Health Inequalities Tool for Scotland
Modelling the impact of interventions on health inequalities

User Guide

Overview

The Health Inequalities Tool for Scotland (HITS) intervention tools are intended to model the potential impact of selected interventions to reduce health inequalities. The tool comprises three separate spreadsheets, each of which allows users to model one of the following interventions:

- NHS Smoking cessation interventions
- Alcohol brief interventions
- Counterweight (an intervention programme to reduce BMI)

HITS models are based on intervention activity, and effectiveness, for a one year period. The user specifies: the population of interest; baseline throughput (number currently receiving the intervention); and ‘modelled’ throughput or investment. Modelled results are compared with the baseline so that disinvestment or increased throughput can be studied. The outputs compare scenarios in terms of delivery costs, health outcomes and intermediate outcomes. Figure 1 gives an overview:

Choose a population of interest, e.g. NHS board

Specify a new level of investment or new number of interventions

View ‘baseline’ situation with respect to chosen intervention, e.g. current smoking cessation throughput

Specify distribution of interventions across SIMD quintiles

View key outputs including:
- Impact on population health
- Impact on health inequalities
- Cost of delivering interventions
- Risk factor measures e.g. smoking prevalence

This user guide is part of a suite of outputs. It is essential that users read the following materials in advance of using the intervention tools in order to fully understand the limitations of the work and the assumptions behind the models. This is necessary to facilitate the appropriate interpretation of modelled results.

1. User Guide
2. HITS Commentary (which provides illustrative results and discusses the interpretation of findings in the context of the health inequalities challenge facing Scotland)
3. Cost briefing
4. The ‘introduction’ worksheet of the model in question
5. The ‘assumptions and notes’ worksheet of the model in question
User inputs

Users are required to enter data in three stages; illustrated below by screen shots from the model, with explanatory notes.

(i) Population to model

Users have the option of modelling the population of Scotland, NHS boards, local authorities or Community Health (& Care) Partnerships.

(ii) Current activity

Users specify the number of interventions currently delivered annually in their chosen population, and the current cost per intervention. A separate “cost briefing” is available to assist with the latter input. Together these inputs specify the baseline scenario.

(iii) Model data

Users specify a scenario to be modelled and compared with the baseline scenario. First, either ‘throughput’ or ‘investment’ is selected as the parameter to model, and the throughput number of budget is entered in the last cell (throughput is used in the illustration below). Both approaches provide information used to determine the number of interventions delivered under the modelled scenario. A cost per intervention is entered, which may or may not be equal to the baseline cost. The life expectancy gap comparator can be either the least deprived quintile or the local area average (for Scotland this is the national average). ‘SIMD distribution’ specifies whether and how the intervention is targeted to specific SIMD groups (see additional note below).

Model Outcomes

Each tool aims to report outcomes reflecting three areas: (i) mortality – as described by life expectancy and number of deaths prevented; (ii) morbidity – described by hospital admissions, and: (iii) risk factor measures. The primary outcome which is reported for all spreadsheet tools is life expectancy; this provides a key high level outcome, which tends to have relatively robust data to inform calculations. Reporting of other outcomes is dependent on data availability and therefore varies by tool; for example, the impact on hospital admissions cannot be reported for all tools, and each tool reports the impact on risk factors differently. The ‘Charts’ worksheet contains a visual comparison of the number and SIMD distribution of successful interventions under baseline and modelled scenarios.

It should be noted that these tools do not report all relevant outcomes, and alternative measures may also be considered important for planning and decision-making.
Key considerations

Health inequalities
Health inequalities are described by comparisons between the most deprived SIMD quintile (MDQ) and a comparator population. For all populations, the categorisation of SIMD at Scotland level is applied to the local population. This means that the most deprived quintile for a health board, for example, is defined as the population living in that health board area who are living in datazones defined as being among the most deprived 20% in Scotland. The proportion of the local population captured by this definition will vary, i.e. it will not be one fifth of the local population.

Data sources, calculations and assumptions
For modelling purposes, it is necessary to make a number of assumptions about how the available information applies to the scenario being modelled. These are detailed in a worksheet within each tool. All data sources and calculations are clearly presented within the tool. Data come from routine administrative data collected in Scotland and from the scientific literature. The most robust data available, as identified and appraised by the HITS project team, have been used to inform the tools. However, these data are often limited in robustness and applicability, and significant gaps exist. The assumptions underlying the tools and the boundaries of data availability and quality are important limitations of this work and consideration of both is crucial to interpretation of the outputs.

‘Baseline’ scenarios
Many interventions that may by used to improve population health or tackle health inequalities are not necessarily new, and may already be being implemented within the population of interest, to a greater or lesser extent. Accordingly, it is not always appropriate to model the impact of interventions as if they were being introduced for the first time: it may be more useful to allow modelling of changes in levels of intervention activity and / or targeting strategy. The Health Inequalities Tools for Scotland do this by comparing the impact of modelled scenarios with a pre-specified baseline scenario reflecting current practice. If the modelled scenario represents disinvestment (i.e. fewer interventions being carried out) negative impacts on health outcomes may be observed.

Targeting interventions
A key factor in using downstream interventions to address health inequalities is the targeting of interventions by deprivation. The tools allow users to specify whether they wish to target the intervention, and to which SIMD deprivation quintiles. The success or otherwise of targeting will depend on the intervention, the population, and the strategy used, and it may not be possible to achieve ‘perfect’ targeting. For example, delivering interventions through a GP practice in a deprived area will be only partially successful in targeting the most deprived quintile, since not all patients will actually be in this group. To study this issue, the tool allows users to model ‘partial’ targeting, although it should be noted that the partially successful distributions used are illustrative and not evidence-based. It also allows users to specify the anticipated SIMD distribution of an intervention: to do this, select ‘user-specified’ distribution then navigate to the ‘SIMD distribution’ worksheet and enter the relevant data.

Costs
The health inequalities tools for Scotland allow modelling of the costs required to deliver the interventions. No attempt is made to quantify cost savings that may arise from successful interventions; e.g. reduced prescription costs, fewer hospital visits, wider social costs etc. Accordingly these tools should not be considered to provide a full cost / benefit analysis, but rather to provide guidance on the investment required to achieve an anticipated level of change in specific health outcomes. A short paper outlining current ‘best estimates’ of costs at a national level is available to help inform the parameters that users choose for modelling purposes (if no robust local data are available).

Populations
The spreadsheets facilitate modelling of the impact of interventions for a range of geographies; namely Scotland as a whole, NHS boards, local authorities and Community Health (& Care) Partnerships. For geographies that do not include populations from the most deprived SIMD quintile the tools are not able to model certain outcomes and scenarios and error messages will appear in the affected cells within the worksheet.
For all sub-national geographies models are based on the application of national rates (e.g. mortality) to local populations. This is considered sufficient for modelling purposes but means that the data within the model will only approximate actual local figures and will not reflect geographical variations. For example, the baseline life expectancy may differ from local estimates since it is based on the age, sex and SIMD distribution of the population rather than local death statistics. The primary purpose of this approach is to avoid any issues of disclosure, and it has a negligible effect on the modelled impact of interventions (e.g. change in life expectancy). Similarly, for hospital admissions, local data on the overall number is used, but the number in each population sub-group is modelled based on national distributions; for this reason the baseline number of admissions in the most deprived quintile is not presented.

Recruitment rates
The model outputs include an estimate of the recruitment rate required to achieve the specified throughput. This shows the maximum proportion of the eligible population that would need to undergo the intervention for any age/SIMD group, which is a key consideration for implementing an intervention. The estimate is colour coded to indicate challenging or possibly unfeasible recruitment rates. The tool enables users to model recruitment rates of over 100%, and so close attention should be paid to the recruitment rate to ensure the modelled scenario is feasible, or at least interpreted correctly. Similarly, an error against the recruitment rate indicates that an unfeasible scenario is being modelled.

Timescales
The health inequalities tools for Scotland are static arithmetical models; they report intervention activity in one year and the resulting health outcomes for a single hypothetical subsequent year. In practice, where the health behaviour change that occurs as a result of the intervention is sustained, health benefits (and return on investment) will continue to accrue over multiple years. However, the tools do not model a time lag between intervention and benefit nor a deterioration of the effect of the intervention over time. In reality, both these assumptions are very optimistic, and so simply summing the outcomes reported by the model is likely to overestimate the long term impacts.

Setting the tools within a broader context for tackling health inequalities
The interventions being modelled have been chosen because of the relatively high level of interest in these areas and the availability of data to inform modelling. They represent only a small subset of all interventions with potential for tackling inequalities. Initiatives operating further ‘upstream’ and those that are less reliant on action being taken by individuals (i.e. individual ‘agency’) may offer considerable advantages. Nonetheless it is hoped that these tools will contribute to tackling health inequalities in Scotland by enabling better understanding of outcomes based on current evidence.

Amending the tool
By default, only standard user input cells can be altered by the user; the worksheets are protected and other cells are ‘locked’. This is to avoid calculations etc. being changed inadvertently. However, the worksheets are not password protected, and users may access and alter calculations and assumptions for their own modelling purposes simply by un-protecting the sheet in question (in Excel, go to ‘tools’ > ‘protection’ > ‘unprotect sheet’). Likewise, users may view calculations and notes on data sources (embedded within orange-shaded cells), but will need to unprotect the worksheet first.

Intervention flow charts
The following flow charts provide an at-a-glance illustration of the approach and key assumptions used for modelling purposes. Full details and references are contained within the spreadsheet tools.
Scottish Public Health Observatory (ScotPHO)  
September 2012

**Counterweight flowchart**

**User action**  
- Select population

**Model progression and calculations**

1. **START**
   - Current demographics & life expectancy presented for population

2. **Select population**
   - Population eligible for intervention defined as obese group (BMI >30)

3. **Specify baseline activity level and costs**
   - Mortality rate for obese and non-obese groups calculated
   - Calculation & presentation of baseline intervention throughput statistics

4. **Specify new level of activity, costs and SIMD distribution**
   - Distribution by age, sex & SIMD is assumed to follow pattern of eligibility for the intervention.
   - SIMD distribution may reflect a universal or targeted strategy. Within SIMD groups, age / sex distribution follows eligibility. A ‘success rate’ of 40% is applied (Counterweight project team, personal communication, based on evaluation at 12 month follow)

5. **Notes**
   - Data are from National Records Scotland. Life expectancy calculated from mortality rates using Chiang method. All HITS calculations are carried out for population groups defined by age (5-year bands), sex and SIMD quintile, with summary data presented.
   - Age / sex / SIMD-specific obesity rates from Scottish Health Survey are applied. It is assumed that eligibility for Counterweight is restricted to 20-70 yrs age group
   - Mortality rate in obese [Mo] and non-obese group [Mn] calculated from (i) relative risk [RR] of 1.39 (from a Lancet pooled analysis), (ii) mortality rate in whole population [Mp], (iii) the proportion of the population who are obese [b] and (iii) the following formulae relating to Population Attributable Risk [PAR]:
     - $PAR = \frac{b(\text{RR}-1)}{1+b(\text{RR}-1)}$ [calculation of PAR]
     - $\text{MP} = \frac{\text{Mp} - \text{Mn}}{\text{Mp}}$ [calculation of Mn]
     - $\text{RR} = \frac{\text{Mo}}{\text{Mn}}$ [calculation of Mo]

6. **Specify**
   - Calculation of change in BMI in intervention group

7. **Notes**
   - A successful intervention results in a 1.36kg/m² decrease in BMI (Counterweight Project Team). Assuming a background gain of 0.37 kg/m² (NICE), this equates to a difference of 1.73 kg/m² after one year

8. **Notes**
   - Data from a Lancet meta-analysis showed a 30% difference in mortality rate with a 5kg/m² difference in BMI. The % change in mortality rate resulting from the more modest change in BMI in Counterweight subjects is therefore inferred as approximately 10%

9. **Notes**
   - The change in the number of successful interventions delivered under the baseline and modelled scenarios is calculated. Health outcomes are calculated for this group, the non-intervention group and the non eligible group. Outcomes from these three groups are combined to give the overall impact for population sub-groups defined by age, sex and SIMD. Revised mortality rates are used to calculate ‘new’ life expectancy based on modelled deaths, using the Chiang method.

10. **Notes**
    - Presentation of key population health and health inequalities outcomes
NHS Smoking Cessation Services flowchart

User action: Select population
- Current demographics & life expectancy presented for population
- Population eligible for intervention defined as people who smoke
- Mortality rate and morbidity statistics for smokers and non-smokers calculated
- Calculation & presentation of baseline intervention throughput statistics
- Calculation & presentation of new (modelled) throughput statistics
- Calculation of change in smoking prevalence
- Calculation of new mortality rate and morbidity statistics for those undergoing the intervention
- Calculation of modelled health outcomes, based on the change in intervention throughput between baseline and the modelled scenario
- Presentation of key population health and health inequalities outcomes

Model progression and calculations:
- START

Notes:
- Data are from National Records Scotland. Life expectancy calculated from mortality rates using Chiang method. All HITS calculations are carried out for population groups defined by age (5-year bands), sex and SIMD quintile, with summary data presented.
- Age / sex / SIMD-specific smoking rates inferred from the Scottish Household Survey are applied. It is assumed that eligibility for smoking cessation is restricted to those aged 16 and older.
- Mortality rate in smokers and non-smokers [Mn] calculated from (i) relative risk [RR] of 2.19 (from Doll et al., 2004), (ii) mortality rate in whole population [Mp], (iii) the proportion of the population who are smokers [b] and (iii) the following formulae relating to Population Attributable Risk [PAR]:
  - \[ PAR = b(RR-1)/1+b(RR-1) \] [calculation of PAR]
  - \[ PAR = Mp – Mn / Mp \] [calculation of Mn]
  - \[ RR = Mo/Mn \] [calculation of Mo]
- Number of smoking attributable hospital admissions calculated by ISD Scotland applied.
- Distribution by age, sex & SIMD is assumed to follow the pattern of eligibility (i.e. smoking status).
- User defined SIMD distribution may reflect a universal or targeted strategy. ‘Success rates’ are 12 month quit numbers based on the national smoking cessation database, estimated to be 6% (note that a large proportion of clients are lost to follow-up at 12 months).
- A successful intervention is assumed to result in a smoker permanently becoming an ex-smoker.
- Ex-smokers have a lower relative risk of death than current smokers, though this is still higher than for those who have never smoked (RR for ex-smoker = 1.31, from Doll et al., 2004). For modelling purposes it is assumed that smoking attributable hospital admissions only occur in current smokers.
- The change in the number of successful interventions delivered under the baseline and modelled scenarios is calculated. Health outcomes (deaths and hospital admissions) are calculated for this group, along with non-smokers and remaining smokers. Outcomes from these three groups are combined to give the overall impact for population sub-groups defined by age, sex and SIMD. Revised mortality rates are used to calculate ‘new’ life expectancy based on modelled deaths, using the Chiang method.
**Alcohol Brief Interventions flowchart**

**User action**

1. **Select population**
   - Current demographics & life expectancy presented for population

2. **Specify baseline activity level and costs**
   - Population eligible for intervention defined as adults aged 16+ drinking over the recommended limits (harmful / hazardous drinkers)

3. **Specify new level of activity, costs and SIMD distribution**
   - Mortality rate and morbidity statistics for people drinking over the recommended limits calculated

**Model progression and calculations**

- **Calculation & presentation of baseline intervention throughput statistics**

- **Calculation & presentation of new (modelled) throughput statistics**

- **Calculation of change in alcohol consumption in intervention group**

- **Calculation of new mortality rate and morbidity statistics for those undergoing the intervention**

- **Calculation of expected population mortality and morbidity, based on prior rates and the change in intervention throughput between baseline and the modelled scenario**

**Notes**

- Data are from National Records Scotland. Life expectancy calculated from mortality rates using Chiang method. All HITS calculations are carried out for population groups defined by age (5-year bands), sex and SIMD quintile, with summary data presented.

- Age / sex / SIMD-specific rates from Scottish Health Survey applied. All harmful / hazardous [H/H] drinkers are eligible (though currently ABIs are offered opportunistically based on clinical presentation).

- Mortality rate in H/H group [Mh] and non-H/H group [Mn] calculated from (i) relative risk [RR] of 1.25 (Stringhini et al., 2011), (ii) mortality rate in whole population [Mp], (iii) the age/sex specific proportion of the population who are in H/H group [b] and (iii) the following formulae relating to Population Attributable Risk [PAR]:
  - PAR = b(RR-1)/1+b(RR-1) [calculation of PAR]
  - RR = Mo/Mn [calculation of Mo]

- SIMD distribution may reflect a universal or targeted strategy. Within SIMD groups, age / sex distribution follows eligibility (i.e. proportion of H/H drinkers). A 'success rate' of 65% is applied (based on the assumption of 100% uptake and data on loss to follow up, as a proxy for non-compliance, from three UK effectiveness studies).

- It is assumed that a reduction in mortality rate of 10% may plausibly result from ABIs. This is an approximate estimate used in the absence of robust data and inferred from data from the Midspan study (Hart et al., 2008). It is assumed that the relative risk of an alcohol-related hospital admission decreases from 2.0 to 1.5. This is an approximate estimate used in the absence of robust data and based on the assumption that although the risk of an alcohol-related hospital admission will decrease following a successful intervention it will still be greater than the population average.

- The change in the number of successful interventions delivered under the baseline and modelled scenarios is calculated. Health outcomes are calculated for this group, the non-intervention group and the non eligible group. Outcomes from these three groups are combined to give the overall impact for population sub-groups defined by age, sex and SIMD. Revised mortality rates are used to calculate 'new' life expectancy based on modelled deaths, using the Chiang method.

**Presentation of key population health and health inequalities outcomes**