceptualisation; Data curation; Writing – original draft. **Marleen Bekker:** Conceptualisation; Data curation; Writing – review and editing; Supervision. **Maria Jansen:** Conceptualisation; Writing – review and editing. **Henk Hilderink:** Writing – review and editing; Validation. **Jan-Kees Helderman:** Conceptualisation; Writing – review and editing. **Dirk Ruwaard:** Conceptualisation; Writing – review and editing; Supervision.

Declaration of Competing Interest

None declared.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.eiar.2020.106509.

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