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Does the UK-public's aversion to inequalities in health differ by group-labelling and health-gain type? A choice-experiment.

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ABSTRACT: Public health policy has two primary aims: promoting population health and reducing health inequalities. When these aims conflict, policy-makers must determine the relative importance to place on each in decision-making. We conducted a computer-based, face-to-face, choice-experiment to explore how the UK-public think government should act in these situations; and to explore how "inequality-aversion" may differ depending on the groups between which a health inequality exists and type of health an intervention provides. We tested three hypotheses: (1) the UK-public are more averse to inequalities in health between socioeconomic groups than they are to inequalities in health between neutrally labelled groups; (2) this difference is, at least in part, driven by the role non-health information plays in determining aversion to inequalities in health between socioeconomic groups; and (3) the UK-public are more willing to prioritise groups with lower lifetime health over groups with higher lifetime health if an intervention improves life-expectancy than if it improves quality-of-life. Eighty people participated in Sheffield and Hull in May/June 2019. Each participant completed three Person-Trade-Off exercises between interventions that would improve population health and reduce health inequalities, or improve population health by a larger amount but increase health inequalities. Participants were randomised to exercises involving scenarios with socioeconomic groups or neutrally-labelled

groups, and each answered questions about three health-benefit types: increased life-expectancy; pain-relief; and mobility-improvement. Following the exercises, participants provided rationales for their selections. Respondents were (1) more averse to inequalities in health between socioeconomic groups than neutrally labelled groups. Participant rationales suggest (2) this divergence is partly motivated by factors other than health: for example, financial inequality between socioeconomic groups. The sample was also (3) more willing to prioritise neutrally labelled groups with lower lifetime health if an intervention improves life-expectancy rather than if it improves quality-of-life.

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1. Introduction

We live in an unequal world, formed of unequal nations (Marmot, 2015). In many of these nations, people who live in relatively deprived communities can expect to experience shorter lives than people who do not (Marmot, 2015). For example, people who live in the most deprived quintile of neighbourhoods in England have a life-expectancy at birth 7.5-years lower than people who live in the least deprived quintile (Love-Koh et al., 2015). Similarly, people who live in deprived communities in England can expect to experience greater morbidity in their lifetime (Marmot et al., 2010), and to live, on average, with lower health-related quality-of-life (Love-Koh et al., 2015).

Public health policy-makers in the United Kingdom want to reduce inequalities in health; however, they also want to improve population health (NHS Health Scotland, 2016; NICE, 2020; Public Health England, 2017; Public Health Wales, 2017). These objectives sometimes conflict with each other. For example, an intervention may improve population health but increase inequalities in health (Thomson et al., 2018). In these cases, decision-makers must trade-off efficiency and equality to decide whether or not a policy is introduced.

Cost-effectiveness analysis (CEA) is a tool that policy-makers can use to evaluate the efficiency of health interventions (Drummond et al., 2015). In CEAs, health is typically quantified using the "Quality Adjusted Life Year" (QALY) (NICE, 2013; Pliskin et al., 1980) Conventionally, QALY-based CEAs are conducted under the assumption that all incremental QALYs are of equal value irrespective of who receives them (Weinstein, 1988). This "distributionally naïve" approach fails to reflect decision makers' stated objective to reduce inequalities in health. Distributional cost-effectiveness analysis (DCEA) is new form of "distributionally sensitive" CEA (Asaria et al., 2016)In

contrast to conventional CEA, in DCEA the impacts of an intervention on both population health and the social distribution of health are formally modelled, and then valued using a health-related social welfare function (HRSWF). Whilst conventional CEA applies an additive HRSWF grounded in the judgement that our aim is QALY maximisation, DCEA can implement alternative HRSWFs, including those that reflect a concern for inequality.

Asaria et al. (2016) identify two distributionally sensitive HRSWFs that could be used in DCEA: one based on the Atkinson social welfare function (Atkinson, 1970) and one based on the Kolm social welfare function (Kolm, 1976). A key parameter in these HRSWFs is the "inequality aversion parameter". This number defines the relative priority placed on average health and the reduction of inequalities in health in the analysis undertaken. In the context of the allocation of public resources in democratic countries, McNamara et al. (2019) argue the health inequality aversion parameters applied in DCEAs should be defined based on the views of the public in those countries.

Globally, a number of studies have elicited the public's aversion to inequalities in health between socioeconomic groups using "benefit trade off" (BTO) choice-experiments. In these studies, participants are typically asked to choose between pairs of hypothetical scenarios that offer varying levels of life-expectancy, or variants upon, to different socioeconomic groups. Participant responses are then analysed in order to determine whether, and to what extent, they are willing to prioritise improvements in the life-expectancy of disadvantaged socioeconomic groups over improvements in the life-expectancy of advantaged groups. For example, Abásolo and Tsuchiya (2013, 2004) conducted two BTO studies of this kind, and found that the Spanish public are willing to prioritise disadvantaged socioeconomic groups with lower life-expectancy for gains in life-

expectancy over advantaged groups with higher life-expectancy. Lal et al. (2017) conducted a similar life-expectancy gain based BTO study, and found the Australian public are willing to prioritise disadvantaged socioeconomic groups for gains in life-expectancy. Hurley et al. (2020) conducted a BTO study and found evidence the Canadian public are averse to inequalities in "health adjusted life-expectancy" between groups with differing incomes. Similarly, a recent systematic review of UK health inequality aversion elicitation studies (McNamara et al. (2020), found evidence that the UK-public are willing to prioritise disadvantaged groups for gains in life-expectancy and "years in full health over the average person's life". Whilst these studies have asked participants questions about life-expectancy, or variants thereupon, none of them explored whether the public are as willing to prioritise disadvantaged socioeconomic groups for gains in quality-of-life.

A range of studies have explored the public's aversion to inequalities in health between groups or individuals with unknown socioeconomic status (henceforth "neutrally" labelled groups/individuals). For example, Edlin et al. (2012) fielded a BTO study and found the UK-public are averse to inequalities in lifetime QALYs between two neutrally labelled groups. This aversion to inequalities in health between neutrally labelled groups is mirrored by the findings of Petrou et al. (2013) in the UK; Wiseman (2005) and Richardson et al. (2012) in Australia; Ubel et al. (2001, 2000) in the USA; Olsen (2013) in Norway; and Hurley et al. (2020) in Canada. In totality, these studies suggest that, in many counties, the public are averse to inequalities in lifetime health between neutrally labelled groups; however, no study has explored whether the UK-public are as averse to inequalities in health between neutrally labelled groups as they are to inequalities in health between socioeconomic groups.

In this paper, we build on these two gaps in this literature, and explore three hypotheses relevant to the conduct of distributionally-sensitive economic evaluations in the UK.

Hypotheses 1 and 2

Pinho and Botelho (2018) find Portuguese students are more averse to inequalities in health between socioeconomic groups within the working age population, than to inequalities in health between neutrally labelled groups. Similarly, Hurley et al. (2020) find the Canadians are more averse to inequalities in health between groups with different levels of income than to inequalities in health between people of unknown income. These findings suggest aversion to inequalities in health between socioeconomic groups may be driven, at least in part, by non-health differences between these groups; for example: inequalities in income. This is of interest, because it is not obvious whether health-related resource decisions should consider these factors. For example, it could reasonably be argued that health alone should determine how health-related resources are allocated (Brouwer et al., 2008). In this paper we do not make the case for a specific position on this issue. Instead, we note it is only of practical relevance if inequality aversion differs between a socioeconomic and neutrally-labelled context.

Whilst this issue has been not explored *within* a study using a sample of the UK-public, a systematic review (McNamara et al., 2020) compared findings across studies using neutrally labelled groups and those using socioeconomic groups, and concluded that the UK-public appear to be more averse to socioeconomic inequalities in health than they are to inequalities between neutrally labelled groups. This leads to the first two hypotheses explored in this study. Hypothesis 1: the UK-public are more averse to inequalities in health between socioeconomic groups than they are

to inequalities in health between neutrally labelled groups. Hypothesis 2: this divergence is driven, at least in part, by the role non-health information plays in determining aversion to inequalities in health between socioeconomic groups.

Hypothesis 3

The studies on aversion to socioeconomic inequalities in health discussed above have, typically, asked participants to make choices between interventions, or scenarios, that would vary the life-expectancy of different socioeconomic groups. No study has explored whether the public are equally willing to sacrifice prospective gains in quality-of-life as they are to sacrifice such gains in life-expectancy in return for greater equality in life-time health between socioeconomic groups. This is a notable omission, because evidence suggests that people may value incremental QALYs provided to others differently depending on how those QALYs are composed, independently of an inequality in health. For example, Lancsar et al. (2020) conducted a discrete choice experiment and found that the Australian public place a higher social value on incremental QALYs that are the result of combinations of both extension of life and quality-of-life gains, rather than one of the two in isolation; although there were no statistically significant differences between the social value respondents placed on QALYs that were the result of gains in life-expectancy alone or gains in quality-of-life alone, and the authors did not explore participants rationales for making the choice they did.

If the public were found to have health-gain type specific preferences regarding the prioritisation of disadvantaged socioeconomic groups, this would be an important finding for DCEA, because QALY-based DCEAs are “blind” to the way an incremental QALY gain is composed: they assume

that, given an inequality in lifetime health between two groups of a set QALY magnitude, the public are willing to prioritise the group with lower lifetime health for a QALY-gain to the same degree, irrespective of whether that gain is the result of improvements in length of life or quality of life. If this were found not to be the case, this would motivate the development of new forms of distributionally-sensitive economic evaluation that are capable of reflecting differential levels of willingness to prioritise disadvantaged groups depending on the type of health-benefit an intervention provides.

We anticipate that decisions about interventions that improve quality-of-life are likely to prompt participants to become more efficiency-focused than questions about life-expectancy-improving interventions. This is because we think they will experience a stronger affective reaction to the idea of failing to alleviate people's quality-of-life problems, rather than failing to extend life-expectancy, and so will act in a more consequentialist way for these choices. This motivates our third hypothesis. Hypothesis 3: the UK-public are more willing to prioritise groups with lower lifetime health over groups with higher lifetime health if an intervention improves life-expectancy than they are if it improves quality-of-life.

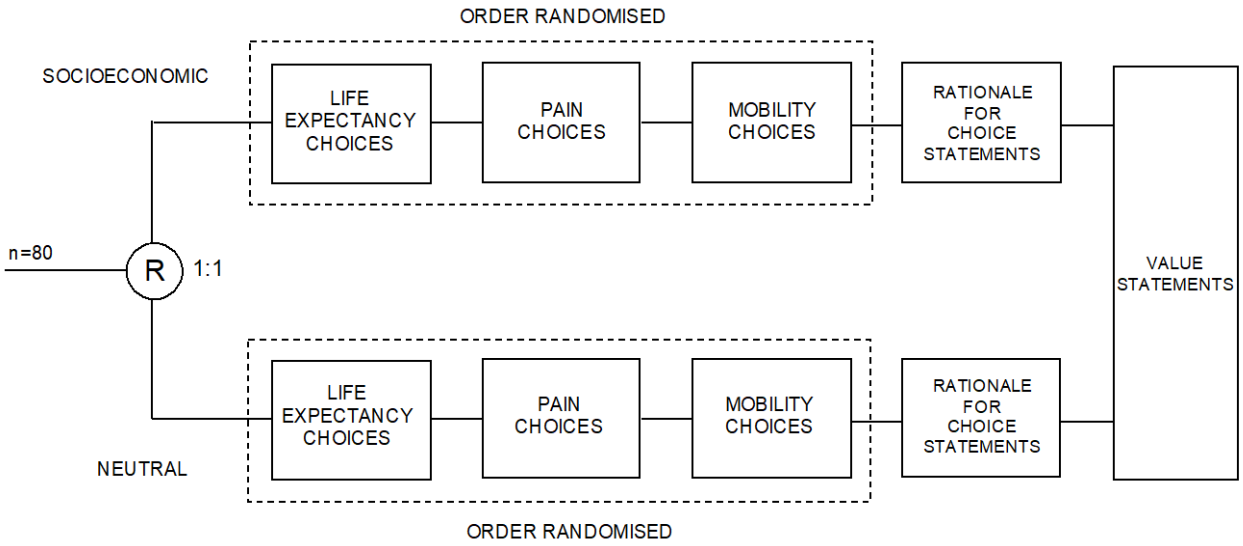
2. Methods

2.1. Survey Design

We fielded a cross-sectional, face-to-face, survey in order to test our hypotheses. This survey included a series of pairwise person-trade-off (PTO) exercises (Nord, 1995) designed to elicit participants' levels of health inequality aversion. The pairwise PTO method is a form of choice-

experiment, in which respondents are asked to make choices between pairs of hypothetical interventions that have the potential to benefit different numbers of people from different groups; in this case: one which would benefit a number of people in a group with lower life-expectancy or one which would benefit a number of people in a group with higher life-expectancy. The number of people in each of these groups is then varied logically in response to a participant's choices, in order to determine the relative priority they place on increasing average population health and reducing inequalities in health. We used PTO because the majority of studies that elicit the UK-public's aversion to socioeconomic inequalities in health have used variations of a single BTO method. Use of an PTO therefore allows us to explore whether the UK-public are still found to be averse to socioeconomic inequalities in health if an alternative method is applied. Figure 1, below, shows the overall design of the survey.

Figure 1. Study design



We 1:1 randomised participants to one of two arms. In one arm, participants were asked PTO questions about policy options that would improve the health of different socioeconomic groups

(people from the poorest or richest fifth of society). In the other, participants were asked the same PTO questions using neutrally labelled groups (people with Disease A or Disease B). Respondents in each arm answered PTO questions about interventions that provided three types of health benefit: increased life-expectancy; pain-relief; and mobility-improvement. We randomised the order of the three choice-sets. Following completion of the PTO exercises, we explored participant's reasons for making their choices using a series of "rationale for choice statement" questions adapted to their arm. Finally, we asked all participants the same broader "value statement" questions to determine how much they agreed with various ways the government or NHS could consider inequalities in health in their decision-making. The survey was programmed in, and hosted by, Qualtrics. Study graphics were developed in Piktochart.

Below, we first describe the PTO exercises participants in the socioeconomic arm completed. We then explain how the exercises in the neutral arm differed from these. After this, we provide further information on the rationale for choice statements. The value statement questions are not directly relevant to the three hypotheses explored in this paper, and so are reported solely in the Online Supplementary Appendix.

2.2 The PTO exercises in the socioeconomic arm.

Briefing

We informed participants that people from the poorest fifth of UK-society have a life-expectancy of 77 years, and that people from the richest fifth of UK-society have a life-expectancy of 84 years (Love-Koh et al., 2015). We then instructed them to imagine they were in government, and that

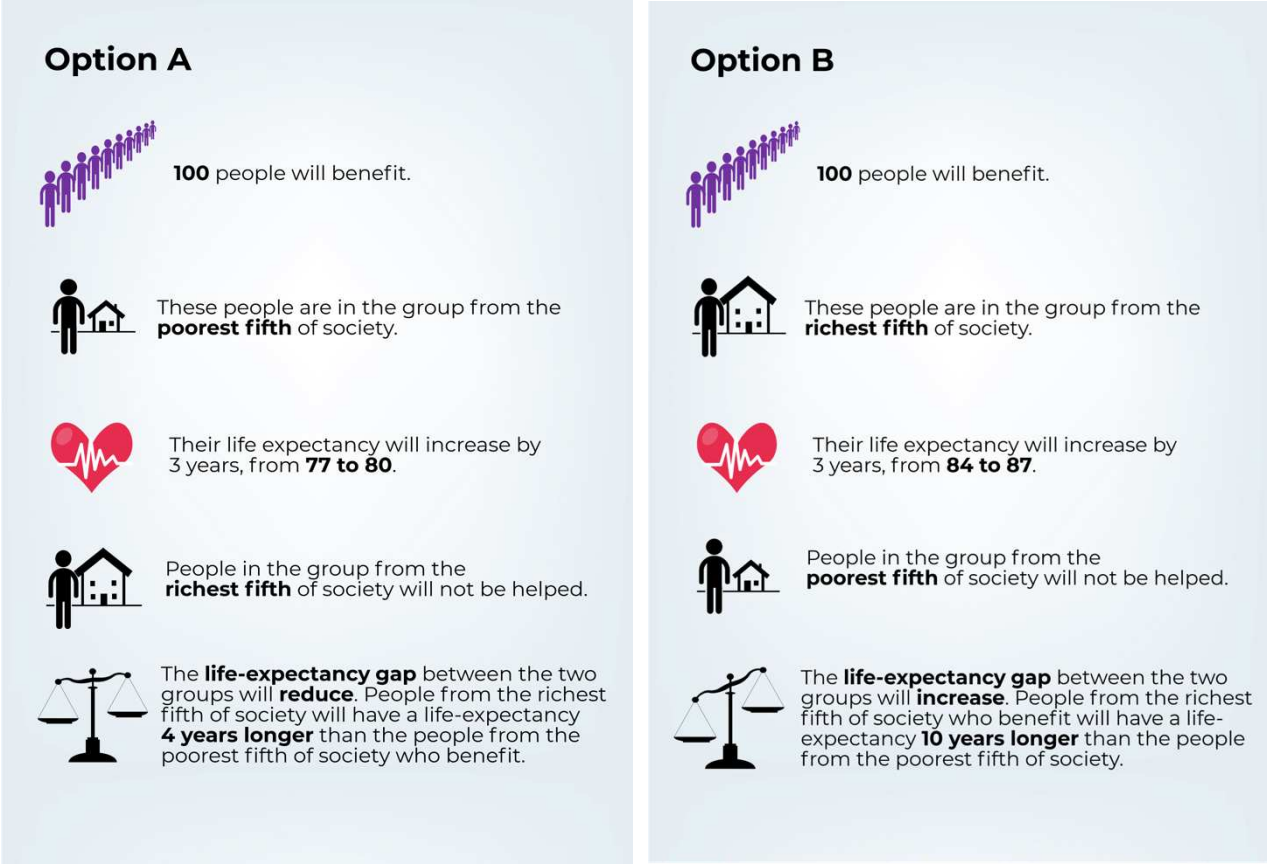
they had been asked to make decisions about policies that would impact peoples' health. Participants were informed that some of these policy options would benefit people from the poorest fifth of society, and that some would benefit people from the richest fifth of society. We stated that the policies were not real, but that the government use the results of surveys like this to make real policy decisions, so the respondents should think carefully about their choices. Participants were told that all policy options impacted people who were currently 70 years old, and that the government could only fund one of the two options presented in each choice. In addition, we informed respondents that there was no other way the benefits of the policy-options could be obtained. We then explained to them that, if they felt each option in a pairwise choice was equally good, they could say they didn't mind which option the government chose.

The PTO questions for improving life-expectancy.

The life-expectancy policy-options improved the life-expectancy of people who benefited from them by three years. We told participants that the people who received this benefit would experience perfect health for those three years (a three QALY benefit) so that people from the poorest fifth of society who benefited from the intervention would have their life-expectancy increased from 77 years to 80 years, and that people from the richest fifth of society who benefited would have their life-expectancy increased from 84 years to 87 years. We clarified that the intervention which benefited the group with lower life-expectancy would reduce the life-expectancy gap between the two groups, and that the intervention that benefited the group with higher life-expectancy would increase the life-expectancy gap between the two.

In the first PTO question, we presented participants with a pairwise choice between interventions that would benefit either 100 people from the poorest fifth of society or 100 people from the richest fifth of society. They were asked "which option should the government choose?". This choice was presented as shown in Figure 2 below. An equivalent figure for the neutral arm, and examples of the graphics used for the other health types, are provided in the Online Supplementary Appendix.

Figure 2. The initial choice: socioeconomic arm; life expectancy



If a participant expressed indifference between the two options, this was recorded and they moved on to the next health-type; if they had completed all three health-types, they instead moved on to the rationale for choice questions. If a respondent selected one of the two options, we varied the number of people in the richer and asked them to choose again. This process was

designed to explore the participant's willingness to sacrifice gains in population health in order to reduce, or increase, the inequality between the two groups. If a participant chose the policy option that benefited people from the poorest fifth of society, we increased the number of people from the richest fifth of society who would benefit from the alternative policy by 100 people (e.g. to 200 people following the initial question). Conversely, if they chose the intervention that helped people from richest fifth of society, we reduced the number of people who would benefit from this intervention down by 50 people (e.g. to 50 people following the initial question). This logically determined +100 or -50 variation continued until a participant either expressed indifference between two options; made a choice beyond the range programmed in the survey (>1000 people, or <50 people from the richest fifth of society); or, could be inferred to have an indifference point between two of the numbers tested. For example, a participant who chose to benefit 200 people from the richest fifth of society rather than 100 people from the poorest fifth of society, and subsequently chose to benefit 100 people from the poorest fifth of society over 150 from the richest fifth of society was assumed to have an indifference point of 175 (midway between the two prior values). If a participant gave an "off the scale" response, their indifference point was recorded as >1000 or <50 respectively. Throughout, we fixed the number of people who would benefit from the intervention targeted at people from the poorest fifth of society at 100 people.

The PTO questions about pain.

In this exercise, we told respondents that the 70-year-olds are currently experiencing severe pain due to a health condition. We informed them that the people with the pain say that, on a scale of 0-100 with 100 being "in perfect health" and 0 being "as bad as dead" they are a 40. Respondents were told that this pain was going to last for the next 5-years, before going away naturally. We

stated that the policy options would completely relieve the pain of those who benefited for those 5 years, and that in this period these people would be in perfect health (equivalent to a 3-QALY benefit; although this was not stated to participants). Respondents were informed that the policy options would not improve the life-expectancy of the people who benefited from them and that, as a result, the intervention would not impact the life-expectancy gap between the two groups. The respondents then took part in a PTO exercise for these policy options. This was conducted as described for the life-expectancy intervention.

The person-trade-off questions about mobility problems.

For the mobility exercise, we told respondents that the 70-year-olds are currently experiencing severe problems in walking about due to a health condition. The duration and severity of these problems was identical to those used in the pain questions, as was the magnitude of the benefit offered, and the PTO protocol.

2.3. The person trade off exercises in the neutral arm

The neutral arm was identical to the socioeconomic arm with the exception that participants were told the groups consisted of individuals with Disease A (a replacement for the poorer group with life-expectancy of 77 years) and Disease B (a replacement for the richer group with life-expectancy of 84 years). Examples of the graphics used in the neutral arm are provided in the Online Supplementary Appendix.

2.4 Quantifying inequality aversion

If a respondent expressed indifference between two options, we assumed they valued both options equally. Consequently, we inferred the relative weight a participant placed on improving the health of people in the disadvantaged group compared to improving the health of people in the advantaged group by calculating the ratio of the number of people in each group at the point they expressed indifference. For example, if a participant expressed indifference between helping 100 people from the poorest fifth of society and 500 people from the richest fifth of society, they were inferred as placing a relative weight of 5:1 on improvements in the health of the poorer group. We evaluated Hypothesis 1 (the UK-public are more averse to inequalities in health between socioeconomic groups than they are to inequalities between groups for which no socioeconomic information is available), by comparing indifference points across the socioeconomic and neutral arms. This was conducted discretely for each type of health and tested using a Mann-Whitney U-test (unpaired data). We evaluated Hypothesis 3 (the UK-public are more willing to prioritise groups with lower lifetime health over groups with higher lifetime health if an intervention improves life-expectancy than if it improves quality-of-life) by comparing indifference points across types of health. This was conducted discretely for each arm and tested using a Wilcoxon-signed rank test (paired data).

2.5 Rationale for choice statements

Following completion of all the choice exercises, we presented participants with "rationale for choice" statements, and asked them to select those statements that informed their choices. These statements were arm and health type-specific, and were generated by the authors based upon

rationales given by participants in a prior study that elicited inequality aversion (McNamara et al., 2019) Irrespective of the order the three health-type PTO exercises were completed in, all participants first answered rationale for choice questions about the options that improved life-expectancy, then those that relieved pain, and subsequently, those that improved mobility. We included rationale for choice statements linked to non-health factors (e.g. money) in the socioeconomic arm in order to test Hypothesis 2 (non-health factors influence aversion to socioeconomic inequalities in health), for example: "it is better to help the poorer people, because they have less money than the richer people" and "it is better to help the poorer people, because richer people could use their money to distract them from their pain". In both arms we included a series of direct-health-related rationale for choice statements, for example: "it is better to help the poorer group, because they have a lower life expectancy" and "it is better to help the poorer group, because the richer group already have a long life-expectancy". A complete list of non-health statements provided to participants in the socioeconomic arm is provided in Figure 6, below. The direct-health-related statements provided to participants in both arms are detailed in Figure 8 and Figure 9 below.

2.6 Pilot

We piloted the choice-experiment with 20 non-academic members of staff at the University of Sheffield in October 2018 (McNamara et al., 2020). Following completion of the choice-task, Simon McNamara interviewed participants to explore their understanding of the exercises, and gain insight into the rationale for their choices. Participants demonstrated high levels of understanding, and provided rationales for their choices consistent with the study design. A small number of participants noted that they had not immediately noticed that their choice of Option A

(the intervention that benefited the group with lower life-expectancy) lead to the number of individuals in the higher life-expectancy group increasing and that they had to go backwards in the exercise after realising the number was changing. In response, we modified the materials so the first change in the number of people in each exercise was presented in purple text.

2.7 Sample size justification

For the primary study, sample size was determined using participant responses to the pilot study. As the person trade off procedure was truncated at the upper (>1000), and lower bounds (<50), and rank-based testing procedures were utilised, this was not done via conventional power-based sample-size calculations. Instead, we estimated the likely effect sizes for both hypotheses using the pilot data, and conducted mock hypothesis tests of this initial data, in order to provide an estimate of the likely sample size required to detect these effects. This analysis indicated that a sample size four times larger than the pilot (n=80) would be sufficient to test the two hypotheses in the primary fielding. Further information on the effect sizes observed in the pilot is available in (McNamara et al., 2019)

2.8 Fielding

We fielded the survey via two "hall tests" held in conveniently located, broadly comparable, cities in the north of England: Sheffield (25th May 2019) and Hull (1st June 2019). A market research company ("Accent") was commissioned to recruit and field the study. On both days, a convenience sample of 40 passers-by was recruited in city centre locations (total n=80). A quota system based on age, gender and socioeconomic status was used to recruit a sample broadly representative of

the population of the United Kingdom. Each respondent reviewed the study information sheet, signed an informed consent form before participating, and received a £5 “thank-you” in return for their time. Seven Accent employees recruited participants, explained the survey, and supervised the respondents whilst they completed the survey on a laptop computer connected to the internet. Simon McNamara was present throughout in order to observe the interviews, and clarify anything to participants or the interviewers.

2.9 Ethics

Ethics approval for the study and pilot was granted by the Research Ethics Committee at the University of Sheffield (ID: 022496).

3. Results

Participants

We randomised 41 people to the socioeconomic arm, and 39 to the neutral arm. During data-cleaning, we noted two participants in the socioeconomic arm had ticked 41 of 43 potential rationale for choice statements. As many of these statements are in direct conflict with each other, we excluded both these individuals from the primary analysis set. We report more information on these individuals and associated sensitivity analyses in the Online Supplementary Appendix. These sensitivity analyses have a minor impact on the results reported here.

Participant characteristics are reported in Table 1, below. In comparison to national census data for England/Wales, the sample were more educated, less ethnically diverse, and more likely to live in a deprived area. Participants in the socioeconomic arm were more likely to be male than in the neutral arm, more likely to have a degree their highest level of qualification, and more likely to support the Labour or Conservative party.

Table 1. Participant characteristics in the analysis set

		Total (n=78)	**Socioeconomic** (n=39)	**Neutral** (n=39)	**England/ Wales***
Male		41%	49%	33%	49%
Age (mean)		42	43	40	39
Education Level	Degree	42%	44%	39%	27%
	A-levels (or equivalent)	28%	21%	36%	12%
	GCSEs (or equivalent)	22%	21%	23%	28%
	Other qualifications	1%	3%	0%	10%
	No qualifications	6%	10%	3%	23%
	Don't know	1%	3%	0%	0%
Ethnicity	White	97%	97%	97%	86%
	Black/African/Caribbean/Black British	3%	3%	3%	3%
	Asian/Asian British	0%	0%	0%	8%
	Mixed/Multiple ethnic groups	0%	0%	0%	2%
	Other ethnic group	0%	0%	0%	1%
Political Affiliation**	Labour	31%	36%	26%	-
	Green	15%	15%	15%	-
	Conservative	13%	15%	10%	-
	Liberal Democrat	8%	5%	10%	-
	Other	6%	5%	8%	-
	None	27%	23%	31%	-
Postcode Deprivation Level***	IMD5 (least deprived quintile)	13%	-	-	-
	IMD4	13%	-	-	-
	IMD3	23%	-	-	-
	IMD2	18%	-	-	-
	IMD1 (most deprived quintile)	32%	-	-	-
Subjective Richness Ranking****	5 (richest fifth)	1%	3%	0%	-
	4	13%	18%	8%	-
	3	24%	23%	26%	-
	2	45%	41%	49%	-
	1 (poorest fifth)	17%	15%	18%	-

* 2011 census data, utilised as a proxy for data for the whole United Kingdom.
** "Forgetting about their policies on Brexit, which political party do you traditionally think of yourself as supporting?"
*** Figures based on the 77 valid postcodes recorded during recruitment. Note that these cannot be linked to individual responses.
**** "If the number 100 was the richest person in the UK, and the number 0 was the poorest person in the UK, how rich do you think you are?"

3.1. Hypothesis 1: the UK-public are more averse to inequalities in health between socioeconomic groups than they are to inequalities in health between neutrally labelled groups.

Comparing across arms, and for all three health types, participants were more willing to prioritise people in the socioeconomic arm who were labelled as being from the poorest fifth of society than they were to prioritise people in the neutral arm with an equivalent health profile who were

labelled as having Disease A. Figure 3, Figure 4, and Figure 5, below show the trade-off indifference points in the socioeconomic arm and neutral arm for life-expectancy, pain, and mobility, respectively. In these figures, the y-axis indicates the proportion of participants yet to express indifference between two options. The x-axis shows the number of people in the higher life expectancy group (people from the richest fifth of society/Disease B). In the choice-exercises we fixed the number of people in the lower life-expectancy group at 100 throughout. As a result, an x-axis value of 100 implies equal weight is given to people in both groups, a value <100 implies a preference for the group with higher life-expectancy, and a value >100 implies a preference for the group with lower life-expectancy. If there was no difference in aversion between the two arms, we would expect to observe two identical curves for each. In contrast, all three of the socioeconomic arm curves are higher than the corresponding neutral arm curves, indicating that participants in the socioeconomic arm were more willing to sacrifice the health of people from the richest fifth of society in order to benefit people in the poorest fifth of society than participants in the neutral arm were to prioritise the health of people with Disease A over Disease B.

Figure 3. Trade-off indifference points: life-expectancy

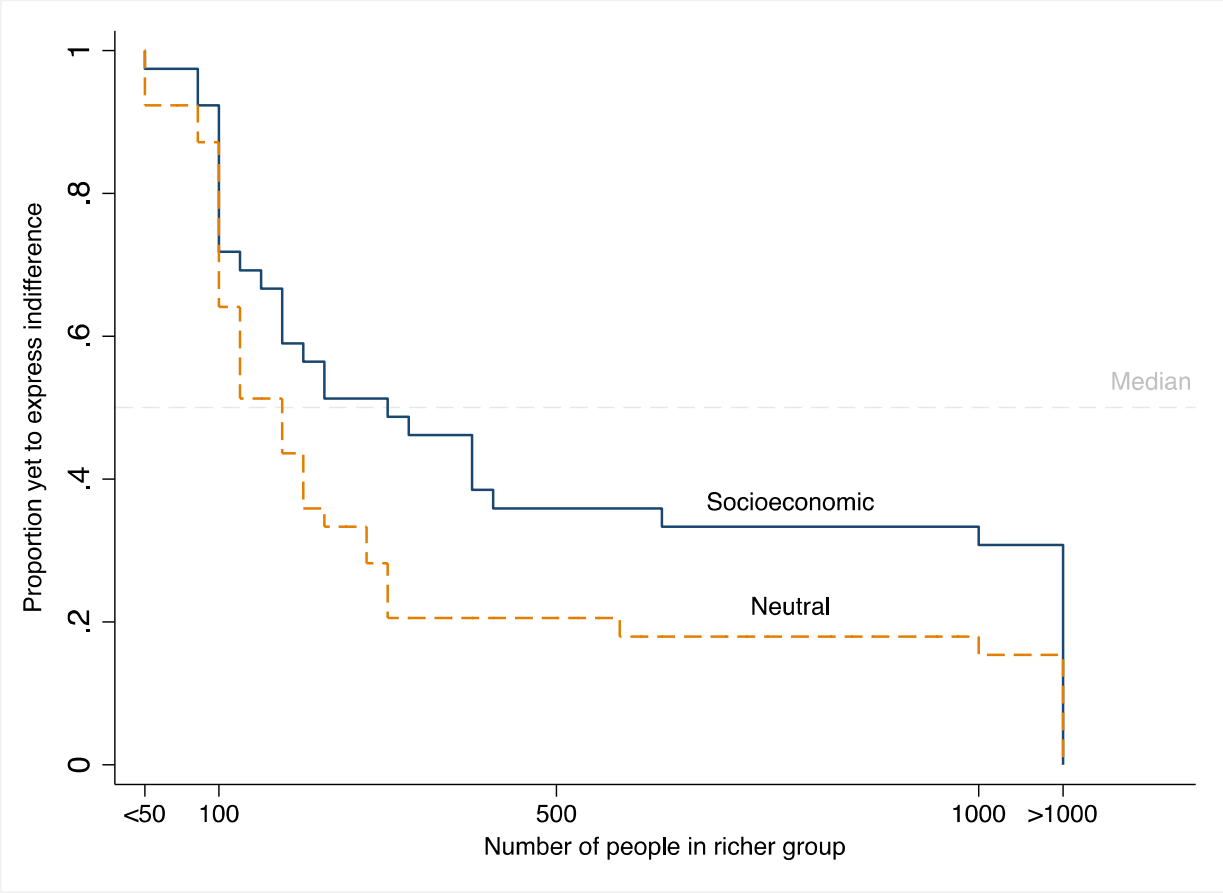


Figure 4. Trade-off indifference points: pain

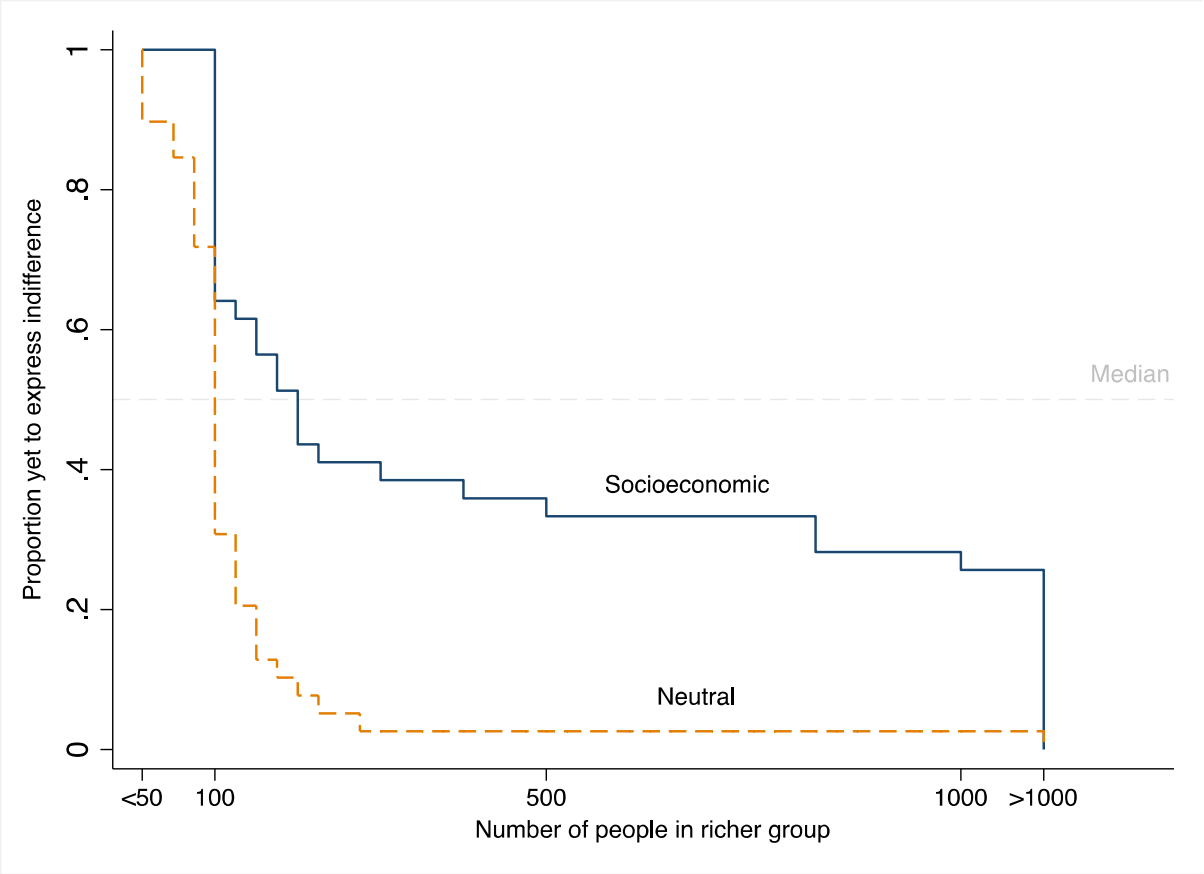


Figure 5. Trade-off indifference points: mobility

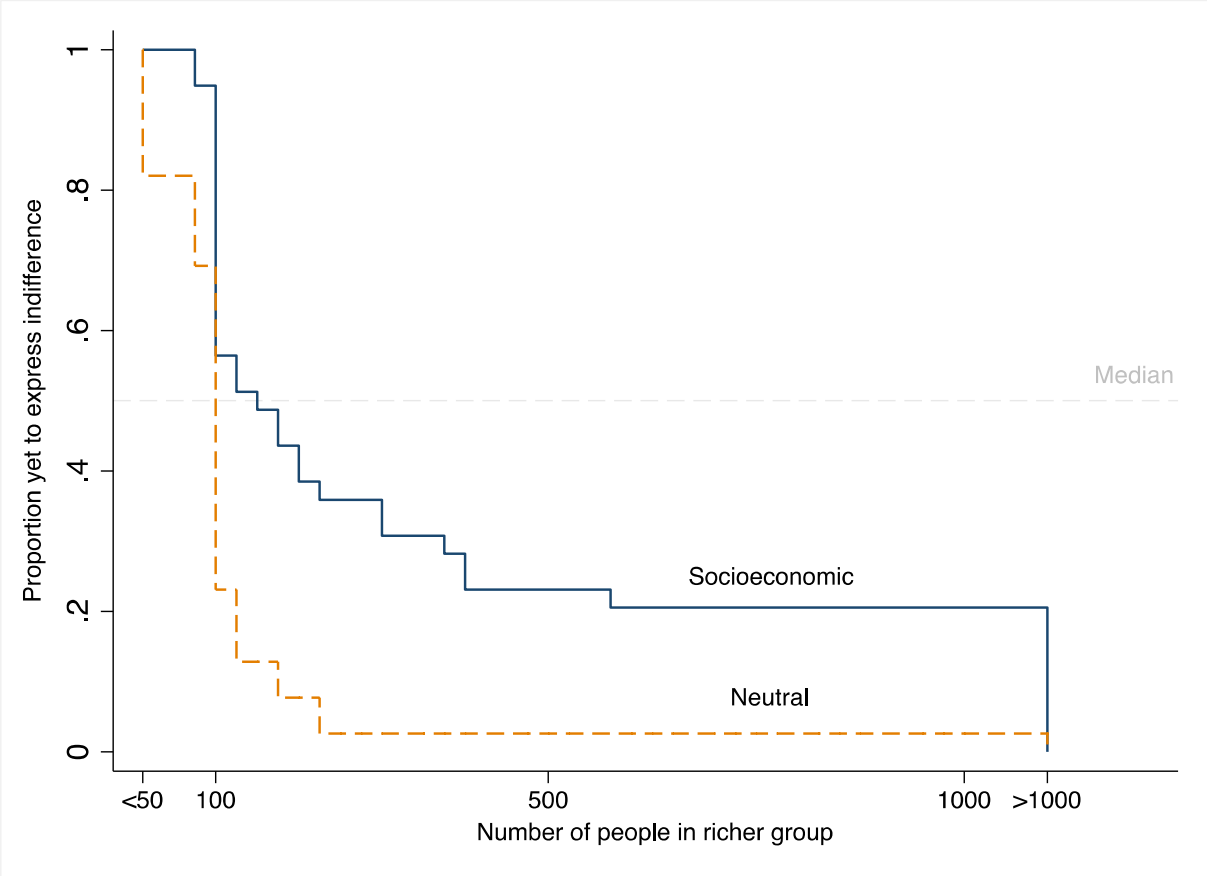


Table 2, below, shows the relative weight the median respondent in each exercise placed on improving the health of the group with lower life-expectancy compared to improving the health of the group with higher life-expectancy. The Mann-Whitney U-test p-values for all three health types were statistically significant at $\alpha = 0.05$.

Table 2. Relative weight median respondent placed on a health-gain to a person in the group with lower life-expectancy, compared to a person from the group with higher life-expectancy

	Relative weight given to a gain to group with lower life-expectancy		
Health Type	*Socioeconomic arm*	*Neutral arm*	*Socioeconomic vs Neutral p-value**
Life-Expectancy	3.00	1.75	*0.04*
Pain	2.00	1.00	*<0.01*
Mobility	1.50	1.00	*<0.01*
Life-Expectancy vs Pain p-value$^{\Psi}$	*0.10*	*<0.01*	
Life-Expectancy vs Mobility p-value$^{\Psi}$	*0.05*	*<0.01*	

**one-sided p-values for Mann-Whitney U-tests of Hypothesis 1.*

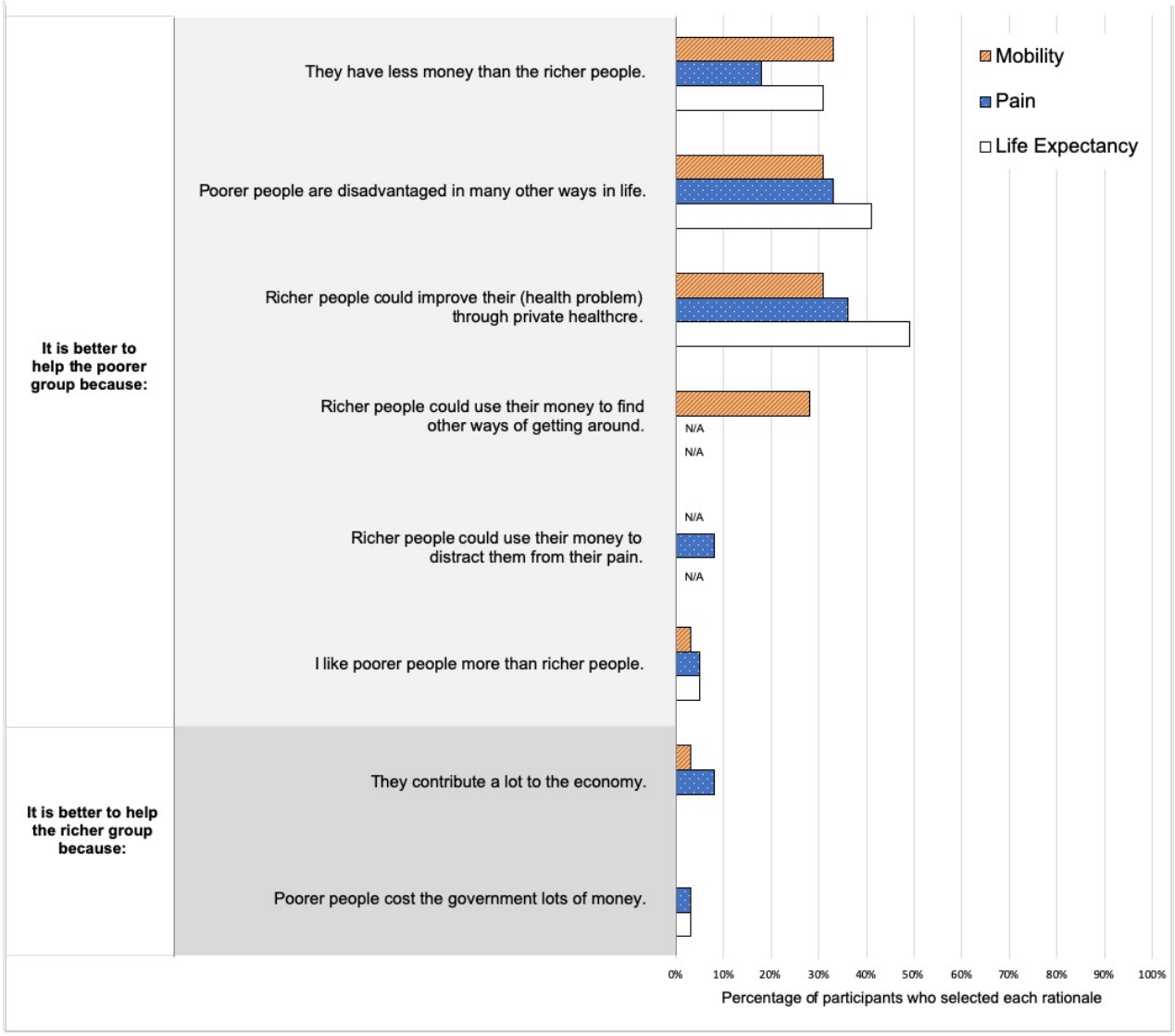
Ψ one-sided p-values for Wilcoxon signed-rank test of Hypothesis 3.

For each health type, the median respondent in the socioeconomic arm placed a higher weight on helping the poorer group compared to the richer group than the median respondent in the neutral arm placed on helping people with Disease A over people with Disease B. In the neutral arm, the median respondents in the pain and mobility exercises were unwilling to prioritise the group with lower life-expectancy. Conversely, the median respondent in the life-expectancy exercise in the neutral arm was willing to prioritise the group with lower life-expectancy. In contrast, in all three socioeconomic arm exercises the median respondent in each exercise made choices consistent with an aversion to inequalities in lifetime health. Note that, if our aim is to generate an estimate of inequality aversion based on health alone, the difference between these two arms equates to the bias associated with the introduction of the “richest” and “poorest” labels.

3.2. Hypothesis 2: the difference between the UK-public's aversion to inequalities in health between socioeconomic and neutrally-labelled groups is, at least in part, driven by the role non-health information plays in determining aversion to inequalities in health between socioeconomic groups.

Figure 6, below, shows the proportion of respondents in the socioeconomic arm who selected each of the non-health rationale for choice statements. Note that these rationales are not relevant to choices between neutrally labelled groups, and so were not presented to participants in the neutral arm. These responses indicate that participants in the socioeconomic arm were influenced by non-health information. For example, 31% stated that they chose to benefit the poorer group for the life-expectancy improving intervention "because they have less money than the richer people". Similarly, 33% stated they chose to favour the poor group for the pain-relief intervention "because poorer people are disadvantaged in many other ways in their life". For each health type, a substantial minority of respondents justified their responses by stating that the richer group could improve their health problems through private healthcare (49% for the life-expectancy intervention, 36% for the pain-relief option and 31% for the mobility-improving policy) – despite the fact that participants were explicitly told that there was no other way the people with the health problems could get the health benefit the intervention provided. These responses are consistent with the idea that the divergence between the UK-public's aversion to inequalities in health between socioeconomic and neutrally labelled groups is, at least in part, motivated by non-health factors.

Figure 6. Socioeconomic arm, non-health rationale for choice responses: percentage of people who selected this rationale for each health type.*



* N/A = Not applicable (the statement was not offered to participants in this exercise).

3.3. Hypothesis 3: the UK-public are more willing to prioritise groups with lower lifetime health over groups with higher lifetime health if an intervention improves life-expectancy than if it improves quality-of-life.

In both the socioeconomic and neutral arms, there was evidence participants were more willing to prioritise people with lower life-expectancy if an intervention improved life-expectancy, rather than if it improved quality-of-life.

Socioeconomic arm

Figure 7, below, shows the trade-off indifference points for each health-type. If prioritisation preferences were equivalent across health-types, we would expect to see three overlapping curves in this figure. In fact, for all trade-off values >100, the life-expectancy curve remains above the mobility curve, and the above or equal to the pain-curve.

Figure 7. Socioeconomic arm trade-off indifference points - health type comparison

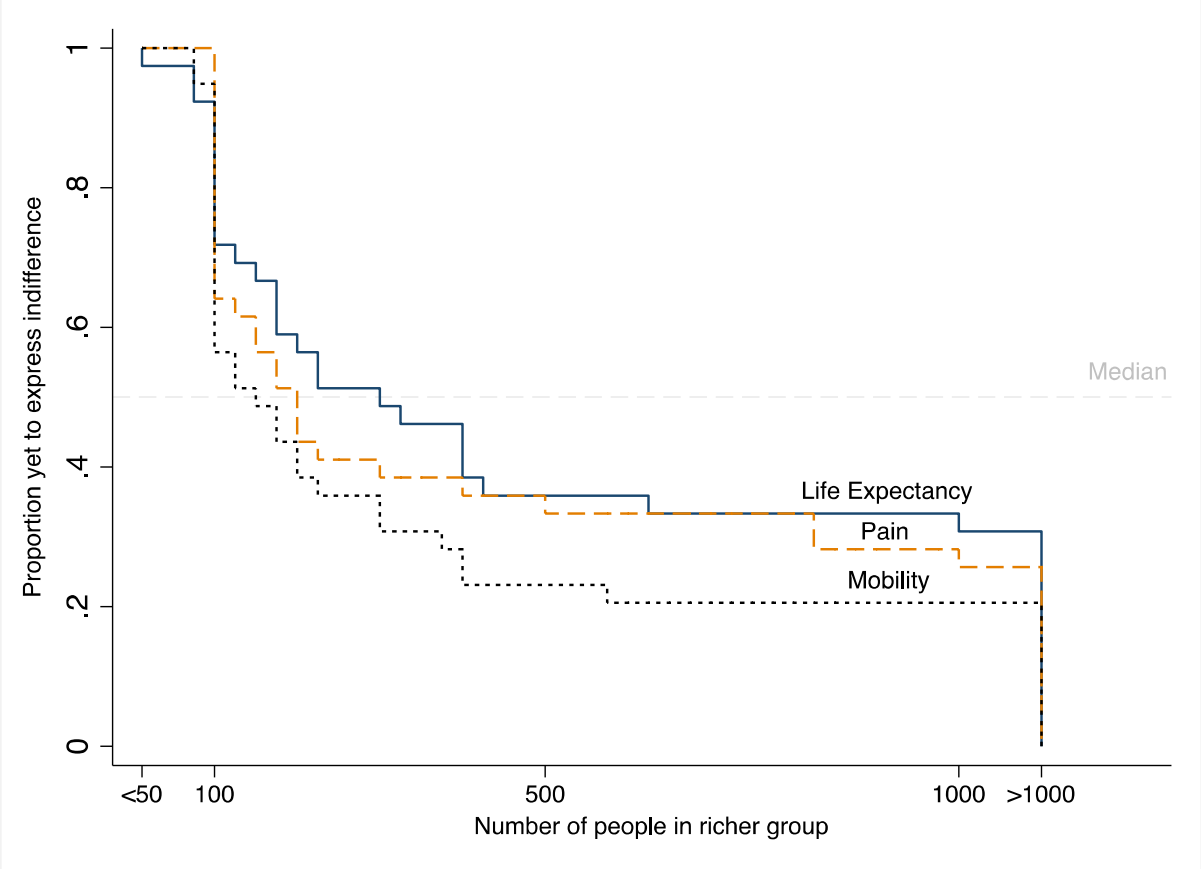


Table 2, above, shows the median weight in the life-expectancy exercise was higher than for the two quality of life exercises. The p-value for the Wilcoxon signed-rank test comparing the life-expectancy and pain-relief responses was 0.05. The equivalent value for the comparison of the life-expectancy and mobility-improvement responses was 0.10.

Neutral arm

Figure 8, below, shows the trade-off indifference points for all three health types in the neutral arm, and provides clear evidence in support of Hypothesis 3.

Figure 8. Neutral arm trade-off indifference points - health type comparison

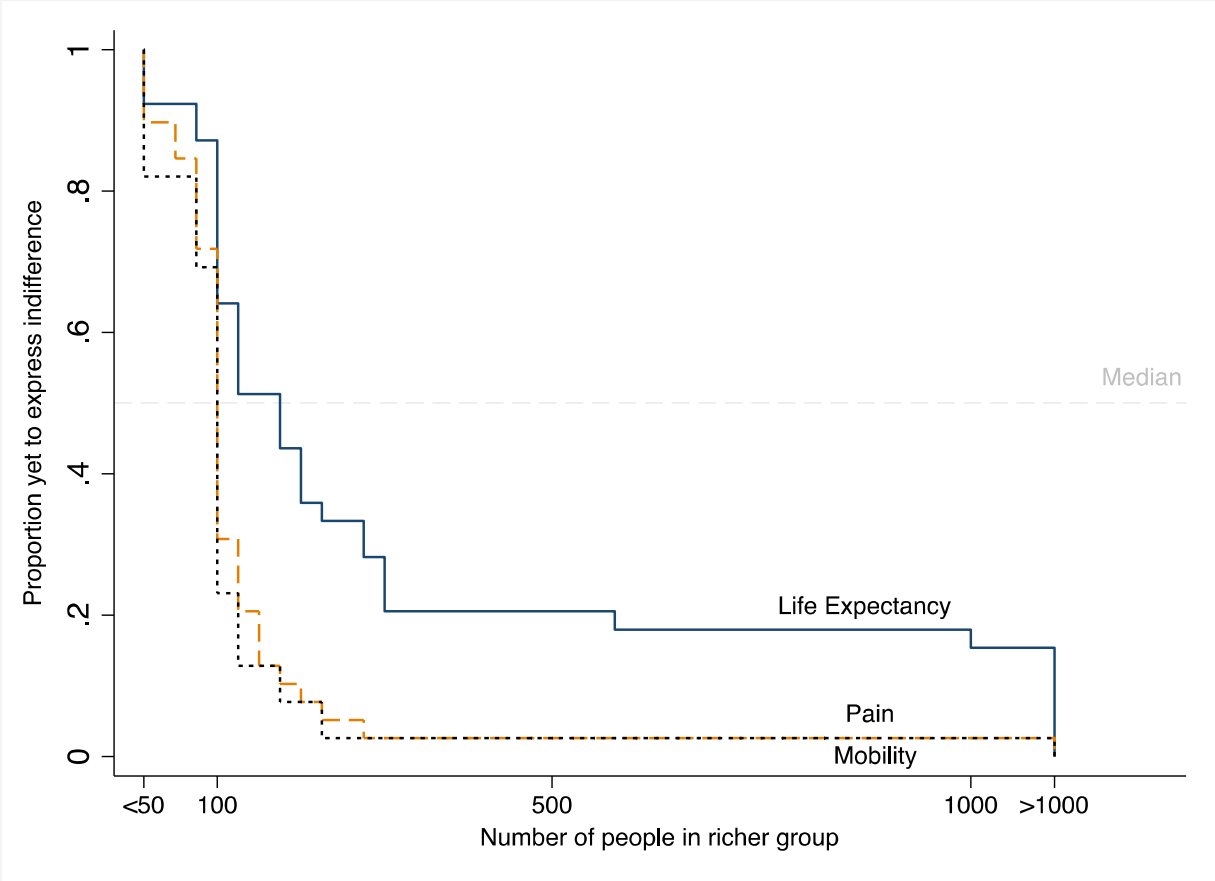


Table 2, above, shows the relative weight the median respondent in each exercise in the neutral arm placed on improving the health of people with Disease A over people with Disease B for each health type. In the life-expectancy exercise, the median respondent was willing to prioritise the group with lower life-expectancy for the life-expectancy intervention. In contrast, the median respondents in both the pain and mobility exercises were unwilling to prioritise the group with lower life-expectancy for either quality of life intervention. The p-values for the two Wilcoxon sign-rank tests comparing the life-expectancy responses to the quality-of-life responses were both <0.01.

Rationale for choice responses - why might participants have been more willing to prioritise a group with lower lifetime health for an intervention improves life-expectancy rather than one that improves quality-of-life?

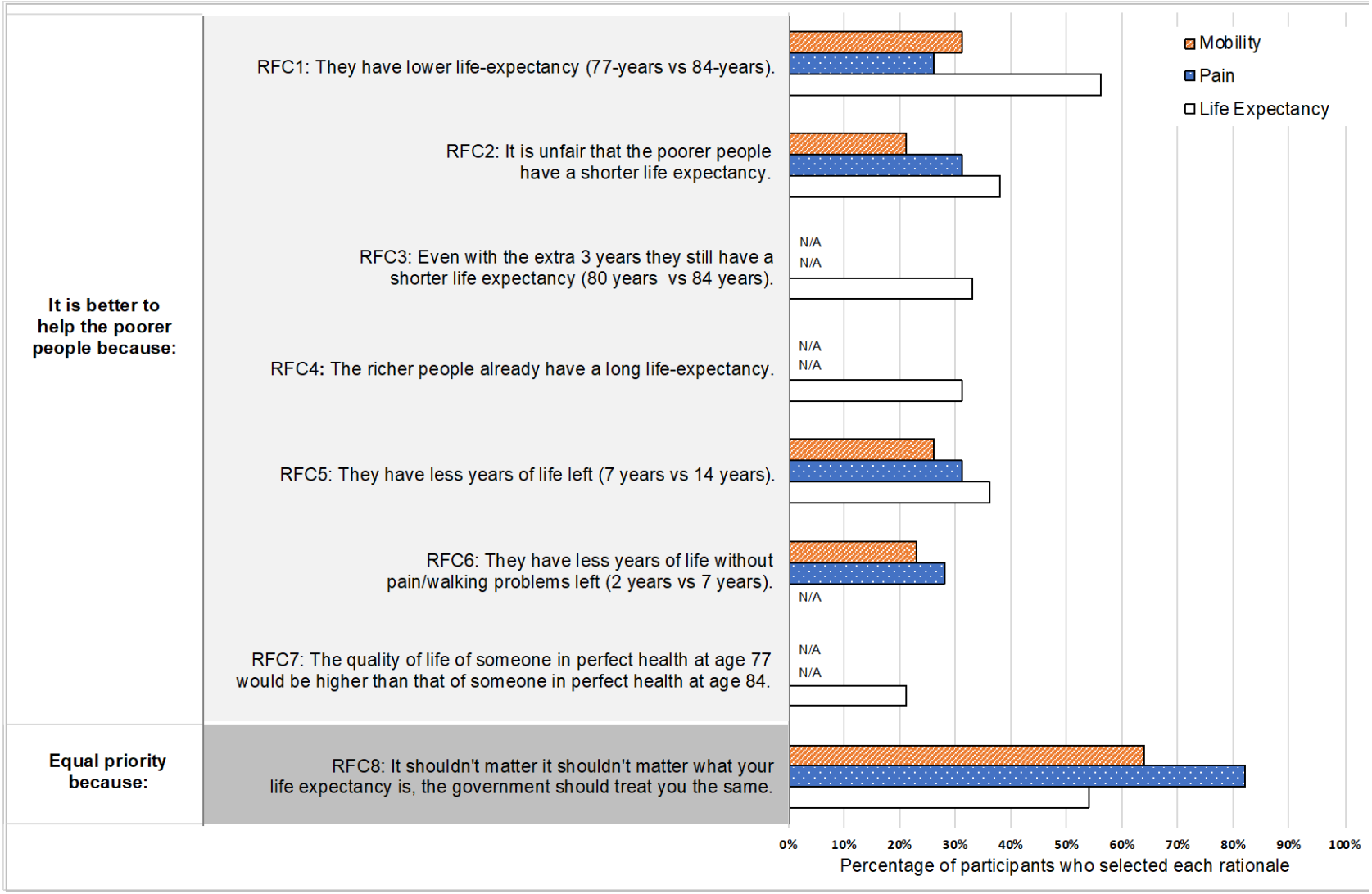
Figure 9 and Figure 10, below, show the direct-health-related rationale for choice responses for participants in the socioeconomic and neutral arms, respectively. These results show that participant choices were influenced by a wide range of factors, many of which differed in frequency between health types. For example, the first rationale presented in each figure (RFC1) is the statement: “it is better to help the poorer people [people with Disease A in the neutral arm], because they have lower life-expectancy (77 years vs 84 years)". In the socioeconomic arm, 56% explained their response to the life-expectancy exercise by selecting this statement. Similarly, 46% in the neutral arm selected this statement for the life-expectancy exercise. In contrast, for the pain and mobility exercises only 26% and 31% of those socioeconomic arm selected this rationale, and only 31% and 18% did so in the neutral arm.

This pattern is mirrored in the rationale presented at the bottom of each of the two figures (RFC8): “it shouldn’t matter what your life-expectancy is, the government should treat you the same”. In the socioeconomic arm, 54% of participants selected this for the life-expectancy exercise, whilst 82% and 64% selected it for the pain and mobility exercises. Similarly, in the neutral arm 46% explained their life-expectancy choices by selecting this rationale, compared to 51% in the pain exercise and 64% in the mobility exercise. This variation suggests that, for some participants, the inequality in life-expectancy between the two groups was perceived as being more relevant to a prioritisation decision about an intervention that improved life-expectancy, rather than one that improved quality-of-life.

In addition, it is notable that a proportion of respondents selected the three rationales that were only applicable to the life-expectancy exercise (RFC3, RFC4, RFC7). In the figures below, these rationales are the three statements that have one bar to right of them, and the term “N/A” (not applicable) written twice above the bar. The first of the three statements presented in each figure (RFC3) is: “it is better to help the poorer people [people with Disease A], because even with the extra 3 years they still have a shorter life expectancy (80 years vs 84 years)”. Thirty-three percent of those in the socioeconomic arm and 36% in the neutral arm responded that their choice was motivated by this statement. The next rationale specific to the life-expectancy exercise shown in each figure (RFC4) is: “It is better to help the poorer people [people with Disease A], because the richer people [people with Disease B] already have a long life-expectancy”. Thirty-one percent of people in the socioeconomic arm and 21% in the neutral arm selected this rationale. The final of the three statements presented in each figure (RFC7) is: “it is better to help the poorer people [people with Disease A], because the quality of life of someone in perfect health at age 77 would

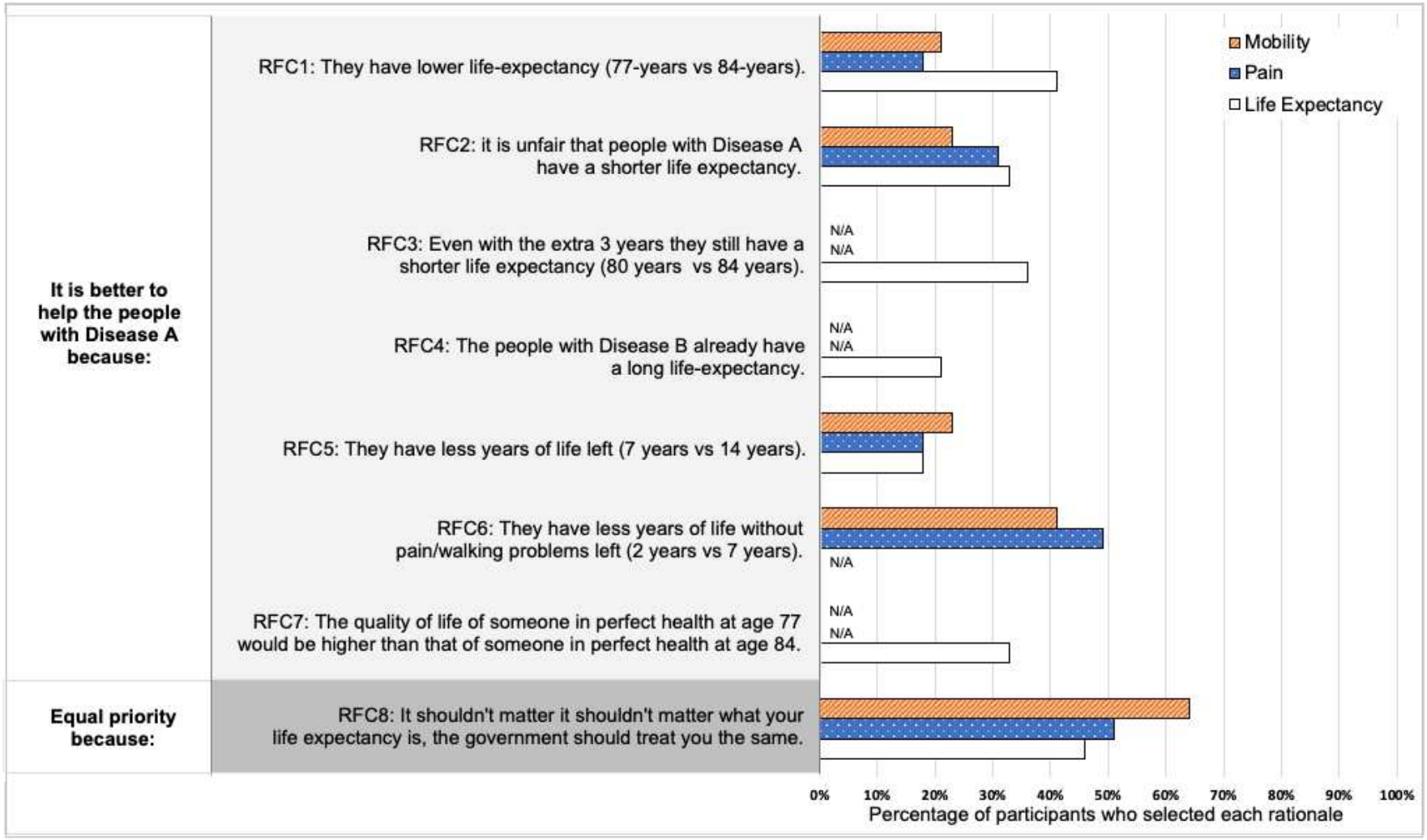
be higher than that of someone in perfect health at age 84".This statement was selected by 21% in the socioeconomic arm and 33% in the neutral arm. As these rationales were not relevant to the choices about the quality-of-life interventions, and each would favour prioritising the group with lower life-expectancy, it is plausible that these rationales may explain, at least in part, why participants were more willing to prioritise the lower life-expectancy group in the life-expectancy exercise than they were in the quality-of-life exercises.

*Figure 9. Socioeconomic arm rationale for choice responses (direct-health-related only); percentage of people who selected this rationale for each health type.**



* N/A = Not applicable (the statement was not offered to participants in this exercise).
RFC = Rationale for choice.

*Figure 10. Neutral arm rationale for choice responses; percentage of people who selected this rationale for each health type**



* N/A = Not applicable (the statement was not offered to participants in this exercise).
RFC = Rationale for choice.

4. Discussion

In this study, we explored three hypotheses: (1) the UK-public are more averse to inequalities in health between socioeconomic groups than they are to inequalities in health between neutrally labelled groups; (2) this difference is, at least in part, driven by the role non-health information plays in determining aversion to inequalities in health between socioeconomic groups; and (3) the UK-public are more willing to prioritise groups with lower lifetime health over groups with higher lifetime health if an intervention improves life-expectancy than if it improves quality-of-life.

Hypotheses 1 and 2

We find evidence consistent with the hypothesis that the UK-public are more willing to prioritise the health of people from deprived socioeconomic groups than they are to prioritise the health of people with equivalent health in neutrally labelled groups. This finding is aligned with the findings of Hurley et al. (2020), Pinho and Botelho (2018), and of the cross-study comparison in a review of relevant literature conducted by McNamara et al. (2020).

While we acknowledge that consideration of aversion to inequalities in health across socioeconomic groups requires a multi-variate social objective function, and is therefore is not compatible with the univariate characteristic of the original Atkinson Social Welfare Function (Atkinson, 1970), we have calculated the inequality aversion parameter from our results in order to facilitate a like-for-like comparison with previous studies. In an Atkinson function (functional form provided in Online Appendix), an inequality aversion parameter of 0 denotes no inequality aversion, parameters >0 denote inequality aversion, and as the parameter increases, so the

strength of that aversion increases. In this study, the Atkinson parameter we estimate for life-expectancy inequality across socioeconomic groups is 12.63. This figure is comparable to the corresponding figures derived by Robson et al. [10.95] (2017), Ali et al. [10.87 or greater] (2017), and Cookson et al. [10.9 and 5.4] (2018), and consistent with other literature that suggests the public are willing to prioritise disadvantaged socioeconomic groups with lower life-expectancy over advantaged socioeconomic groups with higher life-expectancy for interventions that improve life-expectancy (Abásolo and Tsuchiya, 2013, 2004; Lal et al., 2019; Tsuchiya and Dolan, 2009, 2007). Similarly, the corresponding parameter we estimate for the neutral arm [6.43], is comparable to those estimated by Edlin et al. (2012) [5.76 and 7.63], and consistent with existing evidence of aversion to inequalities in health between neutrally labelled groups (Olsen, 2013; Petrou et al., 2013; Richardson et al., 2012; Ubel et al., 2001, 2000; Wiseman, 2005).

Rationale for choice responses suggests that the difference between arms was driven, at least in part, by the influence of non-health information in the questions about socioeconomic groups, in particular, the financial inequality between richer and poorer people, the broader disadvantage faced by poorer people, and the perceived potential for the richer people to improve their health via private healthcare. This raises a critical question for those interested in distributionally sensitive economic evaluations: should these methods apply estimates of inequality aversion that are influenced by non-health information, or estimates based on health alone? In this paper, we do not make a case for either possibility; we simply point out that those conducting, and using, DCEAs should be aware of this issue, and should think carefully about it before using DCEAs to inform resource allocation decisions.

While the neutral and socioeconomic arms were intended to be identical with the exception of group-type, there are differences between the two that may have impacted our results. For example, the socioeconomic arm were asked questions about two socioeconomic quintiles that account for 40% of the UK population, while we did not tell the neutral arm what proportion of the population are within groups A and B. This is potentially important, because evidence suggests our willingness to help others depends on the number of people faced with the same problem that we cannot help (Bartels and Burnett, 2010). Furthermore, we did not provide the neutral arm with information about people who did not have Disease A and B, whilst participants in the socioeconomic arm may have considered the "middle" 60% not in the richest/poorest fifth when answering. Similarly, we did not provide information about inequalities in quality-of-life. As those in the socioeconomic arm may have had existing knowledge about, or inferred the existence of, socioeconomic inequalities in quality-of-life, it is possible they considered this when responding, whilst those in the neutral arm did not.

Hypothesis 3

Our sample was significantly more willing to prioritise neutrally labelled groups with lower life-expectancy over neutrally labelled groups if an intervention improves life-expectancy than they are if it improves quality-of-life. In the socioeconomic arm, we observed a similar trend in aversion across health benefit types, but this was only statistically significant at the 10% level.

Rationale for choice responses suggests that differences in the willingness to prioritise the group with lower life-expectancy across intervention types was partly influenced by the fact that fewer participants considered an inequality in life-expectancy to be relevant to a decision about an

intervention that improved quality of life, compared to a decision about an intervention that improved life-expectancy. As noted in the introduction of this paper, QALY-based DCEA assumes that, given an inequality in lifetime health between two groups of a set QALY magnitude, the public are willing to prioritise the group with lower lifetime health for a QALY gain, irrespective of how that QALY gain is composed. If taken at face value, our results suggest this assumption may not hold. However, it should be noted that we did not explicitly tell participants that each intervention provided a 3 QALY-gain. Instead, we provided them with information about the intervention which equated to a 3 QALY-gain. Given the cognitive burden associated with this task, it is possible we would have observed different results if we had explicitly told participants the QALY-gain the interventions provided. In addition, whilst we assumed the QALY-model was an appropriate way to equalise the size of the health gain provided across health-gain types, evidence suggests that the public may be willing to pay more for QALYs that improve their own health through life-extension rather than improve their own quality-of-life (Ryen and Svensson, 2015). Given this, it is possible that participants may have perceived the different QALY gain types as being of different social value, independently of the inequality between the two groups. Also, we did not brief participants about inequalities in quality-of-life. If this had been done, this may have increased their willingness to prioritise the group with lower life-time health for the quality-of-life improving interventions.

The primary strength of this study is that it was administered face-to-face. We used this mode, because we wanted participants to engage in the tasks, and think carefully about the issues. Having attended the study fielding, we believe we achieved this. However, the decision to use a face-to-face, rather than for example an online, design did mean we could include substantially fewer participants, across a much smaller geographical spread, than would otherwise have been

possible. It would be valuable to repeat this part of study in a larger representative sample of the UK-public. Other strengths of this study include the use of a general-public sample; the testing of three novel and policy relevant hypotheses; and the collection of rationale for choice data.

One limitation of this study is the way we represented the socioeconomically neutral groups. It is possible that the use of the term "disease" impacted the way participants thought about the exercises, and that different results may have been observed had uninformative neutral terms been used (e.g. "A" and "B"). It should also be noted that we did not account for time preference, and it is possible that some participants may have preferred to extend the life-expectancy of those with lower life-expectancy as they perceived the present value of extending their life by 3-years as being higher than for the higher life-expectancy group. In addition, it is possible that our PTO results were influenced by concern for intra-group inequality (i.e. by benefiting only a proportion of people from the impacted groups). It is not clear what impact this may have had on our results. A further limitation is the fact that we are attempting to elicit preferences about complex issues in a simplistic way. In this format, we did not, and could not have, fully explained the breadth of inequalities in health between socioeconomic groups. Equally, we did not explain to participants the hypothesised causes of these inequalities, or the give them information about what different people think about the injustice, or otherwise, of those inequalities. Furthermore, we did not give them opportunity to deliberate with others. Given this, the preferences elicited in this study should be regarded as being based on lay-understandings of the causes of inequalities in health and of the implication of prioritising health-gains to different groups. In future work, it would be interesting to repeat this survey in a sample of individuals who have greater knowledge of inequalities in health, for example members of the public who have received a significant, multi-day briefing on inequalities in health, or public health decision-makers. It should also be noted

that this study applied one of many reasonable methodologies and choice-framings. For example, we highlighted the number of people from each group who would benefit from the intervention, and did not state the number of people who would not. Alternative methods and/or framings may have produced different results. Given this, and the issues identified above: (1) the PTO data should be regarded as being consistent with Hypotheses 1 and 3, rather than definitive evidence in support of them; (2) our results should be regarded as suggesting the assumptions underlying DCEA may not hold, rather than provided strong evidence they do not.

In conclusion, we find evidence that suggests the UK-public are more averse to inequalities in health between socioeconomic groups than they are to those between neutrally framed groups. We provide evidence that non-health factors influence prioritisation questions about the health of different socioeconomic groups. We find evidence consistent with the idea that the UK-public are more willing to prioritise a group with lower lifetime health for an intervention that improves life-expectancy, rather than one that improves quality-of-life.

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