What do we need for robust, quantitative health impact assessment?

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Summary

Health impact assessment (HIA) aims to make the health consequences of decisions explicit. Decision -makers need to know that the conclusions of HIA are robust. Quantified estimates of potential health impacts may be more influential but there are a number of concerns. Firstly, not everything that can be quantified is important. Secondly, not everything that is being quantified at present should be, if this cannot be done robustly. Finally, not everything that is important can be quantified: rigorous qualitative HIA will still be needed for a thorough assessment. This paper presents the first published attempt to provide practical guidance on what is required to perform robust, quantitative HIA.

Initial steps include profiling the affected populations, obtaining evidence for postulated impacts, and determining how differences in subgroups' exposures and susceptibilities affect impacts. Using epidemiological evidence for HIA is different from doing a new study.

Key steps in quantifying impacts are mapping the causal pathway, selecting appropriate outcome measures and selecting or developing a statistical model. Evidence from different sources is needed. For many health impacts, evidence of an effect may be scarce and estimates of the size and nature of the relationship may be inadequate. Assumptions and uncertainties must therefore be explicit. Modelled data can sometimes be tested against empirical data but sensitivity analyses are crucial. When scientific problems occur, discontinuing the study is not an option as HIA is usually intended to inform real decisions. Both qualitative and quantitative elements of HIA must be performed robustly to be of value.

(250 words)

Keywords

Health impact assessment; public policy; quantitative; reproducibility of results

Introduction

Health Impact Assessment (HIA) is enjoying increasing popularity[1;2] as a method of identifying and optimising the health effects of interventions in many sectors. In the United Kingdom, both regional[3;4] and national[5-7] initiatives have encouraged HIA as part of planning and policymaking. Although a range of reviews[8-14], guidelines[4;15-17] and toolkits[18;19] exists, most HIAs share common features. The aim is to gather evidence about potential health impacts and present this to decision-makers to help them decide how best to mitigate harm and augment benefit to health. HIA can also be used as a tool for health advocacy (for example[20;21]).

An emerging problem of HIA is that there is little guidance on what information is needed in order to draw conclusions. Sometimes, listing the expected health outcomes from a proposal, with supporting evidence, is sufficient to inform recommendations. Many important impacts are not amenable to quantification but are still supported by good evidence. In other cases, quantification of one or more impacts may help to make trade-offs between conflicting impacts, or to make the scale of the impacts explicit. Assessments with quantitative estimates may be considered to be more influential by policy-makers and the value of quantifying impacts where feasible has been acknowledged.[4;10] In either case, it is essential that the content of an HIA is robust, that is, it can withstand critical scrutiny and possible challenge.

Recognising the need for a framework to assist conducting HIA in a way that provides estimates that are both quantitative and robust, a workshop was held at the 3rd UK

Conference on Health Impact Assessment in Liverpool in October 2000. This paper has developed from a discussion group that continued after the conference. We present the first published attempt to provide practical guidance on what is needed to perform quantitative HIA. While qualitative research findings may be quantified to some extent, the focus of this paper is on quantitative measures of health impacts. Qualitative methods[22] will continue to play a complementary role in any thorough assessment; criteria for rigorous qualitative methods have been described elsewhere.[23]

Establishing a framework for prospective, quantitative HIA

Quantitative health impact assessment applies epidemiological techniques to policy or planning decisions. Many elements of a high quality HIA apply whether or not impacts are quantified. Agreed explicit values that should underpin HIA are democracy, equity, sustainability, and a transparent use of evidence.[11]

Pre-requisites of any HIA

HIA usually begins by screening to identify proposals that a HIA could usefully influence and to exclude those with no significant health effects .[11] If health impacts are predicted, the process of scoping sets the boundaries of the HIA: the geographical scope, the population groups whose health is considered, and the timescale over which to predict impacts.[11] This is important because a proposal may have beneficial impacts in the short term or to nearby populations, but harmful effects in the long term or to distant populations, or vice versa.

Terms of reference can then be agreed to form the basis for assembling and appraising information on health impacts. Box 1 presents the pre-requisites for HIA that should be clear within the terms of reference. In addition to describing health effects in a population at risk, HIA must be able to inform option appraisal. Therefore it is important to consider at an early stage what information will be likely to achieve change. It is also important to define the model of health used, as this determines the health impacts that are identified. A narrow biomedical model of health will focus on disease outcomes. If a wider socio-ecological model is used, impacts on health determinants and well-being will be included. A broad model of health that integrates social, genetic and environmental factors[24] is preferable, and is likely to identify impacts that are important but cannot be readily quantified.

BOX 1 around HERE

Profiling the affected populations

The population at risk of these effects is likely to extend beyond the target population for whom the proposal is intended. For example, a local authority considering a planning application for an industrial site might be concerned only for its own residents although people in a neighbouring borough will also be affected. If the population included in a HIA is much larger than the target population of the policy or programme, there may be a sizeable increase in the number of people bearing beneficial or harmful impacts.

In order to identify and quantify health impacts, we need a demographic profile of the population at risk. This profile describes the population by age, sex and some validated measure of socio-economic status. More specific consideration of susceptible groups may be needed to identify vulnerable groups such as ethnic minorities, people with disabilities or pre-existing poor health, people living in institutions including prison populations. Community consultation and local knowledge are important in completing a holistic population profile. This allows the impacts of a proposal both on specific sub-groups and on the gradient of inequalities within an area to be considered.[17]

Generating a list of potential impacts

Health impact assessment aims to incorporate both intentional and unintentional health effects of a proposal, so they need to be identified. Consulting with stakeholders[4], using a checklist of health determinants[4;15;25] and reviewing relevant literature can help to identify potential impacts. It is important to ensure that both potential benefits and risks are considered. These will depend on the model of health employed (see above) but usually include impacts on a wide range of determinants of health that affect physical or mental health and well-being, and access to healthcare.

How do exposure and susceptibility vary within the population?

The classic epidemiological triad of temporal, geographical and personal characteristics may affect both exposure to and effects of an intervention, and should be considered whether or not impacts are quantified. In describing the extent to which these factors are important effect modifiers, it may be worthwhile constructing a matrix in which known and

putative effects are listed against the population profile. When doing so, it is important to distinguish between differences in exposure and differences in susceptibility.

For example, if road traffic injuries in children are likely to be affected by a proposal, then one can simply apply the known social class gradient of such injuries (fourfold from social class I to V for all road traffic deaths [26] and fivefold for pedestrian deaths [27;28]) to the affected population. *Exposure* to risks is higher in children from low income families because they have less access to private transport and so cross more roads[29], while speeding[28], and its associated risks to pedestrians[26], is more common in poorer areas. Children from low income families may be more *susceptible* because they may have less understanding of road safety[28] and are less likely to be accompanied by an adult.[28] Knowing how the proposals may differentially alter exposure or susceptibility could refine the estimates of health impacts.

Quantification

An ideal robust, quantitative HIA would be able to apply known risks to the affected populations, to account for interactions in effects, and then produce summary population effect sizes. Although none of these conditions may be fully satisfied, it should be possible to make quantitative estimate of effects in which any assumptions are explicit. Practitioners of HIA usually draw on evidence from epidemiological research that is already available, and appraise critically how relevant it is in the particular circumstances of a specific proposal (as is done in needs assessment).

Sometimes recommendations to maximise health benefit and mitigate risks are obvious as soon as the impacts are identified, so time spent on quantification would be unnecessary and wasteful. Only if quantitative estimates of one or more impacts will help inform decision making and robust estimates can be calculated should we generate these estimates.

Evidence of effects

After determining whether there is sufficient evidence for an effect, quantified risk or benefit estimates to apply to the relevant populations may be sought from epidemiological studies. The World Health Organisation has issued guidance on using epidemiological evidence in health risk assessment.[30] This recommends conducting a rigorous systematic review for risk assessment, with a comprehensive search strategy and meticulous assessment of the evidence. It then describes how to use this evidence for HIA.

Sources of data outside the health sector are often needed to quantify direct determinants of health, such as unemployment or educational attainment, and less immediate determinants, such as traffic projections. Expertise from these other sectors may be needed to appraise these data and use them appropriately. Although different subgroups may be known to differ in susceptibility, it may not be possible to find separate dose-response values for them. Sub-group specific dose-response effects and exposure levels are available for some physical (eg radiation, noise), biological or chemical pollutants but it is harder to quantify differential impacts of broad policies and programmes.

Constructing a causal pathway

Good quality data on health impacts may be unavailable, or valid quantification of the size of effects may not be possible. However, by constructing causal pathways between effects and outcomes, it may be possible at least to indicate the overall direction of effects. Often there is insufficient information to define or quantify the causal pathway but some evidence exists, for example the health effects of social cohesion. Such evidence should be documented and presented when reporting the findings.

Where elements of the causal pathway are unknown, it is important to be explicit about this rather than relying upon "common-sense" assumptions. The counter-intuitive harms of laying infants in the prone position or extended bed-rest following myocardial infarction are historical warnings of the dangers of using received wisdom.[31]

Understanding the causal relationships between an intervention and the outcomes is important if the full ramifications of policies are to be understood. For example, the fall in childhood head injuries following compulsory helmet legislation in Australia[32] was at least partly due to decreased cycling rather than the mechanical protection of helmets. Thus, some health benefits of cycling for the population were lost because of the legislation. Similarly, if more people are encouraged to walk or cycle rather than drive, the predicted benefits on health may not be fully realised because, for example, most car drivers who change mode might be those who were already taking regular exercise.

Measures of impact

Quantitative HIA may produce different kinds of measures, for example: estimates of the population attributable risk of a condition due to the proposal, the predicted number of people with a defined health outcome or a predicted change in established health determinants. The measures used will depend on the impacts identified, the data available, and the information needed to inform decision makers. For example, it may not matter if the actual number of heart disease deaths prevented by encouraging more people to walk or cycle cannot be quantified but it does matter if the impact of the transport intervention on physical activity is unknown.

Modelling impacts on a population

In order to quantify an impact, we need a conceptual model to show how the health impacts arise from the proposal. This model will represent the causal pathway in a way that allows each step to be quantified, integrating different types of data. Often we might want to quantify more than one impact, requiring different models. For some impacts there may be an appropriate statistical tool, such as the PREVENT model[33] that estimates the effects on population cardiovascular mortality of a change in risk factors. The environmental health risk assessment model, that includes exposure to a defined hazard, the dose-response relationship and health outcome, describes the causal pathway for environmental hazards and can be modelled quantitatively. This could also form the basis for statistical modelling of the effects on health determinants of policy proposals.

The choice of statistical model depends on the type of project or policy proposal that is being investigated. Models used should be consistent with the conceptual model of health impacts and the data available. For example, consider an environmental health impact assessment where quantitative estimates are sought for the health impacts of a number of pollutants. Investigators must decide whether to model the effect of different factors separately or in an integrated model, and what exposure-response relationship should be used between the pollutant and its health impact, such as whether to incorporate a threshold. Factors informing these decisions include: existing knowledge and expert opinion; the availability and format of relevant data; the intended use of the quantitative estimates; the timescale and resources available to conduct the assessment; and the availability and utility of available tools (eg Prevent[33] or spreadsheet calculators (Mindell and Joffe, submitted for publication)).

Whatever model is used, its robustness should be tested. Firstly, the validity of predictions generated by statistical models should be compared with empirical data. Secondly, when using models, the robustness of the assumptions should be tested using sensitivity analyses, for example using different assumptions about dose-response and changes in exposure (eg Mindell and Joffe, submitted for publication). Confounders should also be recognised, measured in the population and included in the calculation of effects.

An HIA is usually intended to inform a real decision, so discontinuing the research or not disseminating the results are not available options. Thus it is essential to make explicit any approximations and assumptions made in the assessment and its consequent limitations.

Complex interactions

Many proposals subject to HIA produce impacts that interact in a complex way. For example, building shopping centres may create short- and long-term employment but siting them out-of-town increases both car dependency, and thus air pollution, and inequalities in access to goods, including an affordable and nutritious diet, while reducing opportunities for physically active travel.

It can be particularly problematic to predict or evaluate effects that are inter-related and difficult to avoid double-counting if each exposure is considered separately. For example, unless exposure-effects estimates are available from models that include other relevant pollutants, one cannot sum the effects of changes in a number of different air pollutants as the same people are likely to be affected by changes in each pollutant. One option is to quantify the exposure to just one type of pollutant.[34]

Pseudo-quantitative results that cannot be validated and solely reflect opinions on the quantitative data are unhelpful. An explicit articulation of the various impacts is needed. Often measures of impact other than change in disease outcomes may be more appropriate, for example estimating how many people in vulnerable groups could benefit.

Economic analysis

Economic analysis may be an influential tool in decision making. If done as part of the HIA, those with an interest in health have an opportunity to influence the type of economic

assessment performed. Cost effectiveness analyses of options to mitigate harm or enhance benefit can be useful. However, there are several difficulties with the economic approach.

Economic assessments combine benefits, and often costs, into a single metric, usually giving precedence to one value (money) over others (notably health). This helps to make trade-offs between options but hides value judgements. Knowing the specific details of such trade-offs (e.g. 100 new jobs versus two extra deaths) ensures that these value judgements are explicit rather than hidden. There are also methodological problems in valuing health outcomes.[35-37]

Many economic analyses give little consideration to equity. These data may trade benefits and harms in different groups of people, with susceptible populations having increased costs or reduced benefits. HIA of three spending scenarios for transport in Edinburgh found an overall negative health impact on everyone for the low spend option, with disadvantage more severe in deprived groups. The highest spending option would benefit all in some way, with the greatest benefits for the more deprived groups.[38] The aim of HIA is to make explicit exactly what health impacts are likely to arise from a proposal and which groups in the population will bear each of these impacts. Combining impacts in a single metric often hides important differences.

Report and recommendations

Most HIAs will identify and present a range of different kinds of impacts. Both qualitative and quantitative methods may be used, and quantified impacts should not be given undue

priority. Sometimes a mix of different quantitative measures may also be used. For example an HIA could quantify the number of lives that would be lost through occupational exposure to a hazard, the number of people who would stop smoking, and the number of people who would gain in a measure of well-being due to a defined proposal. The aim of the HIA is not to trade these off against each other, but to make them explicit in order to allow policy makers, who are accountable for the effects of their policies, to make informed decisions.

HIA is done in order to inform decision making and the levers available to influence decisions will affect presentation of results. For example, Table 1 shows predicted health impacts of traffic reduction and increased walking and cycling in London.[39] Health benefits resulting from improved air quality are less than those from increased physical activity and reduced road traffic injuries. If the political decision is whether or not to tackle air pollution, the direct health effects of air pollution reduction will be emphasised. Once air quality management becomes the target, the health effects of the different potential strategies to achieve this should be clearly stated, as there are probably greater health benefits from traffic reduction than from technical fixes to reduce motor vehicle emissions.

BOX 2 around HERE

Conclusion

We have presented a suggested framework for robust quantitative aspects of HIA to complement rigorous qualitative assessment (Box 2). By making explicit the impacts on

health of various possible options, HIA can allow a more informed judgement to be made concerning the way in which agreed targets should be met. This can happen only if HIA practitioners present all the impacts clearly, having ensured that their findings are robust, based on the best available evidence and that assumptions made in generating results are explicit.

Participants in the workshop or subsequent e-mail discussions

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Table 1 Impact of a 10% reduction in traffic in London accompanied by a 10% increase in cycling and walking

	Impact	No of hospital admissions delayed or avoided	No of deaths no longer brought forward
Effect of a 10% reduction in traffic	Road traffic injuries	600	29
	Respiratory	415	8
	Coronary heart disease	165	16
Effect of a 10% increase in cycling and walking	Coronary heart disease	86	27
	Stroke	27	8
Total		**1,293**	**88**

Source: Söderlund, Ferguson & McCarthy[39]

Box 1 Prerequisites at an early stage of all Health Impact Assessments

1. Why is the HIA being conducted?
2. Should the HIA assess wider policies than just the proposal under consideration?
3. Who should participate in assessing the health impacts?
4. Which model of health should be used?
5. What kind of information is relevant to inform decisions?

Box 2 Recommended framework for robust, quantitative HIA

1. Profile affected populations
2. Identify potential impacts
3. Obtain evidence for impacts
4. Determine how impacts are affected by differences in subgroups' exposures and susceptibilities
5. Draw up a causal pathway
6. Select impact measures
7. Select or develop statistical model, using causal pathway
8. Test statistical model against empirical data and do sensitivity analyses
9. Consider doing an economic analysis