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**Working Paper**

## Disability and Multi-Dimensional Quality of Life: A Capability Approach to Health Status Assessment

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# Disability and Multi-Dimensional Quality of Life: A Capability Approach to Health Status Assessment

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## ABSTRACT

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# Disability and Multi-Dimensional Quality of Life: A Capability Approach to Health Status Assessment\*

This paper offers an approach to assessing quality-of-life, based on Sen's (1985) theory, which it uses to understand loss in quality-of-life due to mobility-impairment. Specifically, it provides a theoretical analysis which is able to account for the possibility that some functionings may increase when a person's capabilities decrease, if substitution effects are large enough. We then develop novel data consistent with our theoretical Senian framework that permits comparison of quality-of-life between those with a disability (mobility-impairment) and those without. Empirical results show that mobility impairment has widespread rather than concentrated impacts on capabilities and is associated with higher psychological costs.. We also find evidence that a small number of functionings are higher for those with a disability, as our theory allows. The paper concludes by discussing possible implications for policy and health assessment methods.

**JEL Classification:** D60, I31

**Keywords:** mobility impairment, disability, capabilities, health, Sen, extra-welfarism

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## **Disability and Multi-Dimensional Quality of Life:**

### **A Capability Approach to Health Assessment**

#### **1. Introduction**

Interest in the application of Sen's (1979, 1985, 2010) capability approach to health economics continues to grow following earlier discussions in the literature about its capacity to change the informational basis of policy evaluation and technology assessment (Culyer, 1989). Sen's approach was essentially developed as a constructive response to some of the problems that economists and philosophers had identified in the theoretical foundations of welfare economics. It argues instead for an account of quality of life that emphasises multi-dimensionality, the importance of what people are free to do, a production function for quality of life which is based on resources and abilities and recognises that people are heterogeneous in their abilities to generate quality of life. In this paper, we contribute to the problem of understanding what happens when the capability approach is used to structure empirical analysis relevant to health economics by providing novel evidence of a pattern of diverse capability deprivation for those with a mobility impairment. We also contribute to theory by providing a more general theoretical analysis of capabilities and their determinants than has been discussed to date and use this to help interpret our empirical findings.

Within health economics, Anand (2005), Brouwer et al. (2008), and Coast et al. (2008a) have emphasised the theoretical promise that this approach offered to broaden the informational scope of economic evaluations. As they note, welfarism restricts information to utilities, whereas extra-welfarism goes beyond this by supplementing it with additional information about non-goods characteristics, such as whether individuals have the freedom and ability to do everyday activities or are free from pain or happy. One of the key problems for Sen's approach has been its operationalization. It emphasised the importance of human potential - what people are enabled to do - and yet this seemed to be difficult to measure compared with the activities people engage in or states they experience. However, over the years this has given rise to a growing body of research by economists on the value of autonomy in health (Abadian (1996), Ruger (2010)), safety nets for and prevalence and nature of disability (Burchardt (2004), Mitra (2006), Wolff and De-Shalit (2007), Dubois and Trani (2009))<sup>1</sup>, child development and the promotion of non-cognitive skills (Heckman (2007)), global health governance and social justice (Ruger (2004)), women's quality of life in a low income country (Greco et al. (2015)), as well as the development of new measures of health status for evaluations such as the ICECAP family of measures (Coast et al. (2008b), Al-Janabi et al (2013), Coast (2014), Keeley et al. (2013)) or the OCAP/OXCAP family of measures developed by Simon et al. (2013) and Lorgelly et al. (2015).<sup>2</sup>

Our paper contributes to the practical use of the approach by developing data on the capabilities, functionings and happiness of a group of adults with a disability and then using the data to explore what it might tell us about the quality of life of this group. In addition, because we find that a small number of functionings increase with disadvantage (e.g. sleeping during the day) in a manner not dissimilar to the behaviour of inferior goods in conventional consumer theory, we develop a theoretical framework that allows for this possibility. Our research question can be considered, therefore, to be: what can data (and theory) based on the capability approach to quality of life tell us about people with disabilities? The paper is primarily a contribution to the health economics of quality of life measurement, particularly from a capability perspective, but it is also

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<sup>1</sup> Economists working on health have emphasised that disability can profoundly impact the ability of people to convert resources into valued activities or states and this paper provides an opportunity to complement the work of Trani et al (2018) and to test the proposition in a high income country context.

<sup>2</sup> Following his widely cited IHEA presidential address published in this journal, Sen (2002), a wide array of topics have been shown to be addressable with the approach including work on maternal health, Osmani and Sen (2003), disability classification Saleeby (2007), recovery in mental health Hopper (2007), health inequalities and social determinants, Marmot et al (2008), the value of agency for health Abel and Frohlich (2012), health and justice Venkatarapuram (2013), patient centred care, Entwistle and Watt (2013), theoretical foundations for health assessment Bleichrodt and Quiggan (2013) Brazier and Tsuchiya (2015), psychometric properties of health measures Al-Janabi et al (2013) Hofmann et al (2013), Vergunst et al (2017), aging and quality of life Zaidi and Howse (2017). For a review of applications of the Sen-Nussbaum capability approach in health see Mitchel et al (2017).

relevant to work on disability more generally, or the operationalisation of the Sen-Nussbaum approach to economics and social justice.

The paper is structured as follows. Section 2.1 offers an account of the capability approach focussing particularly on the concept of capability and then develops some theory which makes a novel theoretical contribution to capability analysis connecting it more generally with traditional consumer theory and that we use to structure our interpretation of data results. Section 2.2 describes the data categories that we populate on the basis of the theory described in 2.1. It also provides a valuation formula used towards the end of empirical results section. Section 3 carries the results and descriptive data comparing capabilities, activity involvement and subjective wellbeing measures for people with a capability impairment. We then report the results of regression models in which capabilities and subjective wellbeing depend on mobility impairment as well as a range of other resource and conversion factors and use this to argue that the pattern of capability deprivation is such that *most* capabilities are on average lower for those with a mobility impairment than for those without; and, using a subjective valuation method, the costs appear significant. In section 4 we discuss these results, noting that our results indicate that workplace and other losses are important when measuring the true value of health, that recent disability policy reform in Australia can be understood through a capability lens, and that the subjective measures in this case appear to confirm significant quality of life loss associated with extensive capability deprivation. We also suggest that whether these results could be described as being consistent with a utility approach is less important than the fact that Sen's approach provides a definition of life quality of life that provides a rationale for collecting such data and offers an agenda for further research.

## 2. Theory and Methods

### 2.1 Theoretical Framework

We start by developing a framework based on Sen (1985, pp. 11-14) which emphasizes the importance of capabilities, functionings (activities and states), and subjective wellbeing (e.g. 'experienced utility' or 'happiness') for quality of life assessment. The freedom to choose things, in and of itself, is not well captured in traditional welfare economics. In particular, welfare economics makes no reference to how bliss points, identified with optimal baskets of goods and services, are arrived at. In Sen's framework, and therefore in our analysis, we begin by emphasising the importance of what people are enabled to do or be. We denote the set of all such activities and states that an individual  $i$  can achieve as the set  $Q_i$ , and note that conditional on a person's resources, and abilities to convert them, this can be a significant measure of a person's wellbeing. This set can also be thought of as the outcome of a vector of production functions, denoted by  $f_i$ , of resources and personal abilities,  $c_i$ . So, for the  $i$ th individual we can define the capability set:

$$Q_i \equiv \{f_i; c_i\} \text{ where } f_i \in \mathbb{R}^n \text{ (1).}$$

Variations in personal abilities are central to disability, even in social models, and so this framework is a promising one with which to understand how disability impacts the production of quality of life.

A capability set specifies feasible activities<sup>3</sup> that are achievable with given resources and personal characteristics. We denote the functioning vector thus:

$$f'_i = \langle f_{i,1}(c_i), f_{i,2}(c_i), \dots, f_{i,n}(c_i) \rangle \in \mathbb{R}^n \text{ (2),}$$

where  $n$  denotes the number of elements in the space of possible activities or states. The value of this vector depends on the individual's ability to convert resources into activities, so in the analysis we shall estimate equations consistent with this. Finally, our framework includes a third equation denoting the amount of pleasure or happiness a person derives from any

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<sup>3</sup> For the rest of this paper, we focus on activities and use the term 'functioning' synonymously.

particular vector of activities and states, which depends also on their resources and personal characteristics,  $c_i$ . We can represent this as

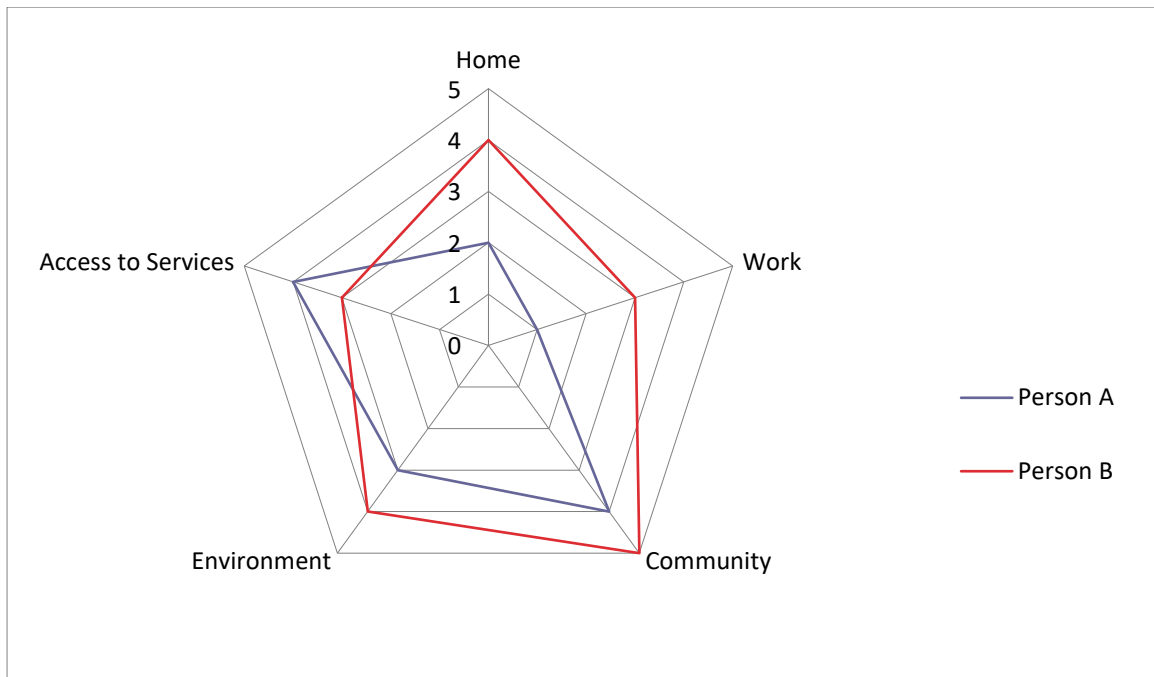
$$U_i = u(f_{i,1}, f_{i,2}, \dots, f_{i,n}, c_i) \quad (3).$$

This last relation can be thought of as representing what has come to be called ‘experienced’ utility, to distinguish it from the decision-based concept of utility proposed by Samuelson (1937).

This is, in essence, Sen’s (1985, pp. 11–14) original model, with only minor notational differences. What people are free to do, as distinct from what they actually do, is important for assessing a person’s overall advantage. This distinction is reflected in standard measures of health which include both actual experience of pain as well as the ability to get around (e.g. The Euroqol Group (1990)). In many situations, activities or states can be ends in themselves, whereas happiness could be a driver or by-product of some desirable state or activity. Happiness, however, is adaptive and people can adapt to both goods and bads, so Sen (1985, pp. 11–14) emphasises that it cannot be relied on as a gold standard measure of value. This important observation has led some to interpret Sen’s capability approach as not being concerned about human happiness Bruni et al (2008). That is not the case, however, so we focus on this aspect of quality of life.

Although all three aspects of wellbeing (capabilities, activities and happiness) are important to understand a person’s overall quality of life, our data on capabilities are the most novel. In Figure 1, we illustrate how capability sets can be visualised. In this particular example, a star graph indicates that person B has more capabilities in all but one domain, but does not dominate A, who has better access to services.

**Figure 1 Capability Sets for Two Individuals**



In the empirical work here as elsewhere (see for instance Anand et al. (2011)), we develop data that measure the vertices of each set. Rather than trying to estimate the elements of the set, which is feasible only for very small sets, our approach relies on the fact that the set of all possible activity and state vectors defines another set of maximal points on each dimension.

Using the fact that the set  $\mathbf{Q}_i$  defines a set of maximum points in the  $n$ -dimensional space indexed by  $j$ , we can define an estimator of the  $i$ th individual's capability set thus

$$\widehat{\mathbf{Q}}_i = \{d_{i,1}^*, d_{i,2}^*, \dots, d_{i,n}^*\} \quad (4),$$

where  $d_{i,j}^*$  are the capability assessments for each of the  $j$  dimensions. This estimator reflects what a person is able to do on a dimension by dimension basis.<sup>4</sup>

To assess the impact of disability on capabilities and activities we first denote disability by  $D_i \in \mathbb{R}^+$ , where higher values denote increasing disability. We assume that in general  $\frac{\partial d_{i,j}^*}{\partial D_i} \leq 0$ ; that is,  $d_{i,j}^*$  is weakly decreasing in  $D_i$  for all  $i, j$ . In other words, a disability is not capability enhancing in any of the  $n$  dimensions. However, disability could be expected to reduce some capabilities more than others. Thus, if an unimpaired individual with a capability set  $\mathbf{Q}_i = \{d_{i,1}^*, d_{i,2}^*, \dots, d_{i,n}^*\}$  were subsequently to become impaired, the resulting capability set  $\mathbf{Q}'_i = \{d'_{i,1}, d'_{i,2}, \dots, d'_{i,n}\}$  would have the following two features:

(i)  $\sum_{j=1}^n d'_{i,j} \leq \sum_{j=1}^n d_{i,j}^*$

(ii) In general,  $d'_{i,j}/d'_{i,k} \neq d_{i,j}^*/d_{i,k}^*$ .

We could expect a similar impact of disability on the set of activities: (i) a reduction in *total* activities, but also (ii) a change in the *relative frequency* of activities. These effects might be considered loosely analogous to the income and substitution effects in the standard neo-classical constrained optimisation problem. In the standard neo-classical problem, these effects arise from the reduction in the budget set and the change in relative prices, arising from one good's price increase. Here, the effects arise from the overall reduction which a disability causes in an individual's opportunity to engage in activities, together with the fact that this reduction is not uniform across different types of activity, making certain activities relatively more 'costly.'

*Opportunity effect of impairment:*  $\sum_{j=1}^n f'_{i,j} \leq \sum_{j=1}^n f_{i,j} \quad (5)$

*Substitution effect of impairment:*  $\frac{f'_{i,j}}{\sum_{l=1}^n f'_{i,l}} = \alpha_j \frac{f_{i,j}}{\sum_{l=1}^n f_{i,l}}$  for some  $\alpha_j \in \mathbb{R}_+$ . (6)

The overall levels of opportunity, or resource, for engaging in activities are lower for disabled people so they 'purchase' fewer activities in (5). However, relative prices are also different, resulting in a substitution in (6) away from activities that have been particularly affected (e.g. more physically demanding activities such as walks in the park) to those which may now be only marginally more difficult (e.g. reading a book).

In (6), if  $\alpha_j > 1$ , this indicates a substitution towards activity  $j$  from the  $n - 1$  other activities (and conversely if  $\alpha_j < 1$ ). In theory, it is quite possible for this effect to be large enough to outweigh the 'opportunity' effect in (5), so that the net effect of disability is an increase in frequency of activity  $j$ . To see this, note that (5) can be rewritten as:

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<sup>4</sup> Geometrically it amounts to proxying the individual's capability set with a multidimensional polyhedron in line with theory discussed by Klemisch-Ahlert (1993).



$$\sum_{l=1}^n f'_{i,l} + \beta = \sum_{l=1}^n f_{i,l} \text{ for some } \beta \geq 0, (7)$$

where  $\beta$  indicates the absolute size of the opportunity effect of impairment.

Substituting (7) into (6), we have  $\frac{f'_{i,j}}{\sum_{l=1}^n f'_{i,l}} = \frac{\alpha_j f_{i,j}}{\beta + \sum_{l=1}^n f_{i,l}}$ . Rearranging, we have

$\frac{f'_{i,j}}{f_{i,j}} = \frac{\alpha_j \sum_{l=1}^n f_{i,l}}{\beta + \sum_{l=1}^n f_{i,l}}$ . Therefore,  $f'_{i,j} > f_{i,j} \Leftrightarrow \alpha_j \sum_{l=1}^n f_{i,l} > \beta + \sum_{l=1}^n f_{i,l}$ , which simplifies to the condition that:

$$f'_{i,j} > f_{i,j} \Leftrightarrow \alpha_j > 1 + \frac{\beta}{\sum_{l=1}^n f_{i,l}}. \quad (8)$$

The intuition from the condition in (8) is clear. The net effect of disability on frequency of activity  $j$  depends on the size of the substitution effect  $\alpha_j$  relative to the size of the opportunity cost of impairment as a proportion of total activities. For the substitution effect to lead to increased frequency of activity  $j$ , it is always the case that  $\alpha_j > 1$ . As the opportunity cost of impairment tends towards zero, there need only be an infinitesimally small substitution effect towards  $j$  in order for activity  $j$  to increase due to impairment.

Almost all applications to date of Sen's theory assume that capabilities are positively related to an individual's resources and ability to convert resources into valued activities. Our framework is also, however, able to allow for negative relations when 'substitution' effects are sufficiently high compared with 'opportunity' effects. If any activities behave like inferior goods, then a framework that does not rule out positive relations between disability and activities, counter-intuitive though this may seem, is required.<sup>5</sup>

## 2.2 Data and Empirical Implementation

The data developed for our analysis were produced through a population level survey in the UK designed to deliver a profile of overall quality of life at national level. To ensure that our sample population was as close as possible to being nationally representative, the panel of respondents was drawn equally from England, Scotland and Wales and is representative of working age adults in terms of age, gender and social class. The survey was conducted by YOUGOV in 2012 and supplemented in 2013 with an additional sample of people, all of whom had a doctor diagnosed mobility problem or were registered disabled (due to mobility impairment)<sup>6 7</sup>. These individuals were asked exactly the same questions as the original representative 2012 sample. In total this provides us with 2013 data for a sample of 633 mobility impaired individuals and 1,172 non-impaired individuals.

Data were collected on capabilities, activity involvement and psychological cost, as well as a range of socio-economic variables<sup>8</sup> (see Anand et al. (2016) for further details for the derivations of these questions). The most distinctive component of our dataset relates to the measurement of capabilities; these are reproduced in the online supplementary materials<sup>9</sup> and

<sup>5</sup> It should be stressed that the purpose is not to suggest that activity involvement often decreases with better health but rather to allow for the possibility. Most goods are consumed more when income rises, but some, like potatoes, though valued are consumed less as income rises – our point is that some capabilities are similar in regards to their 'income' elasticities.

<sup>6</sup> The precise question respondents answered was "Have you been diagnosed by a doctor, or are you registered as disabled [in the following way]: A condition that substantially limits one or more basic physical activities such as walking, climbing stairs, reaching, lifting or carrying." Ethics approval for the collaboration with YOUGOV was granted by the HREC Open University.

<sup>7</sup> Background analysis and early use of related data in health economics can be found, for example in Chirikos and Nestel (1984).

<sup>8</sup> For a discussion of socio-economic variables correlated with health, see for example Fuchs (2004).

<sup>9</sup> All the capability questions are detailed in supplementary Appendix A. Derivation is further discussed across several papers but see for example \*.

relate to the opportunities and constraints individuals face across five domains – Home (i.e. domestic and family life), Work, Community, the Environment in which one lives and Access to Services. In each of these domains, several ‘sub-domain’ questions were asked, regarding various specific things that people are able to do or to achieve. In total, data were collected for 29 capabilities across these domains. Only respondents who reported being employed or self-employed at the time were asked the Work domain questions.

Consider a set of individuals  $i = 1, 2, \dots, N$ . As discussed above, we distinguish between their capabilities,  $d_i$ , things that they can do; their activities or functionings,  $f_i$ , the things that they actually do, and their well-being,  $u_i$ , their satisfaction with life. These are all influenced by their mobility impairment, if any,  $D_i$ , their income  $Y_i$ , and a vector of resources and personal characteristics,  $c_i$ , such as gender, age, race, education, whether working, living with a partner or with dependent children.

From the survey we have data on 29 capability indicators,  $d_i^j$  (such as able to get to places easily); 30 activity indicators  $f_i^k$ , (such as doing exercise) and 8 wellbeing measures,  $u_i^l$  (such as satisfaction with life or with colleagues). Mobility impairment was either diagnosed by a doctor or the person was registered disabled. Sample size differed between general responses and responses specific to the sub-sample who worked.

Three sets of equations were estimated. For capabilities  $j = 1, 2, \dots, 29$

$$d_i^j = \beta_0^j + \beta_1^j D_i + \beta_2^j Y_i + \gamma^j c_i + \varepsilon_i^j$$

For activities  $k = 1, \dots, 30$

$$f_i^k = \beta_0^k + \beta_1^k D_i + \beta_2^k Y_i + \gamma^k c_i + \varepsilon_i^k$$

For well-being indicators  $l = 1, 2, \dots, 8$

$$u_i^l = \beta_0^l + \beta_1^l D_i + \beta_2^l Y_i + \gamma^l c_i + \varepsilon_i^l.$$

These are cross-section equations and, since at least Friedman (1957), it has been common to interpret the between-unit association as representing the long-run permanent relationship rather than the transitory, within-unit, adjustment process. Thus, while there are likely to be person-specific features, such as how long the respondent’s mobility has been impaired, the cross-section variation is likely to dominate, as discussed by Pesaran and Smith (1995).

We report two analyses. First, we know from previous capability research using secondary data that the costs of disability can be high, though we do not know why. By developing and comparing capability indicators for people with a mobility impairment and those without, we can in principle distinguish between two plausible patterns associated with mobility impairment: one in which capability losses are concentrated and a second in which they are widespread. Both are plausible though appropriate policy responses will differ.

Second, we use the subjective wellbeing regressions to derive a monetary estimate of the impact of mobility impairment on life-satisfaction. We use the compensating variation approach, where the value of mobility impairment is estimated as

$$CV = \exp\left(-\frac{\beta_{mi}}{\beta_y} + \ln \bar{y}\right) - \bar{y} \quad (10),$$

where  $\beta_{mi}$  and  $\beta_y$  denote the coefficients on mobility impairment and (log) income, respectively, in an OLS model of life satisfaction, and  $\bar{y}$  denotes mean income. This, or similar methods have been used to assign market values to a wide variety of non-market goods.<sup>10</sup>

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<sup>10</sup> These non-market goods (and bads) include the cost of domestic violence (Santos (2013)), air quality (Luechinger (2009) and (Levinson, 2012)), flood disasters (Luechinger and Raschky (2009)), terrorism (Frey, Luechinger and Stutzer (2007)), noise (van Praag and Baarsma, 2005) and informal care (van den Berg and Ferrer-i-Carbonell, 2007).

As an alternative way of quantifying the impact of mobility impairment in monetary terms, we use the association between mobility impairment and self-reported EQ-5D-3L health utility to estimate the value of quality of life lost as a result of mobility impairment, annually and discounted over remaining life expectancy, using the ceiling willingness to pay of the National Institute for Health and Care Excellence (NICE) of between £20,000 and £30,000 per Quality-Adjusted Life-Year (QALY) gained. EQ-5D-3L health utility was elicited in our survey instrument using standard questions developed by EuroQoL Group (1990).<sup>11</sup> By definition, an individual's EQ-5D-3L health utility is equal to the proportion by which their life years are discounted to obtain their estimated QALYs. Thus, the mobility impairment coefficient in an OLS model of EQ-5D-3L health utility was used to provide an estimate of annual QALYs lost due to impairment. QALYs lost until death were estimated by multiplying this figure by remaining life expectancy. Our estimate of life expectancy was estimated simply by subtracting the mean age of the full sample (45.654) from the general population average life expectancy of 81.5 years and did not adjust for possible reduced life expectancy arising from mobility impairment.

### 3. Results

A descriptive summary of capability scores from our survey is reported in Table 1, showing that people with a mobility impairment are systematically worse off than those without a mobility impairment: pairwise t-tests suggest strongly statistically significant differences in all but two areas. Two out of the top three (in significance terms) are clearly related to spatial mobility (getting to places easily and access to parks), but it is interesting and perhaps less obvious that work-life is also highly related to the disability. Generally speaking, access to services are least significant and, in the case of getting help from doctors, nurses or the police, the differences are not statistically significant.

Turning to measures of functioning as measured by 'involvement yesterday in 28 different activities', Table 2 shows significant differences between impaired and non-impaired respondents in 14 of the 28 areas and that these effects operate in both directions (as allowed in our theory). Thus, active involvement in commuting, cooking, drinking alcohol, exercise, housework, internet use for work, intimate relations, listening to music, paid employment and playing a musical instrument are reported significantly less often by those with mobility impairment compared with others. This does not rule out some substitution effect towards some of these activities, for example from those related to work to those done in the home, but does suggest that in these instances the direct effect of impaired mobility is dominant. By contrast, relaxing, self-care and smoking are reported more frequently by those with a mobility impairment, a pattern compatible with a substitution effect, which has considerable face validity as a possible explanation.

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<sup>11</sup> For an overview of such methods see for instance Dolan et al. (1996).

**Table 1. Capability Scores: Mobility Impairment v No Mobility Impairment**

Capabilities	Impaired			Non-impaired			t-test for Difference
	n	Mean	se	n	Mean	se	
<i>Home life</i>							
Make ends meet	633	5.701	0.12	1172	7.323	0.079	11.29***
Find suitable home	633	6.553	0.124	1172	7.713	0.079	7.88***
Enjoy personal relations	633	5.953	0.129	1172	7.125	0.084	7.597***
Feel loved and valued	633	6.194	0.126	1172	7.27	0.08	7.18***
Share tasks fairly	633	5.232	0.126	1172	7.009	0.089	11.49***
Socialise with family members	633	6.229	0.123	1172	7.308	0.079	7.358***
<i>Work life</i>							
Work-life balance	633	4.564	0.128	1172	6.869	0.081	15.24***
Find work when need	205	6.21	0.218	889	7.562	0.092	5.7***
Can use skills	205	6.58	0.21	889	7.534	0.088	4.19***
Promotion opportunities	205	4.795	0.216	889	5.756	0.1	4.029***
Have good boss	205	6.054	0.229	889	7.018	0.097	3.885***
Treated as equal at work	205	6.517	0.224	889	7.828	0.087	5.446***
Socialise with colleagues	205	5.351	0.211	889	6.451	0.091	4.78***
<i>Community life</i>							
Participate social events	633	4.774	0.114	1172	5.967	0.077	8.65***
Treated as equal	633	7.387	0.121	1172	8.088	0.072	4.99***
Religious freedom	633	7.981	0.115	1172	8.534	0.071	4.086***
Political freedom	633	7.733	0.113	1172	8.091	0.073	2.657***
<i>Local Environment</i>							
Safe at night	633	6.664	0.122	1172	7.893	0.072	8.65***
Access to parks	633	6.408	0.135	1172	8.419	0.076	12.97***
Low pollution	633	5.348	0.127	1172	6.98	0.084	10.74***
Can keep a pet	633	7.581	0.133	1172	8.256	0.09	4.19***
Can get to places easily	633	4.795	0.125	1172	7.994	0.077	21.84***
<i>Access to Services</i>							

Use financial services	633	7.942	0.109	1172	8.658	0.065	5.645***
Get rubbish cleared	633	7.689	0.113	1172	8.544	0.065	6.56***
Get house problems fixed	633	7.376	0.116	1172	7.767	0.072	2.86***
Get doctor or nurse	633	8.299	0.1	1172	8.264	0.067	-0.29
Help from police	633	7.662	0.107	1172	7.83	0.069	1.32
Legal help	633	7.254	0.117	1172	7.772	0.071	3.78***
Range of shops	633	6.886	0.124	1172	8.498	0.068	11.38***
<b>Total Capabilities</b>	205	17.239	0.284	889	20.594	0.232	

Note: means are of quasi-Likert eleven point scales.

**Table 2. Activity Involvement: Impaired v Non-impaired**

	Impaired			Non-Impaired			p-value
	n	Mean	se	n	Mean	se	
Attending class	408	0.015	0.006	770	0.017	0.005	0.7778
Caring (unpaid)	408	0.083	0.014	770	0.068	0.009	0.3212
Commuting	408	0.123	0.016	770	0.305	0.017	<0.0001***
Cooking	408	0.370	0.024	770	0.461	0.018	0.0027***
DIY	408	0.056	0.011	770	0.079	0.010	0.1471
Drinking alcohol	408	0.145	0.017	770	0.209	0.015	0.0069***
Exercise	408	0.108	0.015	770	0.251	0.016	<0.0001***
Housework	408	0.377	0.024	770	0.461	0.018	0.0059***
Internet (personal)	408	0.787	0.020	770	0.764	0.015	0.3682
Internet (work)	408	0.105	0.015	770	0.231	0.015	<0.0001***
Intimate relations	408	0.069	0.013	770	0.105	0.011	0.0393**
Listening to music	408	0.355	0.024	770	0.442	0.018	0.0042***
Looking after pet	408	0.377	0.024	770	0.343	0.017	0.2377
Other outdoor	408	0.054	0.011	770	0.069	0.009	0.3187
Paid employment	408	0.228	0.021	770	0.542	0.018	<0.0001***
Playing musical instrument	408	0.022	0.007	770	0.055	0.008	0.0091***
Praying or meditating	408	0.088	0.014	770	0.066	0.009	0.1695
Relaxing or napping	408	0.404	0.024	770	0.268	0.016	<0.0001***
Reading	408	0.419	0.024	770	0.423	0.018	0.8880
Self-care	408	0.370	0.024	770	0.242	0.015	<0.0001***

Smoking	408	0.199	0.020	770	0.119	0.012	0.0003***
Socialising	408	0.118	0.016	770	0.169	0.014	0.0196**
Shopping	408	0.272	0.022	770	0.316	0.017	0.1211
Time with children	408	0.194	0.020	770	0.235	0.015	0.1027
Visiting park or countryside	408	0.088	0.014	770	0.105	0.011	0.3544
Visiting cinema/concert/gallery/museum	408	0.056	0.011	770	0.066	0.009	0.5069
Volunteering	408	0.059	0.012	770	0.061	0.009	0.8792
Watching TV	408	0.757	0.021	770	0.731	0.016	0.3295

Notes: (i) Smaller sample sizes than in Table 1 because these data relate only to “those for whom yesterday was a normal working day”; (ii) .p-values are from chi-squared tests under null hypothesis of equal means for impaired and non-impaired; means are of binary activity involvement reports; data relate to those for whom yesterday was a normal working day

The third set of measures concern psychological wellbeing. Our initial results for the eight measures are reported in Table 3. Across all eight measures, people with mobility impairment report significantly lower wellbeing than non-impaired respondents. In five cases the difference is highly significant (<1%), while satisfaction with friendships is lower on average, but only at the 10% level of significance. Note that ‘anxiety yesterday’ is the only indicator in which higher scores indicate lower welfare, and is significantly higher on average for those with mobility impairment.

**Table 3. Psychological Wellbeing Measures: Impaired v Non-impaired**

	Impaired			Non-Impaired			t-test
	n	Mean	se	n	Mean	se	
Life satisfaction	633	5.510	0.098	1172	6.850	0.068	11.21***
Happy yesterday	633	5.641	0.101	1172	6.718	0.071	8.74***
Anxious yesterday	633	5.548	0.112	1172	5.234	0.076	-2.326**
Life worthwhile	633	5.905	0.113	1172	6.933	0.070	7.768***
Satisfied with friendships	633	7.039	0.113	1172	7.296	0.072	1.918*
Satisfied with colleagues	633	4.852	0.122	1172	6.871	0.073	14.229***
Satisfied with neighbourhood	633	6.502	0.107	1172	7.124	0.065	4.968***
Yesterday pleasurable	633	5.276	0.096	1172	6.163	0.063	7.709***

Note: means are of quasi-Likert eleven point scales.

Table 4 reports ordered probit results for each of the 29 capability measures. Income and mobility impairment are the most consistent predictors of capabilities across all the areas covered by our indicators. However, said, for some services, including health-care, mobility impairment is not a significant predictor. Being white also stands out as a predictor of access

to a range of services, while having a partner and dependent children are often statistically significant predictors of capabilities related to the environment.<sup>12 13</sup>

Our results in Table 5 repeat the ordered probit analysis for measures of psychological wellbeing. Again, mobility impairment and income are the most consistent predictors across almost all measures, followed by having a partner. The one exception is satisfaction with friendships where there is no statistically significant difference between those with a mobility impairment and others. Controlling for other variables, we find little evidence of any association between ethnicity and subjective wellbeing.

An OLS regression was also performed to estimate the coefficient on mobility impairment, including the same set of variables as the ordered probit and with EQ-5D-3L utility as the dependent variable. These showed that mobility impairment is associated with an annual

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<sup>12</sup> Raw gradients are graphed in online materials (Figure B1).

<sup>13</sup> By way of extension, we also estimated a finite mixture model based on capabilities aggregated into sub-scales representing the five areas discussed. Exploratory results suggest that whilst mobility impairment is generally predictive of capability, there is evidence of two groups in the data differentiated by size of the mobility impact.

**Table 4. Mobility Impairment Impacts on Capabilities: Ordered Probit Results**

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Make ends meet	Find suitable home	Home-relations	Home-loved	Home-share	Home-social	Work-Life Balance	Can find work	Work-can use skills	Work-opportunities
Mobility impaired	-0.401*** (0.058)	-0.365*** (0.057)	-0.327*** (0.058)	-0.283*** (0.059)	-0.446*** (0.058)	-0.293*** (0.058)	-0.662*** (0.060)	-0.342*** (0.087)	-0.253*** (0.087)	-0.220** (0.088)
Age	-0.097*** (0.021)	-0.015 (0.021)	-0.050** (0.021)	-0.054*** (0.021)	-0.044** (0.021)	-0.055*** (0.021)	-0.084*** (0.021)	-0.028 (0.028)	0.017 (0.027)	-0.021 (0.028)
Age Squared/1000	1.112*** (0.247)	0.310 (0.244)	0.659*** (0.245)	0.664*** (0.243)	0.431* (0.245)	0.668*** (0.244)	0.959*** (0.244)	0.272 (0.320)	-0.197 (0.318)	0.145 (0.331)
Logged HH Equiv Income	0.481*** (0.039)	0.260*** (0.038)	0.205*** (0.037)	0.199*** (0.039)	0.168*** (0.037)	0.174*** (0.037)	0.295*** (0.037)	0.480*** (0.053)	0.369*** (0.055)	0.249*** (0.052)
Male	0.028 (0.049)	-0.084* (0.050)	-0.059 (0.050)	-0.130*** (0.049)	0.245*** (0.050)	0.094* (0.050)	0.074 (0.050)	0.107* (0.064)	-0.061 (0.064)	-0.066 (0.064)
Higher Educ.	0.194*** (0.053)	0.148*** (0.052)	0.106** (0.054)	0.138** (0.054)	0.071 (0.054)	0.038 (0.053)	0.122** (0.054)	0.065 (0.068)	0.065 (0.068)	0.084 (0.067)
White	-0.029 (0.105)	0.155 (0.117)	-0.052 (0.119)	0.042 (0.126)	-0.126 (0.119)	0.112 (0.115)	-0.080 (0.111)	0.313** (0.150)	0.179 (0.156)	0.094 (0.151)
Unemployed	-0.442*** (0.110)	-0.221** (0.100)	-0.068 (0.110)	-0.165 (0.110)	-0.007 (0.095)	-0.088 (0.100)	-0.347*** (0.105)			
Married / live with partner	0.276*** (0.056)	0.304*** (0.056)	0.759*** (0.056)	0.576*** (0.056)	0.545*** (0.059)	0.365*** (0.057)	0.182*** (0.056)	0.109 (0.073)	0.114 (0.072)	0.034 (0.072)



Have dep. children	-0.035 (0.059)	-0.005 (0.059)	-0.085 (0.061)	-0.012 (0.060)	-0.087 (0.057)	0.049 (0.059)	0.047 (0.058)	0.100 (0.075)	0.016 (0.077)	0.046 (0.077)
Observations	1740	1740	1740	1740	1740	1740	1740	1058	1058	1058
Pseudo R-squared	0.0561	0.0300	0.0431	0.0325	0.0357	0.0200	0.0449	0.0321	0.0187	0.0117
AIC	7711.707	7721.447	7788.847	7818.001	7748.991	7900.48	7726.841	4652.555	4731.427	4922.882
BIC	7820.94	7830.68	7898.08	7927.234	7858.224	8009.713	7836.074	4746.874	4825.745	5017.2

Notes: 1. \*, \*\* and \*\*\* indicate statistical significance at the 10%, 5% and 1% levels respectively; 2. Robust standard errors.

**Table 4. Ordered Probit Models of Mobility Impairment Impacts on Capabilities (contd)**

VARIABLES	(11) Work-good manager	(12) Work-equal	(13) Work-social	(14) Community- social	(15) Community- treated as equal	(16) Community- religion	(17) Community- political	(18) Environment- safe	(19) Environment- parks	(20) Environment- low pollution
Mobility impaired	-0.226** (0.090)	-0.405*** (0.090)	-0.287*** (0.090)	-0.354*** (0.059)	-0.244*** (0.058)	-0.218*** (0.057)	-0.117** (0.057)	-0.347*** (0.058)	-0.614*** (0.059)	-0.462*** (0.059)
Age	-0.040 (0.028)	-0.032 (0.028)	-0.040 (0.028)	-0.061*** (0.021)	-0.070*** (0.022)	-0.035 (0.022)	-0.045** (0.022)	-0.002 (0.022)	-0.036* (0.022)	-0.010 (0.021)
Age Squared/1000	0.391 (0.329)	0.383 (0.322)	0.368 (0.325)	0.748*** (0.247)	0.001*** (0.000)	0.494* (0.258)	0.608** (0.249)	0.064 (0.253)	0.468* (0.250)	0.128 (0.246)
Logged HH Equiv Income	0.220*** (0.052)	0.200*** (0.052)	0.299*** (0.053)	0.212*** (0.038)	0.139*** (0.038)	0.118*** (0.037)	0.154*** (0.037)	0.160*** (0.038)	0.244*** (0.038)	0.196*** (0.037)

Male	-0.076 (0.064)	0.035 (0.064)	0.019 (0.063)	-0.063 (0.049)	-0.174*** (0.050)	-0.043 (0.051)	-0.034 (0.050)	0.159*** (0.050)	0.059 (0.050)	0.023 (0.050)
Higher Educ.	0.007 (0.068)	0.035 (0.067)	0.012 (0.068)	0.218*** (0.053)	0.071 (0.053)	0.245*** (0.053)	0.220*** (0.053)	0.151*** (0.053)	0.090* (0.054)	0.120** (0.054)
White	0.239* (0.141)	0.117 (0.138)	0.015 (0.131)	-0.014 (0.110)	0.478*** (0.110)	0.406*** (0.108)	0.357*** (0.116)	0.260** (0.120)	0.221* (0.117)	0.048 (0.106)
Unemployed				-0.022 (0.106)	-0.054 (0.105)	-0.058 (0.110)	0.032 (0.107)	0.007 (0.098)	-0.110 (0.108)	-0.242** (0.098)
Married / live with partner	0.128* (0.073)	0.055 (0.074)	0.107 (0.071)	0.238*** (0.055)	0.115** (0.055)	0.020 (0.057)	0.040 (0.056)	0.050 (0.056)	0.102* (0.057)	0.102* (0.056)
Have dep. children	-0.017 (0.077)	-0.006 (0.076)	0.022 (0.074)	0.116* (0.059)	0.137** (0.060)	-0.001 (0.060)	0.015 (0.059)	0.078 (0.059)	0.204*** (0.060)	0.125** (0.060)
Observations	1058	1058	1058	1740	1740	1740	1740	1740	1740	1740
Pseudo R-squared	0.0097	0.0110	0.0148	0.0237	0.0156	0.0129	0.0113	0.0163	0.0346	0.0230
AIC	4857.995	4700.683	4876.292	7839.335	7436.077	6819.667	7272.027	7681.836	7434.294	7894.537
BIC	4952.313	4795.002	4970.61	7948.568	7545.309	6928.9	7381.26	7791.069	7543.527	8003.77

Notes: 1. \*, \*\* and \*\*\* indicate statistical significance at the 10%, 5% and 1% levels respectively; 2. Robust standard errors.

**Table 4. Ordered Probit Models of Mobility Impairment Impacts on Capabilities (contd)**

VARIABLES	(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)	(29)
	Environment- pets	Environment -travel/access	Services-bank	Services- rubbish	Services-fix problems	Services- doctor	Services- police	Services- solicitor	Services- shops
Mobility impaired	-0.255*** (0.058)	-1.021*** (0.062)	-0.238*** (0.058)	-0.329*** (0.058)	-0.076 (0.057)	0.034 (0.058)	-0.025 (0.058)	-0.126** (0.058)	-0.536*** (0.058)
Age	0.009 (0.022)	-0.068*** 0.022	-0.015 (0.022)	-0.032 (0.022)	-0.019 (0.022)	-0.039* (0.022)	-0.030 (0.022)	-0.031 (0.021)	-0.023 (0.022)
Age Squared/1000	0.034 (0.258)	0.809*** 0.250	0.253 (0.250)	0.494* (0.253)	0.264 (0.250)	0.520** (0.255)	0.380 (0.252)	0.479* (0.246)	0.333 (0.249)
Logged HH Equiv Income	0.140*** (0.039)	0.339*** (0.039)	0.234*** (0.039)	0.137*** (0.038)	0.177*** (0.037)	0.092** (0.037)	0.123*** (0.038)	0.251*** (0.038)	0.216*** (0.038)
Male	-0.158*** (0.052)	0.063 (0.050)	-0.014 (0.051)	-0.114** (0.051)	-0.008 (0.050)	-0.069 (0.050)	-0.169*** (0.050)	-0.082* (0.050)	-0.057 (0.050)
Higher Educ.	-0.114** (0.055)	0.021 (0.054)	0.028 (0.054)	0.023 (0.054)	-0.050 (0.054)	-0.021 (0.054)	0.043 (0.053)	0.076 (0.053)	0.110** (0.053)
White	0.474*** (0.101)	0.152 (0.107)	0.185 (0.119)	0.312*** (0.115)	0.235** (0.110)	0.388*** (0.115)	0.359*** (0.112)	0.396*** (0.111)	0.321*** (0.120)
Unemployed	-0.242** (0.105)	-0.222** (0.101)	-0.220** (0.104)	-0.064 (0.103)	-0.128 (0.101)	-0.106 (0.096)	-0.037 (0.096)	-0.135 (0.100)	-0.075 (0.100)
Married / live with partner	0.260*** (0.059)	0.141** (0.056)	0.030 (0.057)	0.100* (0.056)	0.159*** (0.056)	0.066 (0.056)	0.077 (0.057)	0.139** (0.057)	0.061 (0.056)

Have dep. children	0.159*** (0.060)	0.203*** (0.060)	0.028 (0.062)	0.069 (0.063)	0.032 (0.061)	0.068 (0.061)	0.105* (0.062)	0.142** (0.062)	0.073 (0.060)
Observations	1740	1740	1740	1740	1740	1740	1740	1740	1740
Pseudo R-squared	0.0229	0.0696	0.0149	0.0144	0.0085	0.0057	0.0069	0.0189	0.0265
AIC	7096.818	7591.317	7038.618	7224.921	7654.48	7235.591	7459.046	7468.43	7428.83
BIC	7206.051	7700.549	7147.85	7334.154	7763.713	7344.824	7568.279	7577.663	7538.063

Notes: 1. \*, \*\* and \*\*\* indicate statistical significance at the 10%, 5% and 1% levels respectively; 2. Robust standard errors.

**Table 5: Mobility Impairment in Ordered Probit Models of Subjective Wellbeing**

Variables	Life Satisfaction	Happy Yesterday	Anxious Yesterday	Life Worthwhile	Satisfied with Friendships	Satisfied with Colleagues	Satisfied with Neighbourhood	Yesterday Pleasurable
Mobility impaired	-0.467*** (0.057)	-0.371*** (0.056)	0.124** (0.056)	-0.315*** (0.058)	-0.080 (0.057)	-0.629*** (0.061)	-0.209*** (0.057)	-0.355*** (0.057)
Age	-0.098*** (0.022)	-0.080*** (0.022)	-0.006 (0.022)	-0.053** (0.021)	-0.021 (0.022)	-0.016 (0.022)	-0.013 (0.022)	-0.077*** (0.022)
Age Squared (000s)	1.158*** (0.252)	0.949*** (0.250)	0.008 (0.251)	0.699*** (0.245)	0.375 (0.251)	0.169 (0.255)	0.253 (0.251)	0.963*** (0.248)
Logged HH Equiv Income	0.292*** (0.039)	0.212*** (0.037)	-0.098*** (0.036)	0.231*** (0.038)	0.165*** (0.037)	0.308*** (0.038)	0.172*** (0.038)	0.197*** (0.036)
Male	-0.067 (0.050)	-0.065 (0.049)	-0.097** (0.049)	-0.153*** (0.049)	-0.180*** (0.049)	0.022 (0.049)	-0.169*** (0.049)	-0.174*** (0.049)
Higher Educ.	0.118** (0.053)	0.054 (0.053)	0.155*** (0.053)	0.215*** (0.053)	0.047 (0.053)	0.109** (0.054)	0.141*** (0.053)	0.040 (0.052)
White	0.166 (0.131)	0.055 (0.128)	0.020 (0.125)	0.179 (0.128)	0.064 (0.118)	0.005 (0.118)	0.217* (0.125)	0.148 (0.124)
Unemployed	-0.301*** (0.108)	-0.367*** (0.108)	0.136 (0.104)	-0.305*** (0.106)	0.024 (0.112)	-0.621*** (0.106)	-0.181* (0.104)	-0.162 (0.103)
Married / live with partner	0.360*** (0.055)	0.306*** (0.056)	-0.059 (0.055)	0.284*** (0.056)	0.178*** (0.055)	0.061 (0.057)	0.150*** (0.055)	0.253*** (0.056)
Have dep. children	0.050	0.044	-0.025	0.159***	-0.036	0.095	0.027	0.051

	(0.058)	(0.058)	(0.060)	(0.059)	(0.059)	(0.059)	(0.059)	(0.057)
Observations	1,740	1,740	1,740	1,740	1,740	1,740	1,740	1,740
Pseudo R-squared	0.0411	0.0264	0.0049	0.0303	0.0118	0.0467	0.0155	0.0231
AIC	7461.392	7674.882	8057.937	7714.611	7725.453	7316.89	7513.98	7407.354
BIC	7570.625	7784.115	8167.17	7823.844	7834.686	7426.123	7623.213	7516.587

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Notes: 1. \*, \*\* and \*\*\* indicate statistical significance at the 10%, 5% and 1% levels respectively; 2. Robust standard errors.

reduction of 0.428 QALYs. The results reported so far suggest that, contrary to concerns about adaptation (Oswald and Powdthavee (2008a), those with a mobility impairment have a sustained experience and report continuing impaired capabilities and continuing lower wellbeing. Table 6 reports the results of monetizing these wellbeing losses, using the two approaches described in the methods section. Using the life expectation method, we estimate that the impact of mobility impairment on life satisfaction ranges from £42,749 to £78,877 using a linear and log functional form respectively. In our alternative valuation method, at NICE’s £20,000 ceiling willingness to pay the annual reduction in QALYs from impairment of 0.428 corresponds to a value of £8,552 over this timeframe, and £306,546 over remaining life expectancy. At a £30,000 ceiling willingness to pay, the corresponding valuations are £12,828 and £459,820.<sup>14</sup>

Taking these results together, our evidence paints a broad picture of differences in quality-of-life between those with a mobility impairment and their able-bodied counterparts. Mobility impaired individuals have lower capability and poorer subjective wellbeing in all measured dimensions. Mobility impaired individuals tend to take part in fewer activities, but there are a few plausible exceptions including relaxing, self-care and smoking.

**Table 6: Valuations of Mobility Impairment based on Life Satisfaction (LS) and QALYs lost models**

	Estimated Valuation (£)	Annual QALYs lost (95% C.I.)	QALYs lost until death (95% C.I.)
LS value - linear model	£42,749		
LS value - log model	£78,877		
QALYs lost		0.428 <i>(0.398, 0.457)</i>	15.327 <i>(14.263, 16.392)</i>
QALY value (£20k)		£8,552 <i>(£7,958, £9,146)</i>	£306,546 <i>(£285,260, £327,833)</i>
QALY value (£30k)		£12,828 <i>(£11,937, £13,718)</i>	£459,820 <i>(£427,889, £491,750)</i>

Notes: 1. By definition, an individual’s EQ-5D-3L variable is equal to the amount by which their life years are weighted to obtain their estimated QALYs. Our estimate of 0.428 annual QALYs lost due to impairment is the coefficient on mobility impairment in an unreported OLS model of EQ-5D-3L. This model, which is available from the authors upon request, controls for age, age-squared, log income, gender, education, ethnicity, employment status, marital status, and having dependent children. QALYs lost until death is estimated by multiplying this figure by remaining life expectancy. Remaining Life expectancy is estimated by subtracting mean age of full sample (45.654) from general population average life expectancy of 81.5 years. No adjustment made for possible reduced life expectancy arising from implications or comorbidities relating to mobility impairment.

<sup>14</sup> Though direct comparisons are not possible, Powdthavee and van den Berg (2011) find a mental health based valuation of £54,000 for those with ‘problems connected with arms legs hand feet back etc’. These valuations are arguably consistent those previously developed by Kuklys who used satisfaction with income to estimate a cost equivalent of a quarter of income or more.

#### 4. Discussion

This paper demonstrates a way of assessing quality of life which operationalises Sen's theoretical framework to obtain a multi-dimensional assessment of health status that includes measures of capabilities, activities and wellbeing. Our empirical results show, *inter alia*, that in the case of mobility impairment, capabilities are lower in all domains of life, apart notably from access to health services. The finding probably reflects the universal nature of health-care entitlements received by this population. But our results also show that psychological costs are high while many (though not all) daily activities are lower. In this regard, they echo those of Flores et al. (2015) who, in a developing country context, concluded that interventions facilitating daily life hold much promise for improving experienced utility among people with disabilities. In our high-income country sample, many daily activities and several measures of experience are negatively impacted by disability.<sup>15</sup> Our theoretical accounting framework suggests that lower capabilities may be associated with lower, but in some cases higher, levels of activity as a result of substitution effects. Our empirical results were consistent with this and thereby confirm the value of a theoretical framework that allows for greater involvement in some activities as capabilities contract. The empirical results also indicate that the psychological costs of mobility impairment are high, suggesting that disability can be costly in quality of life terms because so many aspects of life are affected. They suggest also that the problems of mobility impairment are not ones to which adaptation is complete.

Taking these results together may help to explain the apparent ineffectiveness of many policies targeting disability. For example, Kidd et al. (2000) found that legislation requiring employers to make workplace adaptations for people with a disability had little impact on labour market participation. Whilst there may be many reasons for this, one possibility is that the legislation focussed on only a small subset of the many constraints imposed by disability. Our evidence, by contrast, points in the direction of a more comprehensive approach to disability policy that might include workplace issues but also social resources and environmental context. Paradoxically, the fact that many areas of life appear negatively affected gives policy-makers and practitioners many potential options and levers to consider when designing interventions to mitigate these losses.

The capability approach emphasises diversity. Recent disability policy changes in Australia appear to share this perspective by taking a personalised approach to disability in which important capabilities, such as the ability to access decent work, are established by understanding the individual's situation in some detail (National Disability Services, undated). The argument on which the Disability Care Australia policy is based is that by understanding what a person can or cannot do, and all the social as well as financial resources to which they have access, forms of support can be developed which maintain economic and social functioning more effectively and at lower cost. The issue of unsustainable disability program costs is one that has been given some prominence in the US also, e.g. Autor (2011), and only time will tell whether the new Australian reforms will be effective for people with disability and/or taxpayers. If they are, then understanding a disabled person's capabilities systematically, as illustrated here, will be a central feature of the policy's implementation.

Our findings may contribute to debates about the measurement of health also. To date, QALY measures have tended to focus on capturing the health status benefits of health interventions of populations (Gold et al. (2002)), and this gives rise to the possibility of bias due to the omission of many potential non-health benefits of 'health' interventions Anand and Hanson (1997 p. 699). For example, appropriate software and a fast internet connection that allows a mobility impaired individual to work from home does not affect health status *per se*, but could have a dramatic impact on overall quality of life. Such changes in the capability set can be recorded with our approach, but are not easily measured or even detected by QALYs. One aspect of this concerns adaptation: the EQ5D-5L asks whether a person has 'difficulties doing my usual activities', a benchmark which may inevitably adapt over time, resulting in underestimation of the value of interventions that help an individual engage in daily activities.<sup>16</sup> While the present study suggests that adaptation does not exercise a strong effect, longitudinal data would be needed to investigate such an effect comprehensively. Capability approaches to health measurement may also contribute to the development of health measures where standard measures are either not feasible or lead to particularly controversial results. For example, standard QALY indices of health for very young children have been

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<sup>15</sup> From the original Senian perspective, activities that people have reason to value, and experiences on which they have reflected, such as judgments about life satisfaction, can be viewed as providing complementary evidence about different qualities of life. It is sometimes forgotten that although Sen emphasizes capabilities, his original formal scheme explicitly allows for utility or happiness. We highlight the fact that if preferences are adaptive (Von Weizsacker, 2005), then life satisfaction based methods may under-estimate the value of losses due to disability.

<sup>16</sup> Hernandez-Alva and Pudney (2017) find significant differences in QALY rankings even when the informational basis is changed simply by expanding response categories.



difficult to develop (Grosse et al. (2010)), whereas direct capability indicators based on parental or clinical assessment already exist.<sup>17</sup> Similarly, at the other end of the age spectrum, there are questions about the normative desirability or practicability of using QALY measures to assess the value of end of life care, for example in the presence of cognitive decline (Round (2012)). A capability approach could avoid at least some of these problems by identifying quality of life aspects that are particularly valued at that stage in life.

In our empirical results we offered two sets of monetary estimates of the quality of life impact of mobility impairment in our sample. Estimates for other events, using the same life expectation method, have ranged from \$156 for a 10Ku increase in aircraft noise to £206,000 for the loss of a spouse (Oswald and Powdthavee (2008b)), which plausibly locates our results (£43k to £79k) for disability as being material but not extreme. The time period to which these estimates relate is somewhat ambiguous, being derived from annual earnings, and consequently it is unsurprising that the estimates lie between the annual monetized QALY loss (£8,552 to £12,828) and the estimated loss over the remaining lifetime of participants (£306,546 and £459,820). Clearly much further work remains to be done in this area, but these monetary valuations do offer another yardstick for measuring the magnitude of the quality of life effects we are addressing in the empirical example.

It can be questioned whether Sen's capability approach is compatible with a general and familiar utility approach.<sup>18</sup> It has not been our purpose to explore this issue and, in general, if a theoretical utility function is allowed to be defined generally enough then anything is compatible with it. However, our analyses and evidence might be taken as suggesting more compatibility than some realise. If for example, Sen's (1985) original three equations are accepted, then conventional utility analysis could be seen as a special case of a more general approach to quality of life in which a person's wellbeing is assessed not just in terms of their behaviour and existential states, and their experiential values of them, but also of their positive freedoms. However, Sen's approach, a little like that of Rawls, brings with it things that utility analysis does not. For example, he emphasises the importance of public deliberation<sup>19</sup> about social choices whereas historically, utility-based welfare economics has, historically, been more agnostic about the need or value of public deliberation instead opting for valuations implicit in market transactions or using stated trade-off methods. The view this paper illustrates is that the practical value to analysts of the approach Sen advocates is that it enriches the way we explicitly think about aspects of value.

Finally, there are several limits of this paper which could be addressed in future research. It would be useful to compare different levels of mobility impairment or other disabilities to understand how capabilities, functionings and subjective wellbeing vary across a range of sub-groups. It would also be useful know more about the use of assistive technologies and their capacity to improve the different aspects of life quality used here. Furthermore, though psychometric properties of capabilities are now becoming available, it would be useful to know more about them for this particular subgroup. The capability indicators reported here are still relatively novel but could easily be incorporated into evaluations of clinical interventions, which would help to address a range of follow-on issues that arise from applying the approach to mobility impairment. That said, the evidence from these data is that the costs of mobility impairment are neither trivial nor concentrated in just a few aspects of life while theory can allow for the fact that a possible result of capability deprivation will be that a few inferior functionings will increase.

## References

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<sup>17</sup> See the German Socio-Economic Panel Survey - <https://www.diw.de/en>

<sup>18</sup> We are grateful to one of the referees for this point.

<sup>19</sup> For discussions of public deliberation in health, see for example Culyer (2006, 2009).

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## Supplementary Appendices (Additional Online Materials)

### Appendix A. Capabilities Questions.

Wording of capability questions was as follows:

**“Here are some questions about the opportunities and constraints that you face. For each of the following statements, please indicate how much you agree, or disagree on a scale of 0 to 10, where 0 indicates you strongly disagree and 10 that you strongly agree.”<sup>20</sup>**

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#### **Thinking about your home life...**

I am able to share domestic tasks within the household fairly  
I am able to socialise with others in the family as I would wish  
I am able to make ends meet  
I am able to achieve a good work-life balance  
I am able to find a home suitable for my needs  
I am able to enjoy the kinds of personal relationships that I want  
I have good opportunities to feel valued and loved

#### **Thinking about work...**

I am able to find work when I need to  
I am able to use my talents and skills at work  
I am able to work under a good manager at the moment  
I am always treated as an equal (and not discriminated against) by people at work  
I have good opportunities for promotion or recognition at work  
I have good opportunities to socialise at work

#### **And now thinking about your community...**

I have good opportunities to take part in local social events  
I am treated by people where I live as an equal (and not discriminated against)  
I am able to practice my religious beliefs (including atheism/agnosticism)  
I am able to express my political views when I wish

#### **Thinking about your local environment...**

I am able to walk in my local neighbourhood safely at night  
I am able visit parks or countryside whenever I want  
I am able to work in an environment that has little pollution from cars or other  
I am able to keep a pet or animals at home with ease if I so wish  
I am able to get to places I need to without difficulty

#### **Moving on to think about access to services. When needed..**

I find it easy to make use of banking and personal finance services  
I find it easy to get my rubbish cleared away

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<sup>20</sup> Questions are free to use for academic purposes and reprinted here with permission of the joint copyright holders, The Open University, The University of Oxford and Birkbeck, University of London.

I find it easy to get trades people or the landlord to help fix problems in the house

I find it easy to be treated by a doctor or nurse

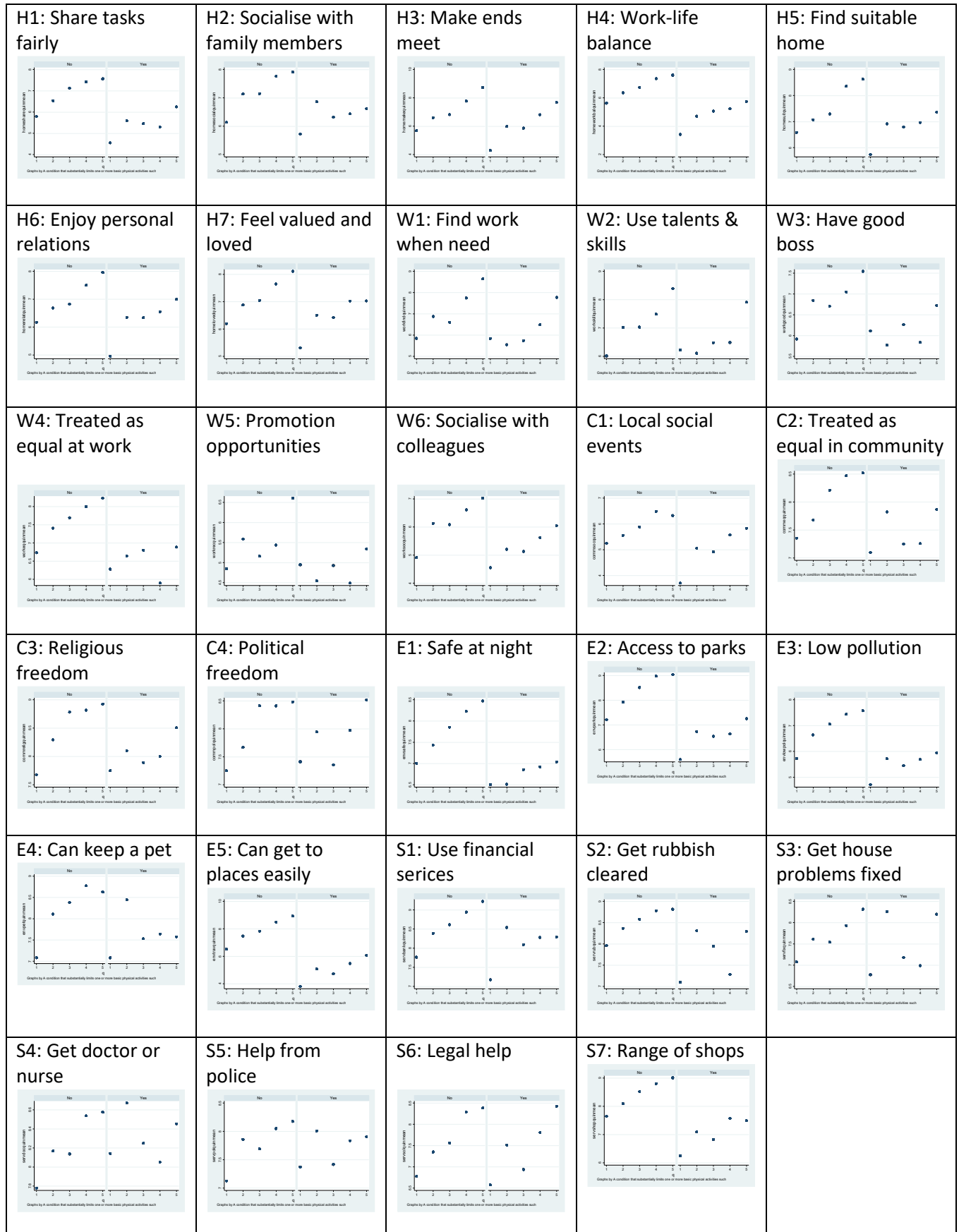
I find it easy to get help from the police

I find it easy to get help from a solicitor

I find it easy to get to a range of shops

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**Appendix B. Figure B1. Income-Capability Gradients for Impaired v Non-Impaired Sample**



## Appendix C

**Table C1. Probit Models of Impact of Mobility Impairment on Activities**

VARIABLES	Evening class	Caring	Commuting	Cooking	DIY	Drinking	Eating	Exercising	Housework	Internet-personal use	Internet-work
Mobility impaired	0.085 (0.187)	-0.051 (0.102)	-0.407*** (0.085)	-0.277*** (0.069)	-0.240** (0.108)	-0.276*** (0.079)	-0.169** (0.072)	-0.566*** (0.086)	-0.274*** (0.070)	-0.005 (0.074)	-0.318*** (0.091)
Age	0.064 (0.067)	0.030 (0.047)	-0.049 (0.031)	-0.034 (0.027)	0.017 (0.041)	0.000 (0.033)	-0.047* (0.028)	-0.083*** (0.031)	-0.026 (0.027)	-0.048* (0.029)	0.025 (0.034)
Age Squared/1000	-0.760 (0.767)	-0.091 (0.526)	0.511 (0.353)	0.535* (0.313)	-0.009 (0.463)	0.153 (0.371)	0.575** (0.321)	1.020*** (0.358)	0.373 (0.313)	0.660** (0.335)	-0.247 (0.395)
Logged HH Equiv Income	0.269*** (0.103)	-0.197*** (0.064)	0.351*** (0.055)	0.039 (0.045)	-0.114* (0.063)	0.188*** (0.053)	0.108** (0.047)	0.068 (0.052)	-0.007 (0.045)	0.072 (0.049)	0.243*** (0.060)
Male	-0.033 (0.156)	-0.098 (0.092)	0.239*** (0.072)	-0.326*** (0.062)	0.363*** (0.093)	0.254*** (0.070)	-0.118* (0.065)	0.156** (0.072)	-0.599*** (0.063)	0.090 (0.066)	0.209*** (0.076)
Higher Educ.	0.597*** (0.193)	0.082 (0.096)	0.112 (0.076)	0.137** (0.066)	-0.104 (0.099)	0.058 (0.076)	0.125* (0.069)	0.264*** (0.075)	0.119* (0.067)	0.095 (0.071)	0.336*** (0.082)
White	0.267 (0.375)	0.247 (0.278)	0.012 (0.161)	0.000 (0.146)	-0.249 (0.203)	0.147 (0.181)	0.368** (0.145)	-0.072 (0.159)	0.169 (0.154)	0.379*** (0.146)	-0.049 (0.176)
Unemployed	-0.026 (0.398)	-0.399* (0.242)	-0.656*** (0.195)	0.035 (0.131)	0.082 (0.184)	0.154 (0.147)	0.206 (0.138)	-0.165 (0.157)	0.131 (0.130)	0.067 (0.139)	-1.050*** (0.302)
Married / live with partner	-0.259* (0.157)	0.164 (0.105)	-0.101 (0.081)	0.006 (0.069)	0.186* (0.110)	0.000 (0.079)	0.118* (0.071)	-0.065 (0.081)	0.063 (0.070)	-0.130* (0.075)	-0.242*** (0.087)
Have dep. children	-0.111 (0.189)	0.157 (0.107)	-0.011 (0.086)	0.181** (0.074)	0.164 (0.107)	0.069 (0.083)	0.035 (0.078)	0.019 (0.089)	0.326*** (0.075)	0.015 (0.079)	0.061 (0.093)
Constant	-6.485*** (1.647)			-0.075 (0.679)	-1.157 (0.992)	-3.267*** (0.845)	-0.001 (0.686)	0.096 (0.765)	0.253 (0.681)	0.365 (0.723)	-3.917*** (0.879)
Observations	1,740	1740	1740	1740	1740	1740	1740	1740	1740	1740	1740
Pseudo R-squared	0.0929	0.0477	0.0859	0.0291	0.0514	0.0372	0.0190	0.0527	0.0576	0.0135	0.0781
Linktest	Fail*	Pass	Pass	Fail**	Pass	Pass	Pass	Pass	Pass	Pass	Pass
AIC	282.155	935.5663	1601.145	2323.693	903.7072	1693.259	2078.38	1617.694	2259.477	1950.432	1416.003
BIC	342.233	995.6444	1661.223	2383.771	963.7852	1753.337	2138.458	1677.772	2319.555	2010.51	1476.081



**Table C1. Probit Models of Impact of Mobility Impairment on Activities (contd)**

VARIABLES	Intimate	Listen music	Look after pet	Other outdoor	Paid employment	Play music	Praying or meditating	Relaxing or napping	Reading	Self-care	Smoking
Mobility impaired	-0.195* (0.100)	-0.068 (0.069)	0.109 (0.071)	-0.203* (0.107)	-0.663*** (0.077)	-0.169 (0.127)	0.160 (0.100)	0.280*** (0.070)	-0.053 (0.069)	0.222*** (0.074)	0.168** (0.084)
Age	-0.038 (0.037)	-0.037 (0.027)	0.055* (0.029)	-0.027 (0.040)	0.010 (0.029)	-0.020 (0.048)	-0.006 (0.037)	-0.017 (0.028)	-0.023 (0.028)	-0.019 (0.029)	0.159*** (0.038)
Age Squared/1000	0.386 (0.425)	0.328 (0.310)	-0.605* (0.327)	0.372 (0.458)	-0.159 (0.338)	0.173 (0.550)	0.184 (0.425)	0.230 (0.318)	0.464 (0.316)	0.348 (0.333)	-1.712*** (0.427)
Logged HH Equiv Income	0.062 (0.064)	0.076* (0.045)	0.047 (0.046)	0.025 (0.065)	0.347*** (0.049)	0.094 (0.071)	0.039 (0.061)	0.000 (0.046)	0.039 (0.044)	-0.048 (0.047)	-0.062 (0.056)
Male	0.205** (0.086)	0.263*** (0.062)	-0.426*** (0.064)	0.119 (0.092)	0.170*** (0.066)	0.333*** (0.109)	-0.262*** (0.091)	-0.009 (0.063)	-0.226*** (0.062)	-0.365*** (0.067)	-0.011 (0.078)
Higher Educ.	0.199** (0.092)	0.065 (0.066)	-0.183*** (0.068)	0.134 (0.094)	-0.005 (0.070)	0.241** (0.114)	0.438*** (0.095)	0.082 (0.067)	0.367*** (0.066)	0.337*** (0.071)	-0.328*** (0.086)
White	-0.136 (0.195)	0.033 (0.146)	0.663*** (0.182)	-0.041 (0.216)	-0.155 (0.155)	-0.160 (0.221)	-0.276 (0.187)	0.188 (0.156)	0.178 (0.148)	0.282* (0.165)	-0.056 (0.188)
Unemployed	-0.272 (0.229)	-0.022 (0.129)	-0.135 (0.139)	-0.123 (0.209)	-2.026*** (0.395)	0.240 (0.205)	0.203 (0.174)	-0.065 (0.135)	0.051 (0.132)	0.070 (0.139)	0.195 (0.149)
Married / live with partner	0.508*** (0.108)	-0.035 (0.069)	0.206*** (0.071)	-0.021 (0.104)	0.000 (0.075)	-0.125 (0.120)	-0.077 (0.097)	-0.027 (0.070)	0.016 (0.069)	-0.034 (0.072)	-0.117 (0.087)
Have dep. children	0.088 (0.099)	0.001 (0.075)	0.135* (0.076)	0.163 (0.107)	0.017 (0.080)	0.036 (0.130)	-0.041 (0.103)	0.027 (0.076)	0.093 (0.074)	0.051 (0.079)	-0.156 (0.097)
Constant	-1.374 (0.929)	-0.163 (0.672)	-2.604*** (0.716)	-1.358 (1.022)	-3.515*** (0.738)	-2.120** (1.032)	-1.778* (0.956)	-0.463 (0.694)	-0.802 (0.682)	-0.409 (0.722)	-3.811*** (0.939)
Observations	1740	1740	1740	1740	1740	1740	1740	1740	1740	1740	1740
Pseudo R-squared	0.0550	0.0181	0.0449	0.0144	0.1312	0.0450	0.0427	0.0111	0.0338	0.0415	0.0469
Linktest	Pass	Pass	Fail*	Pass	Pass	Fail*	Pass	Pass	Pass	Pass	Pass
AIC	1070.144	2323.166	2154.512	908.1876	1977.404	635.994	963.7184	2192.744	2308.894	1979.29	1327.978
BIC	1130.222	2383.244	2214.59	968.2656	2037.482	696.0721	1023.796	2252.822	2368.972	2039.368	1388.056

**Table C1. Probit Models of Impact of Mobility Impairment on Activities (contd)**

VARIABLES	Socialising	Shopping	Time with children	Visit cinema	Visit park	Volunteering	Watching TV	Other
Mobility impaired	-0.162** (0.081)	-0.233*** (0.072)	-0.099 (0.087)	0.028 (0.104)	-0.222** (0.097)	0.051 (0.112)	-0.004 (0.073)	-0.201 (0.124)
Age	-0.063** (0.030)	-0.005 (0.029)	0.066** (0.033)	-0.024 (0.037)	-0.019 (0.040)	-0.025 (0.047)	-0.019 (0.028)	-0.020 (0.044)
Age Squared/1000	0.684* (0.352)	0.253 (0.328)	-0.708* (0.386)	0.260 (0.436)	0.335 (0.453)	0.419 (0.536)	0.310 (0.328)	0.290 (0.508)
Logged HH Equiv Income	0.073 (0.052)	-0.004 (0.047)	-0.231*** (0.057)	0.090 (0.068)	-0.019 (0.065)	0.005 (0.076)	0.076 (0.049)	-0.090 (0.075)
Male	-0.086 (0.071)	-0.136** (0.064)	-0.248*** (0.078)	0.067 (0.092)	-0.015 (0.085)	-0.300*** (0.103)	-0.071 (0.066)	0.081 (0.104)
Higher Educ.	0.022 (0.075)	-0.094 (0.068)	-0.046 (0.082)	0.141 (0.096)	0.091 (0.090)	0.480*** (0.107)	-0.176** (0.070)	0.155 (0.107)
White	-0.059 (0.163)	0.161 (0.162)	0.218 (0.214)	-0.313* (0.186)	-0.174 (0.192)	-0.005 (0.232)	0.556*** (0.145)	-0.482** (0.187)
Unemployed	-0.163 (0.158)	-0.114 (0.139)	-0.062 (0.165)	-0.097 (0.210)	-0.019 (0.188)	0.652*** (0.169)	0.042 (0.137)	-0.398 (0.266)
Married / live with partner	-0.019 (0.078)	-0.076 (0.071)	0.358*** (0.091)	0.017 (0.096)	0.195** (0.096)	-0.190* (0.112)	0.006 (0.073)	-0.042 (0.110)
Have dep. children	-0.008 (0.086)	0.180** (0.077)	1.541*** (0.082)	0.034 (0.107)	0.083 (0.100)	0.237* (0.122)	0.109 (0.081)	-0.010 (0.127)
Constant	-0.056 (0.747)	-0.769 (0.706)	-0.889 (0.880)	-1.626* (0.979)	-0.956 (0.945)	-1.583 (1.169)	-0.377 (0.702)	-0.056 (1.135)
Observations	1740	1740	1740	1740	1740	1740	1740	1740
Pseudo R-squared	0.0120	0.0236	0.2889	0.0119	0.0176	0.0615	0.0195	0.0203
Linktest	Fail*	Pass	Fail***	Pass	Pass	Pass	Pass	Pass
AIC	1665.829	2123.478	1359.642	910.4673	1089.59	745.5631	1978.667	675.5686
BIC	1725.907	2183.556	1419.72	970.5454	1149.668	805.6412	2038.745	735.6466

## Appendix D. Finite Mixture Models of Capability Groupings

Disability is known for its heterogeneity and some of earliest empirical results, marked by large but imprecise impact estimates, suggest this could be important so we also estimate equation (7) in the manuscript using finite mixture models that allow for this by enabling us to identify and model separately subgroup responses. This allows for the possibility that there are at least two distinct groups within the sample distinguished by whether disability has a severe or moderate impact on capabilities. In the general case, the density function for a component finite mixture is:

$$f(y|x; \theta_1, \theta_2, \dots, \theta_C; \pi_1, \pi_2, \dots, \pi_C) = \sum_{j=1}^C \pi_j f_j(y|x; \theta_j) \quad (C1)$$

where  $0 < \pi_j < 1$  and  $\sum_{j=1}^C \pi_j = 1$ . Weights and coefficients are estimated by maximising the log likelihood i.e  $\max_{\pi, \theta} \ln L = \sum_{i=1}^N (\sum_{j=1}^C \pi_j f_j(y|x; \theta_j))$ . In many cases, a small number of components are sufficient to explain the data and to test whether severity of disability impact distinguishes we estimate two component models in the five areas for which we have data (home, work, community, environment and access to services). This in effect means that for these five domain groupings, we also estimate an expanded version of (5) in which:

$$d_{i,j}^* = \beta_0 + \beta_1^1 \cdot D_i + \beta_2^1 \cdot Y + \sum \beta_k^1 \cdot c_{i,k} + \beta_1^2 \cdot D_i + \beta_2^2 \cdot Y + \sum \beta_k^2 \cdot c_{i,k} + \varepsilon \quad (C2)$$

and this model can be viewed as an assessment of the robustness of results obtained from (5)

**Table D1 Finite mixture models of capabilities**

	homecapw2		workcapw2		commcapw2		envcapw2		servcapw2	
	Comp 1	Comp 2	Comp 1	Comp 2	Comp 1	Comp 2	Comp 1	Comp 2	Comp 1	Comp 2
physcondw2	- 9.177***	- 4.589**	- 9.193**	-2.432*	- 5.690**	-1.394**	- 9.474**	- 4.068**	- 11.30**	- 2.008*
	(-8.52)	(-2.69)	(-5.10)	(-2.02)	(-4.46)	(-2.95)	(-11.15)	(-4.65)	(-4.19)	(-2.52)
agew2	- 1.398***	-0.837	-1.034	-0.0823	-0.616	-0.503**	-0.303	-0.185	-1.163	-0.282
	(-3.31)	(-1.65)	(-1.81)	(-0.19)	(-1.31)	(-2.77)	(-0.98)	(-0.61)	(-1.19)	(-0.93)
agesqw2	0.0159**	0.0112	0.0105	0.000436	0.00744	0.00405	0.00316		0.0145	0.00437
	-3.33	-1.94	-1.59	-0.09	-1.39	-3.27	-1.15	-0.91	-1.31	-1.27
loghhequiv~c	4.594***	3.936**	5.830**	3.851**	1.316	1.656**	3.614**	1.691**	0.56	3.201**
	-6.59	-4.22	-5.19	-4.7	-1.65	-5.47	-6.84	-3.41	-0.35	-6.45
malew2	0.0366	1.534	0.782	-0.842	-2.423*	-0.279	-0.0561	1.317	-0.993	-1.245
	-0.04	-1.44	-0.58	(-0.93)	(-2.13)	(-0.67)	(-0.08)	-1.94	(-0.43)	(-1.87)
aboveschoo~2	3.531**	0.636	3.770*	-0.19	4.472**	1.042*	1.548	-0.188	6.065*	-0.466
	-2.98	-0.56	-2.41	(-0.19)	-3.58	-2.26	-1.95	(-0.27)	-2.31	(-0.63)
whitew2	1.727	-0.305	2.712	2.597	6.433**	1.357	2.555	4.056*	13.65**	3.425*
	-0.64	(-0.13)	-0.86	-1.33	-2.65	-1.48	-1.48	-2.34	-2.75	-2.29
unemployw2	-5.224*	-4.539*			-1.49	0.0822	-1.693	-4.583**	-2.853	-2.394
	(-2.46)	(-2.04)			(-0.66)	-0.1	(-1.07)	(-2.80)	(-0.52)	(-1.75)
marriedpar~2	9.663***	4.873**	2.709	0.909	1.647	0.626	2.743**	-0.105	-1.279	2.029**
	-8.86	-3.65	-1.77	-0.89	-1.35	-1.37	-3.5	(-0.14)	(-0.51)	-2.7
anydepchil~2	-0.52	0.634	0.545	0.0147	1.677	0.576	2.473**	1.570*	1.917	1.122
	(-0.46)	-0.45	-0.34	-0.01	-1.25	-1.17	-2.84	-2.01	-0.74	-1.41
_cons	20.13	31.88*	-8.545	10.05	15.79	22.51**	-0.3	26.31**	48.08	28.17**
	-1.94	-2.36	(-0.57)	-0.9	-1.26	-5.06	(-0.04)	-3.49	-1.92	-3.76
imlogitpi1		0.583		-0.477		-		0.41		-
						1.059**				1.426**
						*				*
lnsigma1		-1.13		(-1.12)		(-3.56)		-1.66		(-3.85)
		2.526**		2.313**		2.112**		2.239**		2.634**
		*		*		*		*		*
lnsigma2		-48.84		-20.75		-36.78		-66.2		-39.59
		2.208**		2.226**		1.795**		1.820**		2.338**
		*		*		*		*		*
		-20.3		-37.66		-50.11		-28.94		-63.83
N		1740		1058		1740		1740		1740