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Evaluation of Intervention Impact on Health Inequality for Resource Allocation

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Title: Evaluation of intervention impact on health inequality for resource allocation

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Abstract

Introduction: We describe a simplified distributional cost effectiveness analysis based on aggregate data to estimate the health inequality impact of public health interventions.

Methods: We extracted data on costs, health outcomes expressed as quality adjusted life years (QALYs), and target populations, for interventions within NICE public health guidance published up to October 2016. Evidence on variation by age, sex and index of multiple deprivation informed socioeconomic distributions of incremental QALYs, health opportunity costs, and the baseline distribution of health. Total population QALYs, summary measures of inequality and a health equity impact plane show results by intervention, and by guideline. A value for inequality aversion from a general population survey in England let us combine impacts on health inequality and total health into a single measure of intervention value.

Results: Our estimates suggest that of 134 interventions considered by NICE: 70 (52%) reduce inequality and increase health; 21 (16%) involve a trade-off between improving health and improving health inequality; and 43 (32%) reduce health and increase health inequality. Fully implemented, the potential impact of all recommendations was 23,336,181 additional QALYs for the population of England and Wales, and a reduction of the gap in quality adjusted life expectancy between the healthiest and least healthy from 13.78 to 13.34 QALYs. The combined value of the additional health and reduction in inequality was 28,723,776 QALYs.

Discussion: Our analysis takes account of the fact that existing public health spending likely benefit the most disadvantaged. This simple method applied separately to economic evaluation produces evidence of intervention impacts on the distribution of health that is vital in determining value for money when health inequality reduction is a policy goal.

Introduction

In the UK, no formal approach prescribes how health inequality impacts should inform public health investment decisions. In England women and men in the most deprived areas live up to 9 years fewer, and have up to 20 fewer years in good health, compared to those in the least deprived areas.(1) The reduction of health inequalities associated with socioeconomic factors is a prominent social goal, demonstrating that societies regard these inequalities as unfair and value lessening of inequalities alongside improving health.(2, 3) It has been argued that public health interventions can tackle this objective through their focus on lifestyle changes and other social determinants of health.(4, 5)

The National Institute for Health and Care Excellence (NICE) produces public health guidelines that recommend interventions for provision by national and local healthcare commissioners, or within the wider public and private sectors. NICE's equality objectives note that public health guidance in particular is concerned with tackling health inequalities associated with underlying socioeconomic factors and with inequities in access for certain disadvantaged groups.(6) The current guidance does not describe a process by which Public Health Advisory Committees (PHACs) should take account of impact on health inequalities in their recommendations. A formal review of the available evidence supported with expert testimony and economic evaluation informs their recommendations. The economic evaluations estimate the scale of the health benefits produced for a given investment in an intervention. The PHAC make a judgement about whether the health benefits are valuable compared to alternative uses of the same resources. However, the economic evaluations do not currently evaluate the distribution of outcomes within the population.

Evidence on the health inequality impact of interventions presented to PHACs is typically qualitative and pertains to the characteristics of the target population. This informs the likely socioeconomic distribution of the benefits of the intervention, but fails to account for the distribution of the benefits produced by investing the intervention costs in other public health activities. This omission of opportunity cost prevents estimation of the magnitude of the inequality impact. The socioeconomic distribution of health opportunity costs depends on the characteristics of individuals that benefit from existing services. Where health inequalities are a policy concern, the magnitude of the net health inequality impact is relevant to determining value for money. Producing recommendations without information on health inequality impacts risks failing to promote the most valuable interventions.

In principle a formal distributional cost-effectiveness analysis could evaluate health inequality impacts to support each public health guideline.(7, 8) In the absence of bespoke distributional analysis we demonstrate a method for conducting quantitative inequality impact assessment using available aggregate data. We apply this to NICE guidelines conducted between 2006 and 2016 to

estimate how the public health interventions considered affect the distribution of health, taking into account variation in health outcomes by age, gender and socioeconomic groups.

Methods

The methods are based on distributional cost-effectiveness analysis, and we focus on change in lifetime health inequality across the whole population.(7) Figure 1 shows the steps in combining information on additional costs and health outcomes produced by standard economic evaluation with routine data about the distribution of targeted health problems, and prior knowledge of health opportunity costs, according to age, gender, socioeconomic status. In essence, this scales up average costs and health outcomes using patient population numbers, and disaggregates them to describe the distribution of health benefits by age, gender and socioeconomic status. We show the calculations for public health guideline 43 (Hepatitis B and C testing) in Box 1. Combining the distributions of intervention impacts with a baseline distribution of health shows how interventions and public health recommendations might affect lifetime health inequality in the English population. We used quality adjusted life years (QALYs) and quality adjusted life expectancy (QALE) as our measure of health, and the Index of Multiple Deprivation (IMD) as our measure of socioeconomic status.(9)

We describe seven stages of analysis:

(i) Extract incremental costs and health benefits and size of the target population;

(ii) Estimate the distribution of population health benefits by gender and socioeconomic status;

(iii) Convert population costs into health opportunity costs;

(iv) Estimate the distribution of population health opportunity cost by gender and socioeconomic status;

(v) Calculate the net health impact (health benefit minus health opportunity cost) for gender and socioeconomic subgroups;

(vi) Combine net health impacts with a baseline distribution of lifetime health;

(vii) Calculate inequality measures on the pre- and post-intervention health distributions to summarise health inequality impact.

(i) Extract incremental costs and health benefits and size of the target population

We reviewed cost-effectiveness evidence and the associated PHAC recommendations for NICE public health guidance issued between March 2006 and October 2016. We extracted information from guidance documents, economic modelling reports and costing templates. We excluded guidelines if: (i) no economic modelling was conducted; (ii) the economic modelling did not use QALYs as a health outcome measure; (iii) incremental costs and QALYs were not reported separately; (iv) hypothetical analyses were conducted rather than modelling specific interventions; (v) the guideline was obsolete.

For each intervention we extracted the PHAC recommendation and the per recipient incremental costs and QALYs that formulated the base-case incremental cost-effectiveness ratios. These represent the present value of the costs and QALYs accruing over the time horizon of the underlying cost-effectiveness analysis, for which the NICE reference case indicates the use of an annual discount rate of 3.5%. To estimate the number of recipients we extracted population size estimates from NICE documentation, and if unavailable, from alternative sources including previously published studies and national population statistics. Where no specific intervention was explicit in PHAC recommendations, we used the Committee's consideration of the cost effectiveness evidence to inform assumptions about whether the intervention would fall under the general recommendation. Where the economic evidence included a range rather than a single estimate of cost-effectiveness for an intervention, we extracted the best and worst case, with the best case used for our primary analysis.

(ii) Estimate the distribution of population health benefits by gender and socioeconomic status

We multiplied the target population size by the per person QALY gain to calculate the incremental population health benefit for each intervention. This value represents the upper limit of health gains as it entails every person in the eligible population receiving the intervention (i.e. 100% reach and 100% implementation) and does not account for any proportion of the population that may already be in receipt of the intervention.

To estimate the size of each gender and socioeconomic subgroup within a target population we first categorised interventions as: (i) targeting specific diseases, such as Type 2 diabetes; (ii) targeting health behaviours, such as smokers; or (iii) targeting disadvantaged groups such as low income or high deprivation populations.

For interventions targeting diseases, we mapped those diseases to three-digit International Classification of Disease (ICD) codes. We then calculated subgroup sizes based on the corresponding proportion of NHS hospital activity by gender, IMD and ICD code for that group using Hospital Episode Statistics (HES) (2011-12 and 2012-13). For interventions targeted by age, we used data from the relevant age band. Where interventions targeted behaviours, we searched for data sources that reported behaviour distribution by gender and IMD. For interventions specifically targeting low

income, disadvantaged or deprived groups we made a simplifying assumption that the health benefits would accrue to the most deprived fifth of the population in terms of IMD.

(iii) Convert population costs into health opportunity costs

We calculated incremental population costs by multiplying the target population size by the per person incremental cost. As costs represent investments that could be spent elsewhere, namely other public health interventions, we converted them into health losses using an estimate of the health opportunity cost per pound of public sector expenditure. This value signifies the cost per QALY of services that could otherwise have been funded (or can be introduced if a public health intervention is cost saving). We use a value of £20,000 per QALY for the base case analysis, which corresponds to the lower bound of the health sector cost-effectiveness threshold used within NICE.(10) If this figure is overestimated or if public health activities are more efficient than medical care activities this value underestimates health opportunity costs.(11-13)

(iv) Estimate the distribution of population health opportunity cost by gender and socioeconomic status

We found no published estimate of the socioeconomic gradient for marginal changes in public health expenditure, and so we assumed the same gradient as observed in NHS funded interventions. The gender and socioeconomic distribution of population health gains from marginal changes in NHS expenditure has recently been estimated.(14) We use this to represent the distribution of the health benefits that would have been produced by alternative public health interventions. The distribution provides the proportion of the marginal QALY gain that would accrue to each gender and IMD subgroup, and when multiplied by the population health opportunity costs for each intervention this provides the subgroup health opportunity costs.

(v) Calculate the net health impact for gender and socioeconomic subgroups

The population net health impact by intervention and subgroup is the difference between the incremental population health benefits and incremental population health opportunity costs. The impact by guideline is the sum of the costs and benefits of all interventions recommended within a guideline. Where a guideline included recommendations for multiple interventions that would be mutually exclusive from an individual perspective we assumed an even split in utilisation across each intervention in the target population.

(vi) Combine net health impacts with a baseline distribution of lifetime health

The baseline distribution of health represents existing health inequality by gender and socioeconomic status across the population in England and Wales.(15) The incremental net health effects of each intervention or guideline added to this baseline provide a picture of health inequality following the implementation of the intervention or guideline. This describes the impact of interventions at the level of the population of England and Wales.

(vii) Calculate inequality impact measures

We chose the slope index of inequality (SII) and the relative index of inequality (RII) to summarise inequality in the distribution of health.(16) The SII is commonly used in public health research when examining absolute inequality in life expectancy by IMD. It is obtained by fitting an ordinary least squares model to estimate the slope or health gradient, and interpreted as the absolute difference in QALE when moving from the least to most healthy in the population. The RII is the SII divided by the mean QALE, and represents the relative change in QALE when moving from the least to most healthy. The net inequality impact is the difference between SII or RII value pre- and post-intervention. We report the reduction such that positive values indicate interventions estimated to reduce health inequality.

We combined the impacts on total population health and health inequality into a single indicator of value by first summarising inequality in the distribution using the Atkinson and Kolm indices.(17-19) These indices on their own summarise the magnitude of relative and absolute inequality respectively, and in essence assign a weight to each individual's QALE that decreases as the individual's rank in the distribution of lifetime health increases. A perfectly equal distribution of health results in an inequality index of 0, and a perfectly unequal distribution results in an index equal of 1. The weights and the value of improvements in total population health relative to the value of reduction in inequality are determined by an inequality aversion parameter, which signifies the level of concern for health inequality. The higher the inequality aversion parameter, the greater the priority to reducing health inequality compared to increasing overall health. We used inequality aversion parameters estimated in a survey of the general public in England that asked respondents to choose between an intervention that provided more health overall and one that provided less health overall but reduced the gap in health achievement between the richest and poorest.(20) The estimated inequality aversion parameters are 10.95 for the Atkinson ε and 0.15 for the Kolm α. Given the initial levels of quality-adjusted life expectancy presented to study participants, these figures suggest a weight for health gains to the poorest fifth of people between 6 and 7 times as high as incremental gains to the richest fifth.

When subtracted from one and multiplied by the mean level of health, the Atkinson and Kolm indices can be used to summarise the value of a distribution of health in terms of the 'equally distributed equivalent' (EDE) level of health. The equally distributed equivalent is the level of population health (expressed in QALYs), that if provided uniformly to everyone in a population, would yield the same amount of social welfare to the distribution of health being evaluated. An intervention estimated to reduce health inequality will have an equally distributed equivalent health impact more positive than its net population health impact. Conversely, interventions that increase health inequality would have an equally distributed equivalent more negative than their net population health impact, with the difference showing the loss of social welfare in terms of QALYs.

Sensitivity analyses

To assess the sensitivity of the results to the estimated cost per QALY of services that could otherwise have been funded (or introduced using resources freed up by cost saving public health interventions) we varied the value from its base case of £20,000 between £2,000 to £50,000. We explore sensitivity to the level of relative inequality aversion by varying the inequality aversion parameter used to calculate the Atkinson index from its base case of 10.95 between 0 and 20. We also investigated the differences in our results when using the costs and health estimates associated with the worst case scenario for those interventions where multiple cost-effectiveness results were reported.

Results

The final dataset consisted of 33 guidelines covering 134 discrete interventions. Detail of the included guidelines (Table A1), flow diagram (Figure A1) and exclusions for data extraction (Table A2), full results by intervention (Table A4) and full results of sensitivity analyses are provided in an online supplement.

Table 1 summarises the net population health and inequality impacts of interventions, and Figure 2 and Figure 3 show the interventions' locations on the health equity impact plane, separated according to whether they were recommended by the PHAC. Estimated SII reductions varied between -0.02 to 0.36, suggesting that the maximum a single intervention could reduce the gap in QALE between the least and most healthy from its baseline value of 13.78 was by 0.36 QALYs, and at most a single intervention could increase the gap by 0.02 QALYs. At the population level of England and Wales, the majority of interventions had small impacts on health inequality (interquartile range for change in SII -0.0002 to 0.001). Ten percent of interventions were associated with reductions in SII of 0.06 or greater. Positive correlation was observed between net population health impact and SII reduction (Pearson correlation coefficient = 0.94). The change in Atkinson index indicated improvement in

social welfare for 73 (86%) of interventions recommended by the PHAC and 15 (31%) of interventions that were not recommended by the PHAC.

Table 2 and Figure 4 show the results of full implementation of all recommendations by guideline. Eighteen (60%) were estimated to increase total population health and reduce health inequality; four (13%) were estimated to reduce total population health and increase health inequality; and eight (27%) involved a trade-off. Estimated net population health benefits range from -1.1 million QALYs (NG6) to 10.9 million QALYs (PH50). Health inequality impacts range from an increase in SII of 0.02 (NG6) to a reduction by 0.23 (PH50). The guidelines where the value of health gains are reduced by the fact that they increase inequality in the distribution of health are PH41 and NG34 (increase in absolute inequality only), and PH17, PH20 and NG21 (increase in relative and absolute inequality). The equally distributed equivalent indicated that social welfare would increase from recommendations in all but four guidelines (PH29, PH31, PH54, NG6), all of which were associated with negative changes in population health. The potential cumulative impact across all guidelines was an additional 23,336,181 QALYs in the population of England and Wales and a reduction in SII of 0.44. The equally distributed equivalent health from full implementation of recommendations across all guidelines was 28,723,776 QALYs, implying that the inequality reduction is equivalent in worth to an additional 5.4 million QALYs.

We estimated different measures of relative inequality and absolute inequality, and found little disagreement between them. For two guidelines (PH41 and NG34) relative inequality measured by Atkinson index reduced while absolute inequality measured by Kolm index and SII increased, and for two more (PH3 and PH24) the SII increased but Atkinson and Kolm indexes indicated a reduction in inequality. The sensitivity analyses indicated that increasing the value of the health opportunity cost above £20,000 per QALY had little impact (Figure A2 in online supplement). However, the estimated cumulative reduction in SII fell as the cost per QALY of alternative investments reduced, to 0.42 using £10,000 per QALY and to 0.27 using £2,000 per QALY. The ranking of guidelines in terms of equally distributed equivalent health impact was sensitive to changes in the inequality aversion parameter, with a change of rank observed for 12 out of 30 guidelines when the inequality aversion was increased from 0 to a value of 20 (Figure A3 in online supplement). However, overall conclusions about the direction of change in social welfare were less sensitive and changed for only 1 out of 30 guidelines. Using worst case estimates for incremental costs and QALYs in general reduced estimated reductions in health inequality (Table A3 in online supplement).

Discussion

The method we propose produces quantitative information on health inequality impacts from the evidence routinely provided for the formation of public health recommendations. Equally distributed equivalent health calculations place a greater value on health gains if they reduce inequality in lifetime health. This prioritises an additional QALY to someone with low quality adjusted life expectancy over an additional QALY to someone with high quality adjusted life expectancy. New public health interventions are often funded with resource that would have been used for alternative public health activities, and this method ensures that health opportunity costs contribute to the estimates of net health inequality impact.

The moderate positive correlation between cost effectiveness and health inequality reduction in this sample suggests that recommendations based on cost effectiveness alone might coincide with decisions that incorporate concern for health inequality, but not always. The majority of PHAC recommendations were for interventions that reduce health inequality; where this is the case focussing on population health gains alone routinely undervalues investment in public health interventions. This is important where public health interventions compete for funds with downstream healthcare interventions, which may have less scope to reduce inequality.

If health inequalities influence PHAC recommendations, a lower probability of recommendation would be expected for interventions that increase population health and increase health inequality compared to those that increase population health and reduce health inequality. Similarly, we would expect a higher probability of recommendation for interventions that reduce population health but reduce health inequality compared to interventions that reduce population health and increase health inequality. The small sample of trade-offs we found does little to inform this, and we did not search for qualitative discussion of inequality in the considerations section of the guidelines. Overall, we found that PHAC recommendations were highly concordant with social welfare. Some PHAC recommendations improved health but increased absolute inequality in health. Our analysis indicates that society values the associated increase in population health associated with these recommendations (5.6 million QALYs) sufficiently to accept the increased health inequality (increase in SII of 0.005).

We systematically extracted data from published NICE guidelines and used an empirical estimate of the socioeconomic distribution of the health opportunity cost to represent the potential harms from diverting resources from alternative activities. However, we made a number of simplifications that are worth consideration in future applications of this method. We did not attempt to characterise PHAC considerations regarding the quality of evidence nor the impact of uncertainty. Our estimates represent the maximum possible impact as we did not search for evidence on differential uptake between population groups and present our results in terms of full implementation of the interventions. Where interventions are more likely to be utilised in least deprived groups, as can be

the case where uptake relies on individual agency, we will have overestimated reductions in health inequality.(21, 22) The method we propose can easily incorporate differential uptake by distributing the population health benefits only to the proportion of each group assumed to utilise the intervention.

We also did not search for evidence of differential efficacy. Determining the impact of this on health inequality impacts is not straightforward as the relationship to average QALY gains may be non-linear and counterbalanced by interaction with differential baseline risks. Evidence for differential efficacy between population groups can guide the use of full distributional cost effectiveness analysis in place of this simplified approach.

The value used to convert costs into health opportunity costs is a significant driver of the results, which demonstrates the importance of getting this value right for any formal appraisal process. Since opportunity costs fall heaviest on the poorest and least healthy, inequality increases with the health opportunity cost for cost increasing interventions. If the value we use is too high, we will have overestimated improvements in total population health, reduction in health inequality and improvement in social welfare. The £20,000 per QALY used by NICE for a health sector perspective is higher than empirical estimates within the health sector.(11) The cost per QALY for a public health perspective could be lower than the health sector; the median cost per QALY for public health interventions considered by NICE is £7,843.(13) The level of health inequality aversion is also uncertain and can be difficult to measure without bias. UK estimates range from 5.4 to 28.9.(23, 24) However, our results were not particularly sensitive to variation in this parameter.

We based the socioeconomic distribution of the health opportunity costs on the characteristics of beneficiaries from NHS spend. Targeting of public health interventions to disadvantaged groups could imply that the health opportunity costs fall even more on disadvantaged groups in comparison to NHS expenditure, but we did not identify evidence for this. If true, it implies that we underestimated the reduction in health inequality from cost savings and the increase in health inequality from additional costs. Our method assumes that funds used to provide public health interventions would otherwise have been spent on health generating activities. This ignores how opportunity cost may differ where public health interventions impose costs across different sectors with interests outside of health improvement. However, previous research has shown that healthcare costs are the predominant category of cost impact within NICE public health guidance.(25)

Previously Owen et al. examined the cost-effectiveness of public health interventions underpinning NICE public health guidance.(13, 26) Our study is the first to examine the health inequality impacts of those same interventions, and follows the same principles outlined for full distributional cost effectiveness analysis.(7) McAuley et al. modelled the impact of a range of policies on population health and inequality by IMD in Scotland.(27) They did not assume 100% reach for all interventions, but as the assumed equal uptake across population groups their health inequality impacts would be

expected to be smaller but in the same direction as our estimates. However, their analysis did not include health opportunity costs. For public health interventions they found impacts on health inequality of similar magnitude and direction to those presented here.

Future applications of this method should seek to incorporate evidence on differential uptake, and to carefully consider the implications where there exists evidence of differential effectiveness between socioeconomic groups. Ongoing research to estimate both the mean and the socioeconomic distribution of the health opportunity cost specific to public health investments and to explore how this varies across the public sector will boost the application of this method.

This method is fast, requires little data above that routinely produced to support public health guidelines, and provides information about the potential magnitude of health inequality impacts to support recommendations. The Health and Social Care Act of 2012 introduced legal duties for decisions in the NHS to be made with due regard to reduce health inequalities. Our analysis demonstrates that a simple distributional cost effectiveness analysis framework is feasible and could provide additional information on which to base recommendations for health interventions. The proposed use is within a deliberative decision making process that takes account of factors outside of the economic calculations, such as the quality of the underlying evidence. In the current cost constrained funding environment for public health, consideration of the socioeconomic distribution of the health opportunity cost is vital to ensure that new investments perform better than existing activities for the most disadvantaged. Showing the location of public health interventions on the health equity impact plane could draw attention to, and prompt further examination for, interventions found to have negative impacts.(28) Presenting the results using equally distributed equivalent health can demonstrate the added social value of reducing health inequality over and above improvements in total population health, and could be a useful tool for advocating increased investment in public health.

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Impact	Recommended	Not recommended	% Recommended
Increases total health and reduces inequality	57 (67%)	13 (27%)	84
Increases total health and increases inequality	14 (16%)	2 (4%)	86
Reduces total health and reduces inequality	3 (4%)	2 (4%)	50
Reduces total health and increases inequality	11 (13%)	32 (65%)	26
Overall	**85**	**49**	**63**

Code	Topic	NPB	ΔSII	$\Delta EDE_{A,\varepsilon}$ (ε=10.95)	$\Delta EDE_{K,\alpha}$ (α=0.15)
PH50	Domestic violence and abuse	10,862,451	0.2317	12,890,044	12,524,194
PH15	Coronary heart disease	5,835,560	0.1496	7,876,529	7,568,577
PH41	Walking and cycling	5,329,142	-0.0015	5,421,791	5,309,340
PH35	Type 2 diabetes prevention: population and community level	786,051	0.0724	1,866,502	1,734,321
PH45	Smoking: harm reduction	594,011	0.0110	750,737	724,712
PH14	Child smoking prevention	171,359	0.0031	215,036	207,693
PH17	Physical activity in children	169,267	-0.0009	163,623	160,766
PH19	Reducing absenteeism	121,518	0.0009	132,345	128,993
PH24	Preventing and treating alcohol-use disorders	118,338	-0.0009	123,023	119,042
NG22	Older people with social care needs and multiple long-term conditions	18,033	0.0048	93,719	84,952
NG32	Older people: independence and mental wellbeing	83,144	0.0005	89,281	87,137
NG21	Home care for older people	111,340	-0.0023	88,568	88,356
NG27	Inpatient hospital and community or care home transition	82,582	0.0002	87,948	85,872
PH4	Substance misuse interventions for under 25s	64,550	0.0019	80,637	78,126
PH43	Hepatitis B and C testing	56,046	0.0010	69,947	67,673
PH28	Looked-after children and young people	23,757	0.0003	27,551	26,765
PH38	Type 2 diabetes prevention: people at high risk	10,251	0.0001	12,446	12,051
PH23	School-based interventions for smoking cessation	4,529	0.0001	7,431	7,043
NG34	Sunlight exposure	5,449	-0.0000	5,583	5,445
PH26	Smoking cessation for pregnant women	3,280	0.0001	4,101	3,965
PH20	Emotional and social wellbeing in secondary schools	2,588	-0.0000	2,219	2,197
NG55	Harmful sexual behaviour (HSB) among children and young people	1,717	0.0000	2,010	1,951
NG33	Tuberculosis	866	0.0001	1,654	1,553
PH3	STI Infection and Teenage Conception	1,260	-0.0000	1,445	1,397
PH30	Unintentional injuries in the home for under 15s	-258	0.0000	290	232
PH21	Immunisation programmes	23	0.0000	25	25
PH29	Unintentional injuries: prevention strategies for under 15s	-583	-0.0000	-805	-778
PH31	Unintentional injuries on the road for under 15s	-1,067	-0.0000	-1,323	-1,284
PH54	Physical activity: exercise referral schemes	-2,325	-0.0001	-3,584	-3,442
NG6	Excess winter deaths and illness	-1,116,696	-0.0167	-1,285,862	-1,250,886

PH43 Hepatitis B and C testing

This guideline contributed five interventions to the analysis. This worked example focussed on one: the use of dried blood spot testing in specialist addiction services.

(i) The economic evaluation reported total incremental costs of £917,478 and incremental quality-adjusted life years (QALYs) of 63.

The target population was injecting drug users (IDU), aged 15-59, in contact with specialist services. The economic evaluation submitted to NICE indicated that 0.65% of the population aged 15-59 are current IDU, 25% of whom are undiagnosed and in contact with specialist addiction services. We multiply these by the 2011 UK census figure of 37,899,000 individuals aged 15-59 to obtain a target population size of 61,586.

Note that if per person incremental costs (£14.90) and QALYs (0.001) had been reported, these would have been multiplied by population size.

(ii) This guideline targets the diseases Hepatitis B and C, which map to ICD codes B17, B18 B19.

The subgroup sizes are determined using the proportion of NHS activity by gender and ICD code. We report the calculations for females, who constitute 48% of all NHS activity in this ICD code. The same approach applied to males provides the subgroup sizes within the remaining 52%.

The distribution of NHS hospital activity by IMD quintile for females in these ICD codes is, in order from most deprived to least deprived, 0.14, 0.11, 0.11, 0.07 and 0.06.

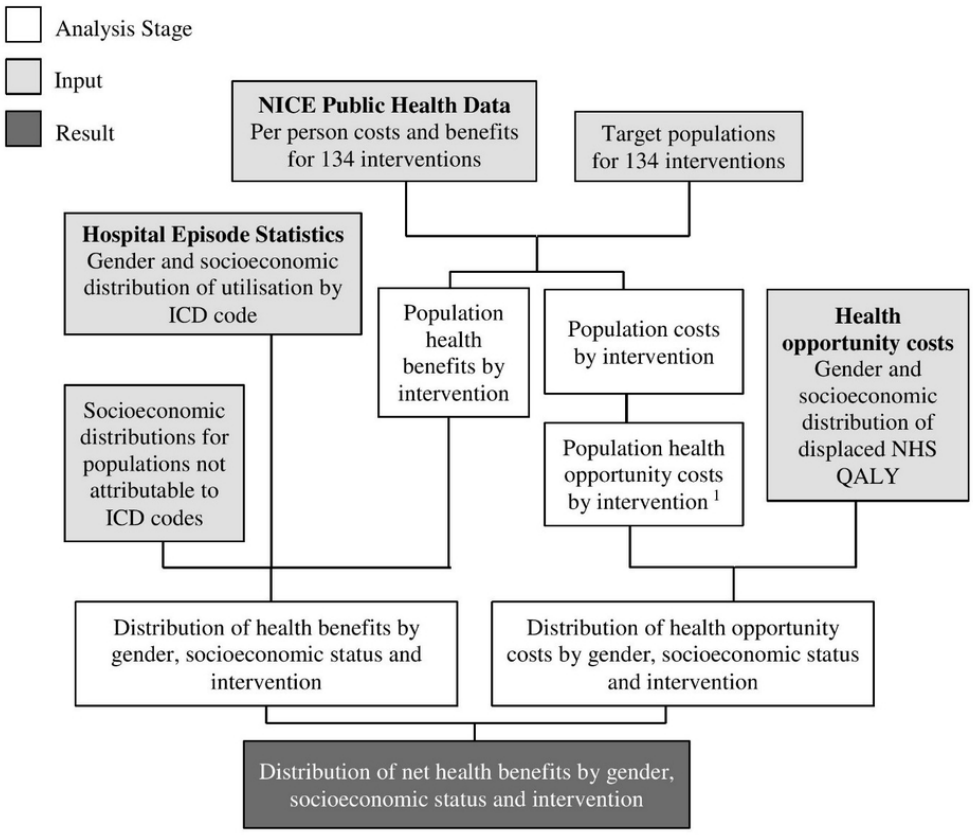
(iii) The same health opportunity cost of one QALY per £20,000 applies for all interventions. The total population cost in terms of health opportunity costs is £917,478/£20,000 = 46 QALYs.

(iv) The distribution of this opportunity cost is the same for all interventions. In females, the order from most deprived to least deprived IMD quintile is 0.14, 0.12, 0.12, 0.09, and 0.08.

(v) Calculation of the distribution of net benefits by index of multiple deprivation quintile (IMD) for females from dried blood spot testing for Hepatitis B and C

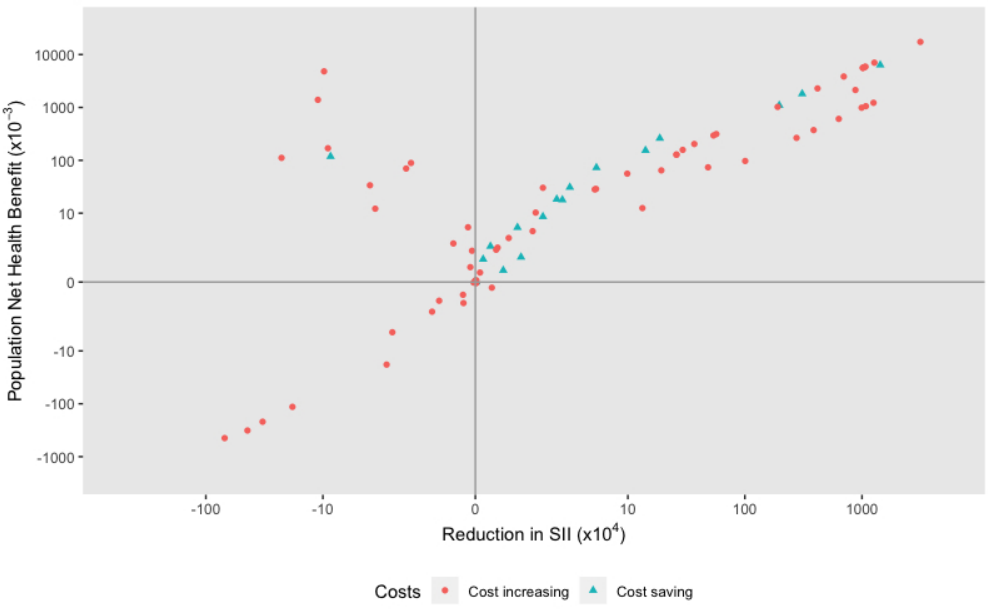
	IMD1	**IMD2**	**IMD3**	**IMD4**	**IMD5**
(a) Proportion of health benefits	0.14	0.11	0.11	0.07	0.06
(b) Total health benefits (a*63)	8.7	6.8	6.8	4.4	3.7
(c) Proportion of health opportunity costs	0.14	0.12	0.12	0.09	0.08
(d) Total health opportunity costs (c*46)	6.4	5.5	5.5	4.1	3.7
(e) Net benefits (b-d)	2.3	1.3	1.3	0.3	0.0

Note: Health is measured in terms of quality-adjusted life years; IMD1 is the most deprived quintile



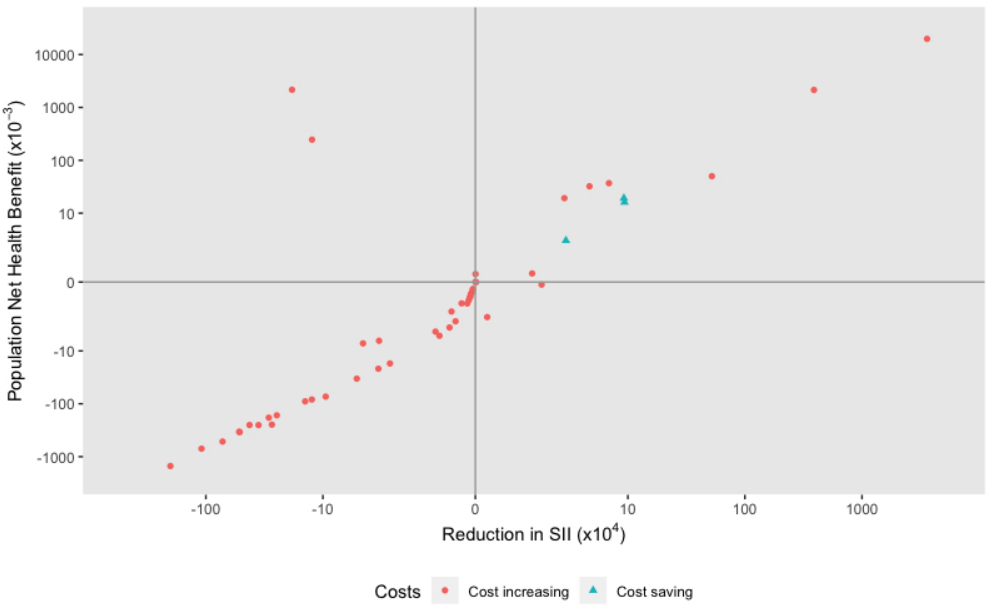
Influence diagram demonstrating how data are combined to estimate the net distributional effect of interventions.
Footnote 1. Intervention costs are converted into health opportunity costs using a cost-effectiveness threshold of £20,000 per QALY.

160x139mm (150 x 150 DPI)



Health equity impact plane for PHAC recommended interventions
Footnote: Axes are subject to an inverse hyperbolic sine transformation and reduction in SII is multiplied by 104 to allow all interventions to be displayed on a single plane

282x176mm (72 x 72 DPI)



Health equity impact plane for interventions not recommended by the PHAC
Footnote: Axes are subject to an inverse hyperbolic sine transformation and reduction in SII is multiplied by 104 to allow all interventions to be displayed on a single plane

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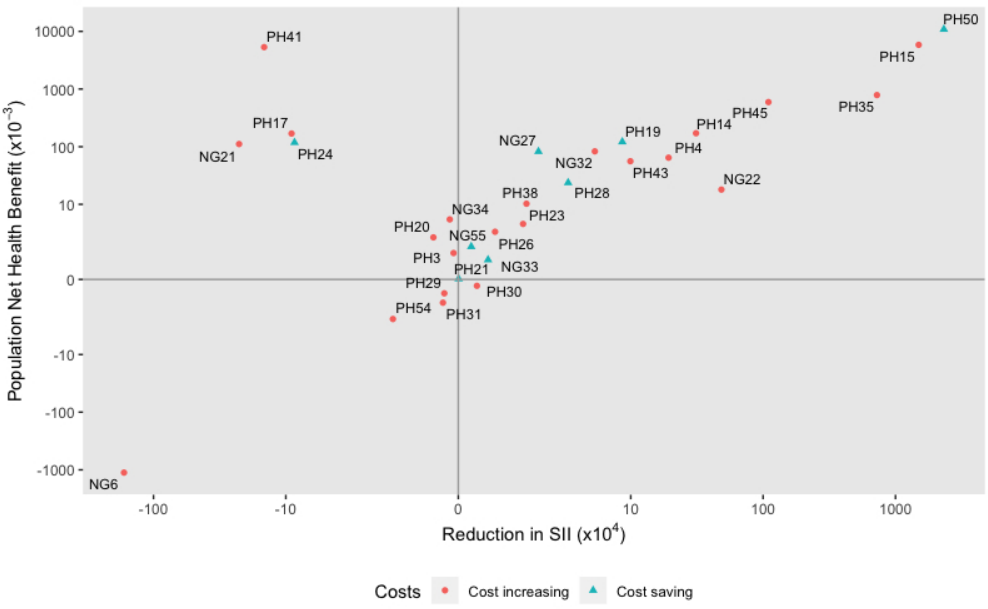


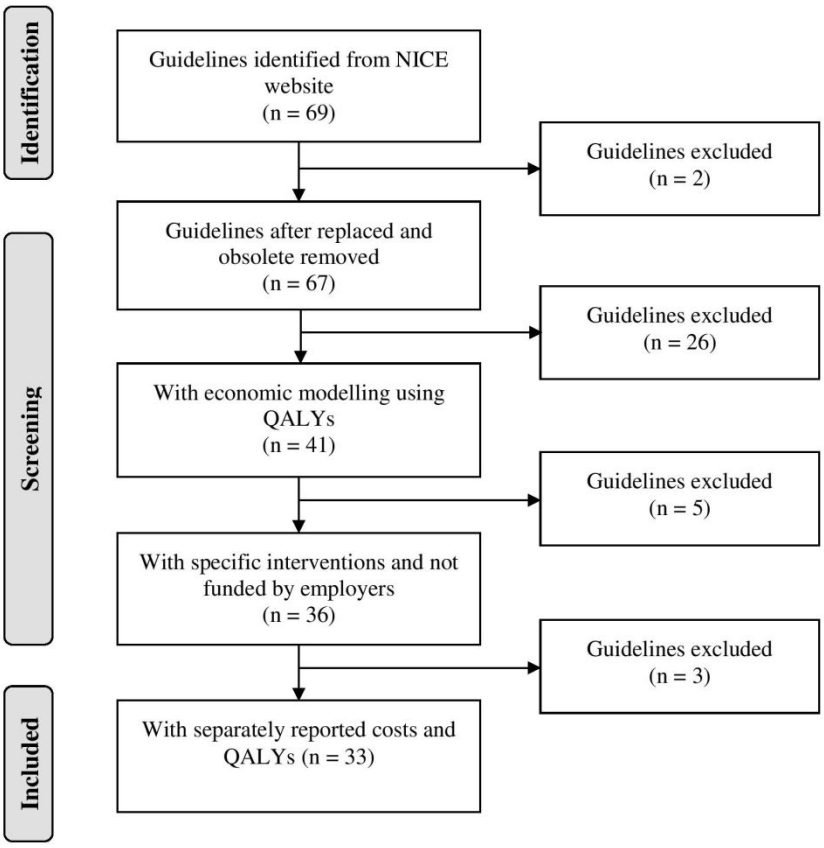
Health equity impact plane for PHAC recommended interventions by guideline
Footnote: Axes are subject to an inverse hyperbolic sine transformation and reduction in SII is multiplied by 104 to allow all guidelines to be displayed on a single plane

282x176mm (72 x 72 DPI)

Table A1: Guidelines in the analysis alongside total number of included interventions and number recommended

		Interventions in guideline	
Code	**Topic**	**Included**	**Recommended**
NG21	Home care for older people	1	1
NG22	Older people with social care needs and multiple long-term conditions	1	1
NG27	Inpatient hospital and community or care home transition	4	3
NG30	Oral health promotion	2	0
NG32	Older people :independence and mental wellbeing	2	2
NG33	Tuberculosis	6	4
NG34	Sunlight exposure	5	2
NG55	Harmful sexual behaviour (HSB) among children and young people	2	2
NG6	Excess winter deaths and illness	14	5
PH3	STI Infection and Teenage Conception	2	2
PH4	Substance misuse interventions for under 25s	4	1
PH14	Child smoking prevention	2	2
PH15	CHD - Smokers	22	18
PH17	Physical activity in children	4	1
PH19	Reducing absenteeism	3	3
PH20	Emotional and social wellbeing in secondary schools	1	1
PH21	Immunisation programmes	2	2
PH23	School-based interventions for smoking cessation	1	1
PH24	Preventing and treating alcohol-use disorders	1	1
PH26	Smoking cessation for pregnant women	5	5
PH28	Looked-after children and young people	2	2
PH29	Unintentional injuries: prevention strategies for under 15s	1	1
PH30	Unintentional injuries in the home: interventions for under 15s	1	1
PH31	Unintentional injuries on the road for under 15s	4	2
PH32	Information to prevent skin cancer	8	0
PH35	Diabetes prevention	5	3
PH38	Diabetes prevention	3	1
PH40	Social and emotional wellbeing: early years	4	0
PH41	Walking and cycling	6	4
PH43	Hepatitis B and C testing	5	5
PH45	Smoking:harm reduction	4	4
PH50	Domestic violence and abuse: multi-agency working	2	2
PH54	Physical activity: exercise referral schemes	4	3

Figure A1: Flow diagram showing reasons for exclusion of guidelines



Note: NICE = National Institute of Health and Care Excellence; QALY = quality adjusted life year

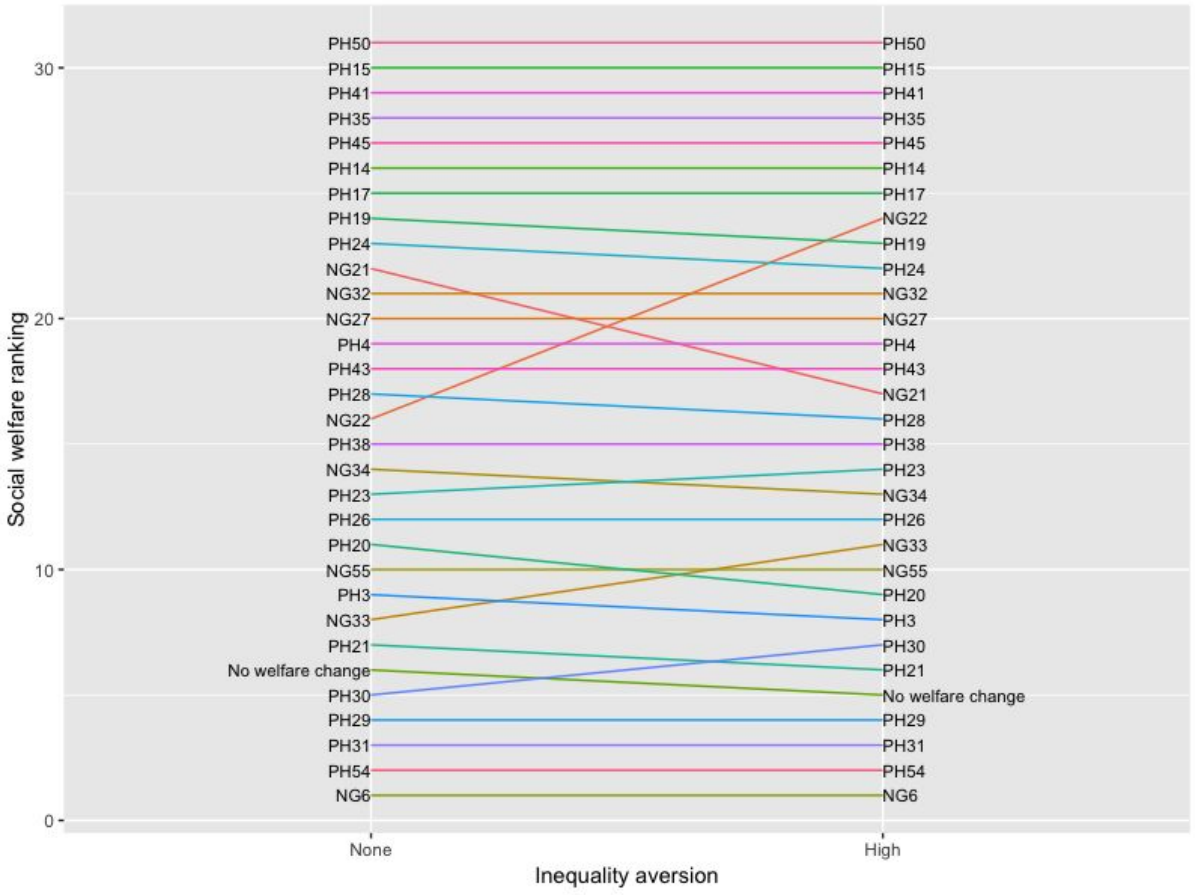
Table A2: Guidelines excluded, or containing interventions excluded, from the study

Reason for exclusion	Guideline codes
Guidance replaced and obsolete	PH2, PH9
No economic modelling / benefits not expressed in QALYs	PH7, PH10, PH11, PH13, PH18, PH25, PH33, PH34, PH36, PH39, PH42, PH44, PH46, PH47, PH48, PH49, PH51, PH52, PH53, PH55, PH56, NG7, NG44, NG48
Incremental costs and QALYs not reported separately	PH1, PH6, PH12
Specific interventions not modelled	PH8, PH21, NG13
Intervention costs funded by employers	PH5, PH22
Includes interventions where data on population or distribution was not available (number excluded)	PH15 (2), PH38 (1)
Includes interventions with no reported QALYs (number excluded)	NG30 (1), NG27 (1), NG32 (2)

Table A3: Difference between best and worst case estimates of cost-effectiveness.

Guideline	Intervention	Recommended	$\Delta EDE_{A,\varepsilon}$ (best)	$\Delta EDE_{A,\varepsilon}$ (worst)	Difference
NG22	Outpatient geriatric multidisciplinary assessment and case management intervention	Yes	1,091	187	-904
PH15	Dentist-based interventions	Yes	15,133	6,383	-8,750
PH15	Free mobile phones	No	76,139	10,379	-65,760
PH15	Free NRT	No	8,426	6,292	-2,133
PH15	ID smokers through other means	Yes	21,985	-1	-21,987
PH15	Pharmacist-based interventions	Yes	9,081	3,992	-5,089
PH15	Pharmacist-based interventions (deprived area)	Yes	27,111	1,363	-25,748
PH15	Proactive telephone counselling	Yes	22,721	1,582	-21,140
PH15	Recruitment to 'Quit and Win'	Yes	27,476	738	-26,738
PH15	Social marketing (African Americans)	Yes	114	0	-114
PH15	Pharmacist-based interventions (CHD)	Yes	659	-28	-687
PH24	Screening and brief intervention	Yes	103	-94	-197
PH28	Transition support services (females)	Yes	11	-5	-16
PH28	Transition support services (males)	Yes	51	15	-36
PH3	Accelerated Partner Therapy	Yes	1	0	0
PH3	Counselling	Yes	3	-9	-12
PH32	Multicomponent in community	No	-1	-1	0
PH32	Multicomponent in healthcare setting	No	-3	-3	0
PH32	Verbal advice	No	0	-8	-8
PH4	Life skills training	Yes	180	22	-158
PH41	Led walking	Yes	9	-22	-31
PH41	Pedometer	Yes	343	-13	-356
PH41	TravelSmart	Yes	2,818	157	-2,661
PH45	Quit and substitute with long-term nicotine use with generic professional behavioural support	Yes	4,235	29	-4,207
PH45	Temporary abstinence or reduce smoking with specialist services behavioural support	Yes	630	-3,586	-4,216
PH54	Exercise referral scheme	No	-69	-61	9
PH54	Exercise referral scheme (depression)	Yes	-11	-12	-2
PH54	Exercise referral scheme (hypertension)	Yes	-32	-33	-1
PH54	Exercise referral scheme (obese)	Yes	-14	-15	-2

Figure A2: Social welfare rank order of each guideline: left hand side when only total health benefit is considered (no inequality aversion); right hand side when there is large concern for health inequality



Note: No inequality aversion equates to the parameter ε in the Atkinson Welfare Index set to 0. For high inequality aversion, ε=20.

Figure A3: Effect of the cost-effectiveness threshold on the reduction SII from implementing all guidelines

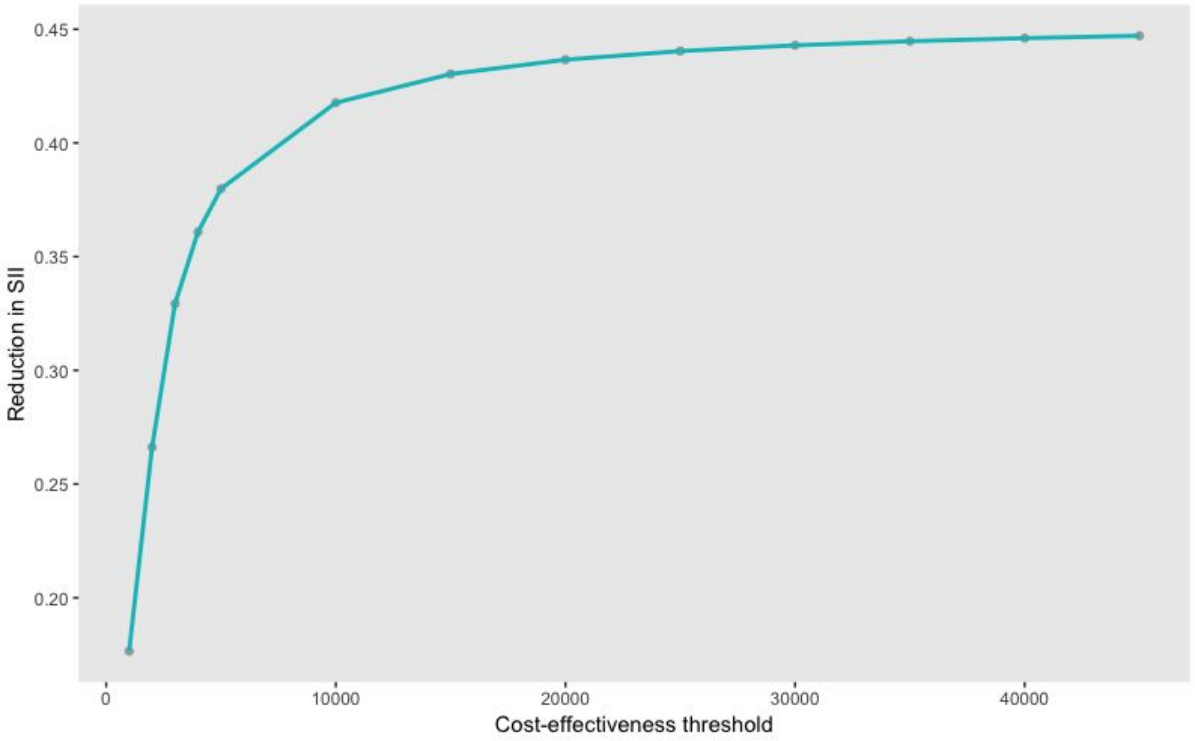


Table A4: Intervention characteristics of extracted NICE public health interventions

Topic	Intervention	Code	QALY	Cost	Population	Recommended
Home care for older people	Social care services provided as part of care package for people living in own home and care planning approach	NG21.1	0.02	£107	7,600,000	Yes
Older people with social care needs and multiple long-term conditions	Outpatient geriatric multidisciplinary assessment and case management intervention	NG22.2	0.17	£1,240	683,070	Yes
Inpatient hospital and community or care home transition	Multidisciplinary palliative care teams	NG27.1	0	-£1,789	200,000	Yes
Inpatient hospital and community or care home transition	Early supported discharge following stroke	NG27.2	0.47	£5,000	152,000	Yes
Inpatient hospital and community or care home transition	Early supported discharge older people	NG27.3	0.02	-£1,727	291,000	Yes
Inpatient hospital and community or care home transition	Specialised geriatric intervention for older people presenting with undifferentiated confusion	NG27.4	0	£933	76,000	No
Oral health promotion	One-to-one health counselling	NG30.1	0.0002	£225	464,422	No
Oral health promotion	One-to-one health counselling	NG30.2	0.0003	£166	89,856	No
Older people:independence and mental wellbeing	Internet and computer training intervention	NG32.1	0.02	£340	3,040,000	Yes
Older people:independence and mental wellbeing	Friendship programmes	NG32.2	0.04	-£314	3,040,000	Yes
Tuberculosis	Mobile X-ray unit screening (homeless)	NG33.1	0.083	-£920	4,134	Yes
Tuberculosis	Enhanced case-management (homeless)	NG33.2	0.093	-£3,470	33	Yes
Tuberculosis	Mobile X-ray screening and enhanced case-management (homeless)	NG33.3	0.138	-£3,580	4,134	Yes
Tuberculosis	Mobile X-ray unit screening (prisoners)	NG33.4	0.013	£280	85,975	No
Tuberculosis	Enhanced case-management (prisoners)	NG33.5	0.013	-£1,340	179	Yes
Tuberculosis	Mobile X-ray screening and enhanced case-management (prisoners)	NG33.6	0.018	-£330	85,975	No
Sunlight exposure	Information programme for schoolchildren	NG34.1	0	£15	641,065	No
Sunlight exposure	Photoageing	NG34.2	0	£12	1,479,039	No
Sunlight exposure	Text messaging	NG34.3	0.0001	£4	16,654,773	No
Sunlight exposure	Tailored messages	NG34.4	0.0003	£4	641,065	Yes
Sunlight exposure	Mass media campaign	NG34.5	0.0001	£0	53,844,267	Yes

Harmful sexual behaviour (HSB) among children and young people	Multi-systemic therapy	NG55.1	0.061	-£9,551	4,209	Yes
Harmful sexual behaviour (HSB) among children and young people	Cognitive behavioural therapy	NG55.2	0.035	-£4,847	4,209	Yes
Excess winter deaths and illness	Home energy efficiency intervention	NG6.1	0.048	£1,358	895,280	Yes
Excess winter deaths and illness	Home energy efficiency intervention	NG6.10	0.002	£1,493	6,099,082	Yes
Excess winter deaths and illness	£200 fuel subsidy intervention	NG6.11	0.001	£1,127	6,099,082	No
Excess winter deaths and illness	Home energy plus fuel subsidy	NG6.12	0.002	£2,358	6,099,082	No
Excess winter deaths and illness	Home energy efficiency intervention	NG6.13	0.001	£1,430	4,545,404	Yes
Excess winter deaths and illness	£200 fuel subsidy intervention	NG6.14	0.001	£1,128	4,545,404	No
Excess winter deaths and illness	Home energy plus fuel subsidy	NG6.15	0.002	£2,311	4,545,404	No
Excess winter deaths and illness	£200 fuel subsidy intervention	NG6.2	0.032	£1,122	895,280	No
Excess winter deaths and illness	Home energy plus fuel subsidy	NG6.3	0.073	£2,210	895,280	No
Excess winter deaths and illness	Home energy efficiency intervention	NG6.4	0.006	£1,456	1,699,129	Yes
Excess winter deaths and illness	£200 fuel subsidy intervention	NG6.5	0.004	£1,130	1,699,129	No
Excess winter deaths and illness	Home energy plus fuel subsidy	NG6.6	0.008	£2,314	1,699,129	No
Excess winter deaths and illness	Home energy efficiency intervention	NG6.7	0.001	£1,500	2,965,131	Yes
Excess winter deaths and illness	£200 fuel subsidy intervention	NG6.8	0.0007	£1,130	2,965,131	No
Excess winter deaths and illness	Home energy plus fuel subsidy	NG6.9	0.002	£2,350	2,965,131	No
Child smoking prevention	Mass media campaign	PH14.1	0.1	£5	3,147,089	Yes
Child smoking prevention	Point of sale intervention	PH14.2	0.01	£17	3,147,089	Yes
CHD - Smokers	Recruiting smokers from community	PH15.10	1.7	£17	10,210,770	Yes
CHD - Smokers	Recruitment to 'Quit and Win'	PH15.11	0.69	£53	10,210,770	Yes
CHD - Smokers	ID smokers through other means	PH15.13	0.55	£6	10,210,770	Yes
CHD - Smokers	Dentist-based interventions	PH15.15	0.38	£75	10,210,770	Yes
CHD - Smokers	Drop-in community-based sessions	PH15.16	0.03	£22	10,210,770	Yes
CHD - Smokers	Pharmacist-based interventions (smokers)	PH15.17	0.23	£121	10,210,770	Yes
CHD - Smokers	Free NRT	PH15.20	0.21	£6	10,210,770	No
CHD - Smokers	Social marketing	PH15.21	0.02	£1	10,210,770	Yes

CHD - Smokers	Workplace smoking cessation + incentives	PH15.22	0.55	£55	10,210,770	Yes
CHD - Smokers (disadvantaged)	Social marketing (african americans)	PH15.24	0.07	£86	428,925	Yes
CHD - Smokers (disadvantaged)	Recruitment at pediatric unit	PH15.25	0.14	£155	94,363	Yes
CHD - Smokers (disadvantaged)	NHS SSS (deprived men)	PH15.26	0.43	£196	887,244	Yes
CHD - Smokers (disadvantaged)	NHS SSS (deprived women)	PH15.27	0.38	£196	717,652	Yes
CHD - Smokers (disadvantaged)	Pharmacist-based interventions (deprived area)	PH15.28	0.77	£151	1,604,897	Yes
CHD - Smokers (disadvantaged)	NRT prescription (deprived area)	PH15.30	0.39	£230	1,604,897	Yes
CHD - Smokers (disadvantaged)	Brief intervention for low income pregnant women	PH15.31	0.37	£211	139,570	No
CHD - Smokers	Free mobile phones	PH15.32	1.94	£68	10,210,770	No
CHD - Smokers (disadvantaged)	Proactive telephone support for pregnant women	PH15.33	0.06	£140	697,852	No
CHD - Statin use	Pharmacist-based interventions (CHD)	PH15.34	0.08	£230	2,300,000	Yes
CHD - Smokers	Interventions at cervical screening	PH15.37	0.21	£18	10,210,770	Yes
CHD - Smokers	Nurse run clinics	PH15.6	0.58	£53	10,210,770	Yes
CHD - Smokers	Proactive telephone counselling	PH15.8	0.57	£52	10,210,770	Yes
Physical activity in children	Walking bus'	PH17.1	0.03	£124	7,112,050	Yes
Physical activity in children	Dance classes	PH17.2	0.002	£58	7,112,050	No
Physical activity in children	Free swimming	PH17.3	0.0001	£5	7,112,050	No
Physical activity in children	Community sports scheme	PH17.4	0.0002	£16	7,112,050	No
Reducing absenteeism	Workplace intervention	PH19.1	0.12	-£304	539,000	Yes
Reducing absenteeism	Physical activity and education	PH19.2	0.06	£77	539,000	Yes
Reducing absenteeism	Workplace intervention + physical activity and education	PH19.3	0.44	-£900	539,000	Yes
Emotional and social wellbeing in secondary schools	Classroom intervention / peer mediation to prevent bullying	PH20.1	0.002	£16	3,234,875	Yes
Immunisation programmes	Increasing first dose coverage to 100%	PH21.1	0.002	-£2	2,415	Yes
Immunisation programmes	Increasing 2nd to 4th doses to 100%	PH21.2	0.007	-£7	2,415	Yes
School-based interventions for smoking cessation	Generic school-based programme	PH23.1	0.003	£46	7,547,800	Yes
Preventing and treating alcohol-use disorders	Screening and brief intervention	PH24.2	0.002	-£1	52,594,874	Yes
Smoking cessation for pregnant women	Cognitive behaviour strategies	PH26.1	0.032	£126	76,066	Yes

Smoking cessation for pregnant women	Stages of change	PH26.2	0.007	£20	76,066	Yes
Smoking cessation for pregnant women	Feedback	PH26.3	0.049	£97	76,066	Yes
Smoking cessation for pregnant women	Rewards	PH26.4	0.111	-£52	76,066	Yes
Smoking cessation for pregnant women	Pharmacotherapies	PH26.5	0.032	£71	76,066	Yes
Looked-after children and young people	Transition support services (males)	PH28.1	0.61	-£76,546	4,151	Yes
Looked-after children and young people	Transition support services (females)	PH28.3	0.38	-£23,825	3,397	Yes
Unintentional injuries: prevention strategies for under 15s	20mph zones in high casualty areas	PH29.1	0.0003	£11	2,150,000	Yes
STI Infection and Teenage Conception	Accelerated Partner Therapy	PH3.1	0.003	£28	434,456	Yes
STI Infection and Teenage Conception	Counselling	PH3.3	0.005	£16	434,456	Yes
Unintentional injuries in the home: interventions for under 15s	Free smoke alarms	PH30.1	0.0001	£3	4,956,173	Yes
Unintentional injuries on the road for under 15s	Mixed priority routes	PH31.1	0.002	£502	10,750,000	No
Unintentional injuries on the road for under 15s	Mandatory 20mph zone (low casualty area)	PH31.2	0.00003	£13	860,000	No
Unintentional injuries on the road for under 15s	Mandatory 20mph zone (high casualty area)	PH31.3	0.00014	£13	2,150,000	Yes
Unintentional injuries on the road for under 15s	Advisory 20mph zone	PH31.4	0.00002	£1	5,375,000	Yes
Information to prevent skin cancer	Verbal advice	PH32.1	0.0001	£1	7,112,050	No
Information to prevent skin cancer	Multicomponent in work-setting	PH32.11	0	£52	31,977,862	No
Information to prevent skin cancer	Verbal advice	PH32.3	0.0001	£2	1,697,150	No
Information to prevent skin cancer	Provision of shade	PH32.4	0	£2	3,063,720	No
Information to prevent skin cancer	Multicomponent in beaches and pools	PH32.5	0	£20	2,669,852	No
Information to prevent skin cancer	Multicomponent in community	PH32.7	0	£1	6,688,036	No
Information to prevent skin cancer	Multicomponent in educational setting	PH32.8	0	£4	3,460,510	No
Information to prevent skin cancer	Multicomponent in healthcare setting	PH32.9	0	£12	1,790,978	No
Diabetes prevention	Education to increase fruit and veg intake	PH35.1	0	£44	7,864,447	No
Diabetes prevention	Dietary education / cooking skills	PH35.2	0.013	£11	7,864,447	Yes
Diabetes prevention	Open new food outlet	PH35.3	0	£0	7,864,447	No
Diabetes prevention	Multi-component small scale	PH35.4	0.138	£78	7,864,447	Yes
Diabetes prevention	Multi-component large scale	PH35.5	0.127	£19	7,864,447	Yes

Diabetes prevention	LPDS > 5.25, HbA1c > 6% (with intensive intvn)	PH38.1	0.012	£131	2,070,854	Yes
Diabetes prevention	LPDS > 5, HbA1c > 5.85% (with intensive intvn)	PH38.2	0.021	£234	2,070,854	No
Diabetes prevention	LPDS > 4.75, HbA1c > 5.7% (with intensive intvn)	PH38.3	0.039	£472	2,070,854	No
Substance misuse interventions for under 25s	Life skills training	PH4.1	0.019	£25	3,576,155	Yes
Substance misuse interventions for under 25s	Say Yes First	PH4.3	0.021	£1,900	3,351,895	No
Substance misuse interventions for under 25s	Teacher training	PH4.4	0.002	£236	7,112,050	No
Substance misuse interventions for under 25s	The Abecedarian Project	PH4.5	0.04	£7,800	4,299,430	No
Social and emotional wellbeing: early years	Weekly home visits	PH40.1	0.032	£2,711	21,136	No
Social and emotional wellbeing: early years	SureStart Cognition for Age 5	PH40.2	0.354	-£10,656	21,660	No
Social and emotional wellbeing: early years	Sure Start Age 3 (3 years)	PH40.3	0.07	£1,059	22,446	No
Social and emotional wellbeing: early years	Sure Start Age 3 (5 years)	PH40.4	0.372	-£6,959	22,446	No
Walking and cycling	Multi component: cycling demonstration towns	PH41.1	0.0062	£30	52,276,421	No
Walking and cycling	Multi component: sustainable travel towns	PH41.2	0.044	£47	52,276,421	No
Walking and cycling	TravelSmart	PH41.3	0.093	£25	52,276,421	Yes
Walking and cycling	Pedometer	PH41.6	0.359	£268	4,029,973	Yes
Walking and cycling	Led walking	PH41.7	0.025	£47	4,029,973	Yes
Walking and cycling	Get walking keep walking	PH41.9	0.020	£55	4,029,973	Yes
Hepatitis B and C testing	Dried blood spot testing in specialist addiction services	PH43.1	0.001	£15	61,586	Yes
Hepatitis B and C testing	Dried blood spot testing to prison services	PH43.2	0.0002	£14	75,798	Yes
Hepatitis B and C testing	GP education and paid targeted testing of former IDU 30-54 years old	PH43.3	0.0027	£37	91,150	Yes
Hepatitis B and C testing	Case finding	PH43.4	0.0022	£46	348,880	Yes
Hepatitis B and C testing	Case finding	PH43.5	0.163	£45	348,880	Yes
Smoking:harm reduction	CDTQ with generic professional BS	PH45.1	0.1	-£146	10,210,770	Yes
Smoking:harm reduction	Quit and substitute with long-term nicotine use with generic professional BS	PH45.2	0.114	£274	10,210,770	Yes
Smoking:harm reduction	Temporary abstinence or reduce smoking with specialist services BS	PH45.4	0.021	£169	10,210,770	Yes
Smoking:harm reduction	Reduce amount smoking with specialist services BS	PH45.6	0.021	£169	10,210,770	Yes

Domestic violence and abuse: multi-agency working	Independent domestic violence advisors	PH50.1	0.08	-£47,000	745,000	Yes
Domestic violence and abuse: multi-agency working	Cognitive trauma therapy _ battered women	PH50.2	1.02	-£150,000	745,000	Yes
Physical activity: exercise referral schemes	Exercise referral scheme (healthy)	PH54.2	0.007	£217	1,865,449	No
Physical activity: exercise referral schemes	Exercise referral scheme (obese)	PH54.4	0.008	£214	621,816	Yes
Physical activity: exercise referral schemes	Exercise referral scheme (hyp)	PH54.6	0.007	£216	1,154,802	Yes
Physical activity: exercise referral schemes	Exercise referral scheme (dep)	PH54.8	0.009	£214	532,985	Yes

Table A5: Inequality impact of interventions

Topic	Code	NHB	ΔSII	ΔRII	Impact	$\Delta EDE_{A,\varepsilon}$ (ε=10.95)	$\Delta EDE_{K,\alpha}$ (α=0.15)	Welfare rank (ε=0)	Welfare rank (ε=20)	Rank change
Home care for older people	NG21.1	111,340	-0.0023	0.0000	+-	88,568	88,356	36	43	-7
Older people with social care needs and multiple long-term conditions	NG22.2	73,772	0.0048	0.0001	++	93,719	84,952	54	37	17
Inpatient hospital and community or care home transition	NG27.1	17,890	0.0003	0.0000	++	20,627	20,062	55	57	-2
Inpatient hospital and community or care home transition	NG27.2	33,744	-0.0004	0.0000	+-	33,163	32,502	45	54	-9
Inpatient hospital and community or care home transition	NG27.3	30,948	0.0003	0.0000	++	34,158	33,308	47	52	-5
Inpatient hospital and community or care home transition	NG27.4	-3,545	-0.0001	0.0000	--	-4,088	-3,976	108	108	0
Oral health promotion	NG30.1	-5,132	-0.0001	0.0000	--	-5,906	-5,745	111	110	1
Oral health promotion	NG30.2	-719	0.0000	0.0000	--	-826	-803	98	97	1
Older people:independence and mental wellbeing	NG32.1	12,160	-0.0004	0.0000	+-	9,084	9,059	58	62	-4
Older people:independence and mental wellbeing	NG32.2	154,128	0.0014	0.0000	++	169,477	165,214	32	35	-3
Tuberculosis	NG33.1	533	0.0001	0.0000	++	1,643	1,537	74	72	2
Tuberculosis	NG33.2	9	0.0000	0.0000	++	19	18	84	85	-1
Tuberculosis	NG33.3	1,311	0.0001	0.0000	++	3,227	3,036	71	68	3
Tuberculosis	NG33.4	-112	0.0002	0.0000	-+	3,511	3,201	73	65	8
Tuberculosis	NG33.5	14	0.0000	0.0000	++	24	23	82	83	-1
Tuberculosis	NG33.6	2,966	0.0003	0.0000	++	8,578	8,041	64	60	4
Sunlight exposure	NG34.1	-481	0.0000	0.0000	--	-554	-539	94	94	0
Sunlight exposure	NG34.2	-887	0.0000	0.0000	--	-1,023	-995	99	100	-1
Sunlight exposure	NG34.3	-1,665	0.0000	0.0000	--	-2,192	-2,117	104	105	-1
Sunlight exposure	NG34.4	64	0.0000	0.0000	+-	37	39	80	87	-7
Sunlight exposure	NG34.5	5,384	0.0000	0.0000	+-	5,546	5,406	61	64	-3
Harmful sexual behaviour (HSB) among children and young people	NG55.1	2,267	0.0000	0.0000	++	2,651	2,574	67	70	-3
Harmful sexual behaviour (HSB) among children and young people	NG55.2	1,167	0.0000	0.0000	++	1,368	1,327	72	75	-3
Excess winter deaths and illness	NG6.1	-18,174	-0.0003	0.0000	--	-21,603	-20,954	115	115	0

Excess winter deaths and illness	NG6.10	-445,538	-0.0069	-0.0001	--	-516,270	-501,994	131	131	0
Excess winter deaths and illness	NG6.11	-338,194	-0.0052	-0.0001	--	-391,378	-380,585	129	129	0
Excess winter deaths and illness	NG6.12	-706,274	-0.0109	-0.0002	--	-817,724	-795,142	133	133	0
Excess winter deaths and illness	NG6.13	-319,996	-0.0044	-0.0001	--	-363,150	-353,714	128	128	0
Excess winter deaths and illness	NG6.14	-253,179	-0.0035	-0.0001	--	-288,220	-280,652	127	126	1
Excess winter deaths and illness	NG6.15	-517,949	-0.0072	-0.0001	--	-588,760	-573,374	132	132	0
Excess winter deaths and illness	NG6.2	-21,755	-0.0003	0.0000	--	-25,516	-24,780	116	116	0
Excess winter deaths and illness	NG6.3	-33,483	-0.0005	0.0000	--	-39,601	-38,429	117	117	0
Excess winter deaths and illness	NG6.4	-114,351	-0.0018	0.0000	--	-132,476	-128,829	121	121	0
Excess winter deaths and illness	NG6.5	-90,054	-0.0014	0.0000	--	-104,232	-101,366	120	120	0
Excess winter deaths and illness	NG6.6	-183,336	-0.0029	-0.0001	--	-212,279	-206,439	123	123	0
Excess winter deaths and illness	NG6.7	-218,530	-0.0033	-0.0001	--	-252,269	-245,339	124	124	0
Excess winter deaths and illness	NG6.8	-165,454	-0.0025	0.0000	--	-190,931	-185,692	122	122	0
Excess winter deaths and illness	NG6.9	-343,066	-0.0051	-0.0001	--	-395,979	-385,105	130	130	0
Child smoking prevention	PH14.1	313,922	0.0057	0.0001	++	393,684	380,263	24	25	-1
Child smoking prevention	PH14.2	28,796	0.0005	0.0000	++	36,377	35,116	49	49	0
CHD - Smokers	PH15.10	17,349,630	0.3151	0.0052	++	21,675,974	20,964,248	2	2	0
CHD - Smokers	PH15.11	7,018,373	0.1275	0.0021	++	8,790,001	8,494,619	3	3	0
CHD - Smokers	PH15.13	5,612,860	0.1019	0.0017	++	7,029,955	6,793,131	7	7	0
CHD - Smokers	PH15.15	3,841,802	0.0699	0.0012	++	4,817,175	4,653,996	10	9	1
CHD - Smokers	PH15.16	295,091	0.0054	0.0001	++	371,128	358,394	26	26	0
CHD - Smokers	PH15.17	2,286,702	0.0417	0.0007	++	2,872,125	2,774,205	11	14	-3
CHD - Smokers	PH15.20	2,141,198	0.0389	0.0007	++	2,683,960	2,592,844	13	15	-2
CHD - Smokers	PH15.21	203,705	0.0037	0.0001	++	255,468	246,757	29	29	0
CHD - Smokers	PH15.22	5,587,844	0.1016	0.0017	++	7,001,147	6,765,095	8	8	0
CHD - Smokers (disadvantaged)	PH15.24	28,180	0.0005	0.0000	++	35,522	34,296	50	51	-1
CHD - Smokers (disadvantaged)	PH15.25	12,480	0.0013	0.0000	++	34,092	31,639	57	46	11

CHD - Smokers (disadvantaged)	PH15.26	372,820	0.0386	0.0006	++	997,033	926,153	23	22	1
CHD - Smokers (disadvantaged)	PH15.27	265,675	0.0276	0.0004	++	712,128	661,410	25	24	1
CHD - Smokers (disadvantaged)	PH15.28	1,223,654	0.1254	0.0019	++	3,234,165	3,006,849	17	11	6
CHD - Smokers (disadvantaged)	PH15.30	607,454	0.0633	0.0009	++	1,628,894	1,513,140	22	16	6
CHD - Smokers (disadvantaged)	PH15.31	50,168	0.0052	0.0001	++	134,838	125,209	42	32	10
CHD - Smokers	PH15.32	19,774,177	0.3592	0.0060	++	24,694,850	23,888,137	1	1	0
CHD - Smokers (disadvantaged)	PH15.33	36,986	0.0007	0.0000	++	46,870	45,234	44	45	-1
CHD - Statin use	PH15.34	157,550	0.0029	0.0000	++	200,216	193,186	31	30	1
CHD - Smokers	PH15.37	2,135,072	0.0878	0.0015	++	2,323,861	2,287,101	14	18	-4
CHD - Smokers	PH15.6	5,895,188	0.1071	0.0018	++	7,385,488	7,136,663	5	4	1
CHD - Smokers	PH15.8	5,793,591	0.1053	0.0018	++	7,258,360	7,013,764	6	6	0
Physical activity in children	PH17.1	169,267	-0.0009	0.0000	+-	163,623	160,766	30	36	-6
Physical activity in children	PH17.2	-6,401	-0.0003	0.0000	--	-9,482	-9,115	112	112	0
Physical activity in children	PH17.3	-1,067	0.0000	0.0000	--	-1,335	-1,293	102	103	-1
Physical activity in children	PH17.4	-4,267	-0.0001	0.0000	--	-5,130	-4,979	109	109	0
Reducing absenteeism	PH19.1	72,873	0.0005	0.0000	++	79,513	77,494	39	41	-2
Reducing absenteeism	PH19.2	30,265	0.0002	0.0000	++	32,641	31,826	48	53	-5
Reducing absenteeism	PH19.3	261,415	0.0019	0.0000	++	284,877	277,657	27	28	-1
Emotional and social wellbeing in secondary schools	PH20.1	2,588	0.0000	0.0000	+-	2,219	2,197	66	74	-8
Immunisation programmes	PH21.1	5	0.0000	0.0000	++	6	5	85	88	-3
Immunisation programmes	PH21.2	18	0.0000	0.0000	++	20	19	81	86	-5
School-based interventions for smoking cessation	PH23.1	4,529	0.0001	0.0000	++	7,431	7,043	63	61	2
Preventing and treating alcohol-use disorders	PH24.2	118,338	-0.0009	0.0000	+-	123,023	119,042	35	38	-3
Smoking cessation for pregnant women	PH26.1	1,917	0.0000	0.0000	++	2,430	2,347	69	71	-2
Smoking cessation for pregnant women	PH26.2	426	0.0000	0.0000	++	537	519	77	78	-1
Smoking cessation for pregnant women	PH26.3	3,328	0.0001	0.0000	++	4,176	4,037	65	66	-1
Smoking cessation for pregnant women	PH26.4	8,603	0.0002	0.0000	++	10,691	10,340	60	59	1

Smoking cessation for pregnant women	PH26.5	2,126	0.0000	0.0000	++	2,671	2,582	68	69	-1
Looked-after children and young people	PH28.1	18,419	0.0002	0.0000	++	21,552	20,913	53	56	-3
Looked-after children and young people	PH28.3	5,338	0.0001	0.0000	++	6,000	5,852	62	63	-1
Unintentional injuries: prevention strategies for under 15s	PH29.1	-583	0.0000	0.0000	--	-805	-778	96	98	-2
STI Infection and Teenage Conception	PH3.1	695	0.0000	0.0000	+-	795	768	75	76	-1
STI Infection and Teenage Conception	PH3.3	1,825	0.0000	0.0000	+-	2,094	2,027	70	73	-3
Unintential injuries in the home: interventions for under 15s	PH30.1	-248	0.0000	0.0000	-+	290	232	91	77	14
Unintentional injuries on the road for under 15s	PH31.1	-252,286	-0.0042	-0.0001	--	-294,802	-286,582	126	127	-1
Unintentional injuries on the road for under 15s	PH31.2	-550	0.0000	0.0000	--	-640	-622	95	95	0
Unintentional injuries on the road for under 15s	PH31.3	-1,047	0.0000	0.0000	--	-1,274	-1,237	101	102	-1
Unintentional injuries on the road for under 15s	PH31.4	-20	0.0000	0.0000	--	-49	-47	88	91	-3
Information to prevent skin cancer	PH32.1	356	0.0000	0.0000	++	269	273	78	79	-1
Information to prevent skin cancer	PH32.11	-83,142	-0.0012	0.0000	--	-95,862	-93,238	119	119	0
Information to prevent skin cancer	PH32.3	0	0.0000	0.0000	++	-9	-8	87	90	-3
Information to prevent skin cancer	PH32.4	-306	0.0000	0.0000	--	-353	-344	92	92	0
Information to prevent skin cancer	PH32.5	-2,670	0.0000	0.0000	--	-3,078	-2,994	107	107	0
Information to prevent skin cancer	PH32.7	-334	0.0000	0.0000	--	-386	-375	93	93	0
Information to prevent skin cancer	PH32.8	-692	0.0000	0.0000	--	-798	-776	97	96	1
Information to prevent skin cancer	PH32.9	-1,075	0.0000	0.0000	--	-1,239	-1,205	103	101	2
Diabetes prevention	PH35.1	-17,302	-0.0003	0.0000	--	-19,948	-19,403	114	114	0
Diabetes prevention	PH35.2	97,126	0.0101	0.0001	++	258,393	239,872	37	27	10
Diabetes prevention	PH35.3	0	0.0000	0.0000	++	0	0	86	89	-3
Diabetes prevention	PH35.4	1,054,622	0.1079	0.0016	++	2,768,726	2,572,802	18	12	6
Diabetes prevention	PH35.5	988,168	0.0993	0.0015	++	2,564,918	2,384,317	20	13	7
Diabetes prevention	PH38.1	10,251	0.0001	0.0000	++	12,446	12,051	59	58	1
Diabetes prevention	PH38.2	19,259	0.0003	0.0000	++	23,351	22,611	52	55	-3
Diabetes prevention	PH38.3	32,305	0.0005	0.0000	++	39,386	38,120	46	47	-1
Substance misuse interventions for under 25s	PH4.1	64,550	0.0019	0.0000	++	80,637	78,126	41	39	2

Substance misuse interventions for under 25s	PH4.3	-248,375	-0.0027	-0.0001	--	-280,067	-272,712	125	125	0
Substance misuse interventions for under 25s	PH4.4	-73,254	-0.0009	0.0000	--	-83,500	-81,262	118	118	0
Substance misuse interventions for under 25s	PH4.5	-1,504,801	-0.0201	-0.0004	--	-1,719,725	-1,673,342	134	134	0
Social and emotional wellbeing: early years	PH40.1	-2,189	0.0000	0.0000	-+	-1,578	-1,610	106	99	7
Social and emotional wellbeing: early years	PH40.2	19,208	0.0009	0.0000	++	32,859	31,108	51	48	3
Social and emotional wellbeing: early years	PH40.3	383	0.0001	0.0000	++	2,637	2,390	76	67	9
Social and emotional wellbeing: early years	PH40.4	16,160	0.0009	0.0000	++	30,298	28,542	56	50	6
Walking and cycling	PH41.1	245,699	-0.0012	0.0000	+-	234,336	230,859	28	31	-3
Walking and cycling	PH41.2	2,156,402	-0.0018	0.0001	+-	2,186,879	2,141,484	12	19	-7
Walking and cycling	PH41.3	4,812,045	-0.0010	0.0002	+-	4,907,397	4,804,110	9	10	-1
Walking and cycling	PH41.6	1,392,356	-0.0011	0.0001	+-	1,386,818	1,361,974	16	23	-7
Walking and cycling	PH41.7	89,179	-0.0002	0.0000	+-	87,911	86,400	38	40	-2
Walking and cycling	PH41.9	69,920	-0.0002	0.0000	+-	68,384	67,246	40	44	-4
Hepatitis B and C testing	PH43.1	15	0.0000	0.0000	++	23	22	83	84	-1
Hepatitis B and C testing	PH43.2	-38	0.0000	0.0000	-+	7	4	89	82	7
Hepatitis B and C testing	PH43.3	77	0.0000	0.0000	++	112	107	79	80	-1
Hepatitis B and C testing	PH43.4	-35	0.0000	0.0000	-+	59	50	90	81	9
Hepatitis B and C testing	PH43.5	56,013	0.0010	0.0000	++	69,747	67,490	43	42	1
Smoking:harm reduction	PH45.1	1,095,616	0.0197	0.0003	++	1,365,983	1,320,091	19	20	-1
Smoking:harm reduction	PH45.2	1,024,140	0.0190	0.0003	++	1,297,979	1,252,741	21	21	0
Smoking:harm reduction	PH45.4	128,145	0.0026	0.0000	++	169,384	162,940	33	33	0
Smoking:harm reduction	PH45.6	128,145	0.0026	0.0000	++	169,384	162,940	33	33	0
Domestic violence and abuse: multi-agency working	PH50.1	1,810,350	0.0309	0.0005	++	2,108,164	2,049,527	15	17	-2
Domestic violence and abuse: multi-agency working	PH50.2	6,347,400	0.1432	0.0024	++	7,580,924	7,361,959	4	5	-1
Physical activity: exercise referral schemes	PH54.2	-7,182	-0.0004	0.0000	--	-11,859	-11,348	113	113	0
Physical activity: exercise referral schemes	PH54.4	-1,679	-0.0001	0.0000	--	-2,589	-2,490	105	106	-1
Physical activity: exercise referral schemes	PH54.6	-4,388	-0.0002	0.0000	--	-6,537	-6,286	110	111	-1

Physical activity: exercise referral schemes	PH54.8	-906	-0.0001	0.0000	--	-1,627	-1,550	100	104	-4

Key for Impact: ++ increase population health and reduce inequality; +- increase population health and increase inequality; -+ reduce population health and reduce inequality; -- reduce population health and increase inequality

Notes: Positive change (Δ) in SII indicates a reduction in absolute health inequality. Positive change for the Atkinson and Kolm welfare scores indicate an increase in social welfare. Shaded rows indicate guidelines where increases in health inequality reduce social welfare to less than net population health benefit, i.e. EDE<NHB