How should interventions to reduce inequalities in health be evaluated?

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Abstract

***Objective*—The effectiveness of interventions which have been proposed or are currently in progress to reduce socioeconomic inequalities in health is largely unknown. This paper aims to develop guidelines for evaluating these interventions.**

***Approach*—Starting from a set of general guidelines which was recently proposed by a group of experts reporting to the national Programme Committee on Socioeconomic Inequalities in Health in The Netherlands, an analysis was made of the appropriateness of different study designs which could be used to assess the effectiveness of interventions to reduce inequalities in health.**

***Results*—A "full" study design requires the measurement, in one or more experimental populations and one or more control populations, of changes over time in the magnitude of socioeconomic inequalities in health. This will usually imply a community intervention trial. Five alternative study designs are distinguished which require less complex measurements but also require more assumptions to be made. Several examples are given.**

***Conclusions*—Building up a systematic knowledge base on the effectiveness of interventions to reduce socioeconomic inequalities in health will be a major enterprise. Elements of a strategy to increase learning speed are discussed. Although the guidelines and design recommendations developed in this paper apply to the evaluation of specific interventions where rigorous evaluation methods can often be used, they may also be useful for the interpretation of the results of less rigorous evaluation studies, for example of broader policies to reduce socioeconomic inequalities in health.**

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After decades of research into the existence and explanation of socioeconomic inequalities in health, there is a growing awareness that something can be done to reduce them. In the United Kingdom the King's Fund report *Tackling inequalities in health* has listed a wide range of interventions and policies that are likely to contribute to a narrowing of inequalities in health.[1] Factors which this report recognises as targets for interventions and policies include the physical environment (adequacy of housing, working conditions, pollution), social and economic influences (income and wealth, unemployment, social support), barriers to adopting a healthier lifestyle, and access to health and social services. A wide range of specific interventions and broader policies is listed which might constitute an "agenda for action". Some examples of the many options mentioned in the King's Fund report are as follows:

- Investments in new social housing and improving the existing housing stock;
- A reversal of the recent trend towards greater income inequality;
- Developing innovative health education programmes and other strategies to reduce smoking in disadvantaged groups;
- Refining resource allocation mechanisms in order to ensure that the health care system responds appropriately to the needs of different social groups.

A recent document on *Variations in health* issued by the UK Department of Health also argues that the National Health Service should play a more active role in reducing inequalities in health, not only by providing equitable access to health care services but also by putting in place public health programmes and by involving other policy bodies to improve the health of disadvantaged communities.[2]

This shift towards a more action oriented climate is by no means restricted to the UK. In Sweden the government has formed a permanent ministerial group which is to translate knowledge on the influence of living conditions on health into concrete policy initiatives, and which will be particularly concerned with reducing class related differences in matters of health.[3] This initiative will be supported by, among other things, a research programme coordinated by the National Public Health Institute. In The Netherlands a national programme, sponsored by the Ministry of Public Health, Welfare and Sports, has recently started which aims at stimulating and evaluating interventions to reduce socioeconomic inequalities in health.[4] Around the world, the WHO *Health for All* initiative and the related *Healthy Cities Movement* have equity in health as one of their main objectives. Within the latter, there are many community based programmes to alleviate the unfavourable health situation of disadvantaged neighbourhoods.[5]

Unfortunately, the effectiveness of all these interventions and policies, both in progress and proposed, is largely unknown.[6] Most are based upon some knowledge of the factors involved in the causation of socioeconomic inequalities in health, such as smoking and other lifestyle

Table 1 Guidelines for the evaluation of interventions to reduce socioeconomic inequalities in health

Area	*Guideline*
I—Specification of intervention objectives	(a) The assessment shall establish the extent to which the intervention has reduced differences between socioeconomic groups, and not only the extent to which the situation in the lower socioeconomic groups has improved, unless the intervention is highly unlikely to affect the higher socioeconomic groups. (b) The assessment shall focus on final health outcomes, unless intermediate outcomes are available (eg health determinants) for which incontrovertible evidence has shown a causal relationship with health.
II—Research design	(a) The assessment shall be carried out in an experimental research design. (b) Depending on the objective and the nature of the intervention, possible alternatives include an experiment involving a number of individuals (eg randomised controlled trial) and an experiment involving a number of groups (community intervention trial). (c) These experiments shall be carried out according to generally accepted rules where possible.
III—Measurements	(a) Socioeconomic status shall be measured at the individual level, using standard methods for recording and classifying education, occupation and/or income. (b) The effect variables to be measured shall be directly derived from the objectives of the intervention, and where possible measurement shall occur with the use of validated methods. (c) The measurement of effect variables shall take into account the expected time lags between interventions and effect. (d) During the assessment, process variables are collected in order to determine whether the intervention was carried out according to plan. (e) During the assessment process, at least some information shall be collected on the costs of the intervention.

Source: Modified from reference 9.

KEY POINTS

- The effectiveness of interventions intended to reduce socioeconomic inequalities is largely unknown.
- Studies evaluating the outcomes of an intervention to reduce health inequalities are likely to be complicated and expensive.
- Guidelines and design recommendations can also be useful for the interpretation of the results of less rigorous evaluation studies.

factors, working and housing conditions, or income inequality. But nobody has as yet directly assessed the effect on socioeconomic inequalities in health of addressing these factors. It is likely that this will have some beneficial effect but the size of the effect, and therefore the cost effectiveness of the intervention or policy, can only be guessed at. This applies even to health care[7] and public health[8] interventions, as two recent reviews have shown. Although some attempts have been made to assess the effects of these interventions to reduce inequalities in health, the quality of the studies performed has often been far from optimal. The NHS Centre for Reviews and Dissemination concluded: "Overall the quality of evaluations considered was poor, even when the difficulties of evaluating complex interventions given to disadvantaged populations are taken into account. (....). Further coordinated and rigorous evaluations of promising interventions would be useful".[7] But what should such rigorous evaluations look like?

We feel that a distinction should be made between the evaluation of specific interventions (eg, an innovative health education programme or a change in the organisation of a screening programme), and the evaluation of broader policies (eg, changes in the income distribution or in health care resource allocation mechanisms). The evaluation of specific interventions is likely to be a much more straightforward enterprise than the evaluation of broader policies. In the case of specific interventions the causal pathways between such interventions and the final health effects will be less complicated; this makes it easier to define outcome measures of success. In addition, because of their discrete and more localised nature, specific interventions lend themselves more easily to manipulation in an experimental design. This implies that evaluators of specific interventions will much more often be in a position to employ classic study designs, such as the randomised controlled trial (RCT) or the community intervention trial (CIT), than evaluators of broader policies. The focus of this paper will be on the evaluation of specific interventions but the results of this analysis also are of relevance to the evaluation of broader policies. In the Discussion section of this paper we will briefly explore these implications.

In this paper, socioeconomic inequalities in health are defined as systematic differences in the occurrence of health problems between individuals with a higher or lower socioeconomic status. "Socioeconomic status" refers to the individual's relative position in the social stratification, and is usually measured with information on level of education, occupational class, and/or income level. Our understanding of the explanation of socioeconomic inequalities in health is that socioeconomic status mainly affects health through a differential distribution of specific health determinants, like working and living conditions, health related behaviours, access to health care, etc. Interventions and strategies to reduce socioeconomic inequalities in health, such as those cited at the start of this paper, can aim either at modifying the differential distribution of these specific determinants or at changing the socioeconomic factors themselves (eg, income distribution). We will assume that reduction of socioeconomic inequalities in health is to be pursued by lowering the rate of health problems in the lower socioeconomic groups, not by increasing the rate of health problems in the higher socioeconomic groups, because the latter is likely to be more controversial, both ethically and politically, than the first.

Evaluating specific interventions to reduce inequalities in health

In The Netherlands a group of experts reporting to the national Programme Committee on Socioeconomic Inequalities in Health has recently issued a report with a number of guidelines for the evaluation of interventions to reduce inequalities in health.[9] These guidelines may provide a good starting-point for our discussion. Table 1 lists some of the recommendations. Many of the guidelines may sound rather basic to those involved in effectiveness studies in other areas of preventive or clinical medicine but in this complex border area between public health and other sectors

Table 2 Study designs to be used for the evaluation of interventions to reduce socioeconomic inequalities in health
(A) In the description of the various designs, the following notation will be used:

		Before the intervention	*After the intervention*
Experimental condition (intervention)	Low socioeconomic status group	L_0	L_1
	High socioeconomic status group	H_0	H_1
X			
Control condition (no intervention)	Low socioeconomic status group	l_0	l_1
	High socioeconomic status group	h_0	h_1

In which:
L = rate of health problem in low SES group, experimental condition
H = rate of health problem in high SES group, experimental condition
l = rate of health problem in low SES group, control condition
h = rate of health problem in high SES group, control condition
$_0$ = subscript denoting situation before the intervention
$_1$ = subscript denoting situation after the intervention
X = aselect (eg random) allocation

(B) The following designs can be distinguished

Design no	*Hypothesis to be tested**	*Assumption(s) required for results to indicate stronger decrease in inequality in intervention population*
A	$\{(L_1-H_1)-(L_0-H_0)\} < \{(l_1-h_1)-(l_0-h_0)\}$	—
B_1	$(L_1-L_0) < (l_1-l_0)$	$(H_0-H_1) = (h_0-h_1)$
B_2	$L_1 < l_1$	As B_1, plus: $L_0 = l_0$
C_1	$(L_1-H_1) < (L_0-H_0)$	$(l_1-h_1) = (l_0-h_0)$
C_2	$L_1 < L_0$	As C_1, plus: $H_1 = H_0$
D_1	$(L_1-H_1) < (l_1-h_1)$	$(L_0-H_0) = (l_0-h_0)$
D_2 (= B_2)	$L_1 < l_1$	As D_1, plus: $H_1 = h_1$

* These formulas assume that socioeconomic inequalities in health are conceptualised in terms of absolute differences in the frequency of health problems between low and high socioeconomic groups (eg L_1-H_1). Similar formulas can easily be developed for (a reduction of) relative differences (eg L_1/H_1). It is also assumed that inequalities in health should be reduced by lowering the rate of health problems in the low socioeconomic groups, not by increasing the rate of health problems in the high socioeconomic groups.

In order to reduce design complexity, various modifications to the "full" design (A) could be considered.

If one were prepared to restrict the study to a comparison of changes in the effect parameters among the low socioeconomic groups in the experimental and control population, and leave out the high socioeconomic groups (design B_1), a straightforward randomised controlled trial would even be possible. The validity of the results would be dependent upon the likelihood that the effect parameters in the high socioeconomic groups are unaffected by the intervention. This may be true in some circumstances but not in others: improvements of working conditions of low paid jobs will hardly affect the better off but a mass media campaign targeting low socioeconomic groups will inevitably also reach some members of high socioeconomic groups.

Another simplification would involve removing the control population (design C_1), thereby reducing the study design to a before and after comparison in the experimental population. This is rather a drastic step which should only be considered where there is certainty that there are no secular trends in the magnitude of socioeconomic inequalities in the effect parameters. Over the past decades, however, many changes have occurred which suggest that socioeconomic inequalities in health are a dynamic, not a static phenomenon.[23 24]

Finally, one could consider removing the baseline measurements, ie the measurements of the effect parameters preceding the intervention (design D_1). Again, this is a consequential change, and should be considered only if one can be sure that socioeconomic inequalities in the effect parameters before the intervention are the same in the experimental and control populations. This will only rarely be the case.

Combining different simplifications could lead to even more easy to handle study designs, with even more strenuous assumptions to make (designs B_2, C_2, and D_2).

of public policy, studies fulfilling these criteria are actually quite rare.[7 8] A proper evaluation starts with a specification of the intervention objectives. If the aim of the intervention is to reduce socioeconomic inequalities in health, then the evaluation should measure the degree to which differences between socioeconomic groups (guideline Ia in table 1) in the targeted health outcome have been reduced. Preferably, final health outcomes should be assessed, and it is only in some rare cases that one can rely on intermediate outcomes (Ib). As in all studies of intended effects, an experimental study design is to be preferred (IIa), with either individuals or groups as units of allocation (IIb). Detailed rules with regard to the execution of such designs are available in the literature (IIc). Measurements of socioeconomic status (IIIa) and the effect variables (IIIb) should use validated methods and instruments where possible. Appropriate time lags should be taken into account (IIIc). In addition to these end point data, process (IIId) and cost (IIIe) data should also be collected.

Although these recommendations sound self evident, it is not just because of bad science that so few studies fulfilling these criteria have ever been performed. An experimental study which tries to assess the outcomes of an intervention to reduce inequalities in health is likely to be a very complicated and expensive enterprise (table 2). A "full" design (design A in table 2B) would require at least eight observations on the effect parameters to be made: two socioeconomic groups (high and low socioeconomic status) * two points in time (before and after the intervention) * two populations (experimental and control). Depending on the nature of the intervention, this may imply a CIT: an experimental study with groups (instead of individuals, as in the more widely known RCT) being the units of allocation to either the experimental or a control condition.[10 11] In this case, one or more populations would be allocated to an intervention to reduce inequalities in health, and one or more other populations to a control condition (no intervention, business as usual). The CIT is the design of choice, if, as will frequently be the case, the intervention is targeted at groups (schools, factories, neighbourhoods) instead of at individuals.

Although in a CIT, as in the case of experiments with individuals, random allocation is to be preferred, this can only be considered if the number of populations to be involved is large enough. This will only rarely be feasible. Despite the fact that the first CITs date back to the 1950s, this design remains relatively unknown. The CIT is a complicated and demanding design, as recent experience with "second generation" CITs of interventions to reduce risk factors for cardiovascular disease has shown.[12-15] The design will be even more

complicated in the situation we describe here, because the aim now is not to reduce the average level of the effect parameters but to reduce differences in effect parameters within populations. This has important implications for sampling and sample sizes, for example.

A study recently started in The Netherlands which closely follows this model and which can serve as an illustration (Buitendijk SE, den Ouden AL, de Jong-van den Berg LTW, *et al*, unpublished research proposal). The study aims at assessing the effectiveness of a special programme to decrease the difference in acceptance of folic acid supplementation around the date of conception between low and high socioeconomic status women. The intervention programme, which consists of targeted media campaigns, involvement of neighbourhood centres, instruction of health care workers etc, is implemented in two experimental regions, while women living in two other regions act as control populations. Surveys measuring socioeconomic inequalities in folic acid intake have been held before the special programmes started, both in the experimental and the control regions, and will be repeated one year after the programme has ended. No health outcomes are assessed because the available evidence on a causal relationship between folic acid supplementation and prevention of neural tube defects is considered to be sufficiently strong to warrant reliance on intermediate outcomes.[16]

Although this example shows that a "full design" to assess the effect of interventions to reduce inequalities in health may in some circumstances be feasible, there may be other circumstances where it is not. In such cases it is useful to consider alternative options. These alternatives, all linked to a less comprehensive evaluation of the intervention objectives, have systematically been ordered and analysed in table 2. On the whole, it seems that most of the alternatives would require rather strong assumptions, eg on the absence of secular trends in socioeconomic inequalities in health or on the absence of differences in the magnitude of socioeconomic inequalities in health between the experimental and control groups before the intervention.

Only a design which leaves out the high socioeconomic groups (design B1 in table 2B) will sometimes be adequate. If one can reasonably assume that the intervention effects will really be limited to the low socioeconomic groups, it may not be necessary to measure the effect parameters in the high socioeconomic groups. This assumption is likely to be violated in the case of community based interventions (even in deprived communities there will be "minorities" with a higher socioeconomic status which could get a disproportionate share of the benefits of the intervention), and also in the case of mass media campaigns, even if these are targeted towards lower socioeconomic groups (the message will inevitably also, and perhaps more so, be picked up by the higher socioeconomic groups). On the other hand, programmes to improve the working conditions of certain occupations will not necessarily also affect other, eg higher, occupations, and then an assessment of the effect parameters among higher occupations is unnecessary.

The main attractions of option B1 are that (a) it requires less extensive data collection, and (b) it will sometimes permit a RCT to be done. If a direct comparison between high and low socioeconomic groups is unnecessary, one can allocate individuals with a low socioeconomic status to either the experimental or a control condition. Because individuals (instead of groups) are the units of allocation, randomization is easier to accomplish. The RCT is an extremely well developed design which, if executed properly, will produce strong evidence on the effectiveness of interventions.[17,18] The NHS Centre for Dissemination and Reviews cites several examples of successful RCTs.[7] One RCT attempted to evaluate the effects of providing free milk to disadvantaged school children in the UK, and allocated some 250 children to either daily milk or nothing. Effects on height and weight were measured after two years. The results suggest that the provision of free school milk to disadvantaged children results in small improvements in their growth rates.[19] Another RCT assessed the effects of a home visiting programme by trained volunteers on various measures of maternal and child health among disadvantaged first time mothers in Dublin, Eire. Some 130 mothers were randomised to either a programme of monthly visits, or nothing. After one year, the intervention group had better scores on immunisation, diet, and subjective well being.[20]

Discussion

In this paper we have focused on the evaluation of specific interventions to reduce inequalities in health, and we have developed a number of guidelines and design recommendations which will hopefully be helpful to those who wish to undertake such evaluations. But what is their usefulness to those who wish to evaluate broader policies which aim at reducing inequalities in health? In the case of broader policies assessment of effectiveness by CIT or RCT is likely to be rare. Nevertheless, these classic designs may serve as a model from which to derive the threats to the validity of less perfect designs.

If one would like to know the effects of a certain policy to reduce socioeconomic inequalities in health, the first thing to do is see whether similar policies have been tried before, either in the same country or in another country. If one ponders the introduction of a new tax regime which would reduce income inequalities one may want to take advantage of the experience with previous attempts, for example by looking at countries where in recent decades income inequalities have narrowed instead of widened. A careful study of changes in health inequalities following a reduction of income inequalities may provide invaluable information on the effectiveness of such a fundamental but politically expensive approach. Such a study would, of course, only be feasible if data on health inequalities have been collected

routinely over the relevant time period, and if one has a clear understanding of the temporal relationship between changes in income inequality and changes in health inequalities.

Although the research design of such observational studies will usually remain implicit, this would actually represent an example of design C1 in table 2B. The main assumption underlying the validity of this design is that without this policy (ie reduction in income inequality) the magnitude of socioeconomic inequalities in health would have remained the same. This may occasionally be a reasonable assumption but unfortunately unexpected and largely unexplained changes in the magnitude of socioeconomic inequalities in health are being observed all the time.[21–23].

Another and well elaborated example relates to the assessment of the effects of pricing policies upon socioeconomic inequalities in cigarette smoking in the UK.[24] This study was based on data from the British general household survey, and looked at changes over time in the prevalence of smoking by socioeconomic group. These changes were related to changes in the price of cigarettes, changes in disposable income, and health publicity. It was found that the lower socioeconomic groups were more responsive than the higher socioeconomic groups to price changes, while the reverse was true for health publicity campaigns. Again, this is an example of design C1 in table 2B: no control populations (eg other countries where these changes in price, income, and health publicity did not take place) were included in the study. However, the ability of the study to explore causal relationships was considerably enhanced by having a detailed look at time trends, instead of simply comparing one observation before and one after the intervention.

Both examples presented in this section involved retrospective assessments of policies which were implemented in the past, but which still are relevant today. In many cases such historical evidence will not be available but regardless of that major new policies should always carefully be evaluated during and after their implementation. Such prospective evaluations will generally follow the same type of research design as the retrospective evaluations but there will be fewer constraints with regard to the availability of data. One is not dependent upon routinely collected data but one can consider special data collection efforts, so as to enhance possibilities for causal inference.[25 26]

Returning to the evaluation of specific interventions to reduce inequalities in health: our analysis shows that building up a systematic knowledge base will be a major exercise, which would greatly benefit from international collaboration.[6] Pooling experience from different countries is likely to increase the scope for drawing sensible and relevant conclusions but this will work better if studies performed in different countries follow the same basic rules. The framework set out in this paper represents a first modest attempt at developing such a set of common rules.

In the short and medium term the evidence on the effectiveness of interventions to reduce socioeconomic inequalities in health will certainly remain fragmentary. Rational policy making will therefore also need to be based on common sense. The limited range of available scientific evidence on the effectiveness of interventions will not deter policy makers from making decisions, and they are right. Notwithstanding the gaps in our understanding of the causal relationships between socioeconomic factors and health, the available knowledge on the determinants of health and their unequal distribution within the population together with common sense dictates that achieving a more equal exposure to these determinants will help to reduce inequalities in health.

Actually, both the fragmentary evidence on the effectiveness of interventions and the available knowledge on the causes of inequalities in health can be used much more effectively if epidemiological simulation models would be developed which could synthesise these bits and pieces of information. Simulation models have proved useful for showing the margins of variation that policy alternatives can make in other areas, eg prevention programmes.[27] It seems worth trying to develop a similar analytical tool to help put all the available information into a population perspective on the reduction of socioeconomic inequalities in health.

Finally, it is important not to isolate the evaluation efforts outlined in this paper from other attempts at assessing the effectiveness of medical and public health interventions. Many interventions are going on, and the popularity of evidence based medicine is likely to further increase the number of well designed evaluation studies. Including a measure of socioeconomic status[23 28] in many of these evaluation studies would offer enormous opportunities for increasing knowledge on the differential effects of medical and public health interventions. More generally speaking, monitoring any programmes that affect health as to the socioeconomic distribution of their outcomes should be one of the priorities of a comprehensive strategy to increase the knowledge base for interventions to reduce inequalities in health.

Evaluating interventions to reduce inequalities in health is likely to be complicated and expensive. This message will not please policy makers, but if one is serious about reducing inequalities in health one should also be serious about assessing the actual attainment of the objectives. At the same time this plea for careful evaluation of options should not be used as an excuse for not implementing a "common sense" policy in the meantime. Just let us make sure that the knowledge gained from both is preserved for those coming after us.

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