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What matters most: evidence-based findings of health dimensions affecting the societal preferences for EQ-5D health states

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Abstract

This study analyzes how different health dimensions defined by EQ-5D-3L instrument affect average individual's preferences for health states. This analysis is an important benchmark for the incorporation of health technologies as it makes possible to consider Brazilian population preferences in the decision of health resources allocation. EQ-5D instrument defines health in terms of five dimensions (mobility, usual activities, self-care activities, pain/discomfort, and anxiety/depression) each divided into three levels of severity. Data came from a valuation study with 3,362 literate individuals aged between 18 and 64 living in urban areas of Minas Gerais. The main results reveal that the decrement in health utility increase with severity level. Regarding health dimension, mobility stands out as the most important EQ-5D dimension. Independently of severity levels of the other EQ-5D-3L dimensions, the highest decrements in utilities are associated to severe mobility problem.

Key words: Quality-Adjusted Life Years, Health evaluation, Technology, Health Economics, Health policy

Introduction

The main purpose of health technology assessment is to assist health policymakers in implementing more cost-effective technologies in order to allocate resources efficiently. HTA is an important tool to analyze the use of technologies at macro and micro levels. At macro-level, HTA assists policymakers in formulating public health policies while at micro-level it is mainly used to support the development of clinical practice guidelines and to assist physicians in efficiently combining individual technologies [1,2]. Even though new health technologies contribute to improve population health, their uncritical use increases health expenditures and may have strong budget impacts. Ultimately this impact can threaten the access to health care services especially among low income groups [3,4,5,6,7,8]. The incorporation process of technologies in the healthcare sector presents peculiar characteristics. Firstly, it is quite dynamic and in general is supplier-induced demand. Because physicians usually have more information about diagnostic and prognostic of patient conditions, information asymmetry performs an important role in this process. Second, differently from other markets, health technologies are barely substitutive. They tend to be accumulative which widen the technological alternatives in this sector. Third, individuals will always demand more care even if there are no clinical evidence about its efficacy. When individuals are sick, the more care they get the better [9,10].

The United States was one of the first countries to formally recognize the importance of HTA with the creation of the Office of Technology Assessment in 1973 by the US Congress. Despite the pioneering efforts of the US, the spreading of HTA took place at the beginning of 80s mainly in European countries. This movement was stronger in countries with organized public healthcare systems such as Sweden, the Netherlands and the United Kingdom. Currently, Australia, Canada and the UK are at the forefront in the use of HTA in order to make decisions about incorporation or discharges of technologies in the healthcare sector [11, 12, 13,14,15].

In Brazil, the demand for new health technologies is also growing mainly due to the aging process and changes in the epidemiological profile [16, 17,18]. The incorporation of new health technologies depends on the institutional design of the healthcare. In the Brazilian healthcare system, the private and public sectors are involved in both the funding and the delivery of health care services. The Unified Health System (Sistema

Único de Saúde - SUS) was created by the Brazilian Federal Constitution in 1988. The main principles of SUS are universality, comprehensiveness and free of charge access. Therefore, in the public healthcare system, health is everyone's right and duty of the government. In the private sector, there are two sources of financing: out-of-pocket payments and health insurance[19].

This institutional design imposes additional challenges to Brazilian policymakers. The incorporation process of new technologies is not centralized and the current regulation is limited to the services financed by SUS. In fact, the incorporation of new technology tends to be endogenous. In this scenario, the economic rationality of private sector can weaken the supremacy of the State in defining criteria for the incorporation of health technologies. As a result, loss of efficiency in resources allocation is often observed. Besides the issues involving efficiency, this institutional design generates asymmetries in the access to healthcare especially among individuals who are covered by a private health insurance. The double access to the healthcare system among wealthier individuals may contribute to increase inequalities in the utilization of health services.

In this context, HTA is an important tool for ensuring efficiency to the policy-making processes concerning the use of technology and financial sustainability of the healthcare system. The main methods used in this type of economic evaluation are 1) cost-benefit, 2) cost-effectiveness and 3) cost-utility analysis. The main difference among the types of economic evaluation is the nature of the consequences stemming from the different alternatives that affect their measurement, valuation and comparison to costs. In cost-benefit analysis health outcomes are expressed in monetary terms. In cost-effectiveness analysis benefits are measured in health natural units such as number of life-years saved and number of hospitalizations avoided. In cost-utility analysis the incremental cost of an intervention is compared to the incremental health improvements [8, 12, 20, 21, 22, 23]. The health outcomes are measured by a combination of mortality (alternatively length of life) and health-related quality of life measures. A usual approach to perform cost-utility analysis is the estimation of Quality Adjusted Life Years (QALY).

The use of QALYs requires the definition of societal preferences weights for different health states [24, 25]. There are several health-state classification systems that can be used in the construction of QALYs as for example HUI (Health Utility Index), SF-36 (Short-Form 36 Items), SF-6D (Short-Form 6 Dimension) and EQ-5D (EuroQol 5

Dimensions). The difference among them is the number and type of health dimensions and levels of severity that each classification system takes into account [26, 27, 28, 29, 30, 31, 32]. EQ-5D is probably the most widely used generic measure of health status in measuring benefits for economic evaluation. Besides, this instrument is recommended by the National Institute for Health and Clinical Excellence (NICE) which is responsible to develop evidence-based guidelines on the most effective health technologies for the National Health Services (NHS) in UK [33]. EQ-5D instrument defines health in terms of five dimensions (mobility, usual activities, self-care activities, pain/discomfort, and anxiety/depression) divided into three (EQ-5D-3L) or five (EQ-5D-5L) levels of severity. In this paper EQ-5D-3L version is used that considers the following categories of severity: no problem, moderate problem and severe problem. The combination of dimension and level of severity generates a total of 243 distinct health states [34, 35, 36, 37, 26, 38, 29, 30]. EQ-5D-5L is a very recent instrument and its use is not widespread among countries making difficult international comparisons. In Brazil this study is the first attempt to estimate societal preference weights using EQ-5D. In this sense it is desirable the use of more known instrument. Besides, only recently studies validating the use of EQ-5D-5L have been published[39].

The aim of this paper is to evaluate the effect of different EQ-5D health dimensions on individual health states valuation in Brazil. Which health dimension is more important for Brazilian health-related quality of life? This analysis is an important benchmark for the decision-makers in performing HTA. Health technologies usually improve health but it can have side effects that result in undesirable health states for the society. Thus, the knowledge of health dimensions that generate the highest welfare gains can assist policy-makers when deciding about the implementation of new technologies.

Method

In Brazil, there are two studies that estimated societal preferences for the population. The first one was conducted in the city of Porto Alegre and used the SF-6D instrument[28]. The valuation parameters were obtained using the Standard Gamble (SG) technique. Recently, a larger research was conducted in Minas Gerais in order to estimate societal preferences weights for EQ-5D health states [40]. Weights were derived by applying the Time Trade-Off (TTO) elicitation method to a subset of 102 EQ-5D health states. The advantage of TTO over SG is that TTO is easier to be applied and can

be more readily understood. As the Brazilian society is still marked by high socioeconomic heterogeneity and low educational level, TTO may have a better performance in evaluating health preferences. A more complex technique can introduce bias due to the difficult of individuals to understand the exercise.

The present paper will take advantage of this new database that provides information about individual preferences for EQ-5D health states in Minas Gerais [40]. Minas Gerais is a large and heterogeneous state in the southeast region of Brazil and has a population of 20 million inhabitants, the majority residing in urban areas [41]. The state has the second largest economy of Brazil but presents great heterogeneity in terms of economic development and standards of living. The analysis of Human Development Index (HDI) shows evidence of how similar is the social economic disparities in Minas Gerais compared to the observed in Brazil: in 2000, the values of HDI for Minas Gerais cities ranged from 0.57 (northeast of the state) to 0.84 (southeast of the state) while in Brazil, the range was 0.64 (northeast of Brazil) and 0.82 (South of Brazil) [42]. Due to its great diversity Minas Gerais is considered to be representative of Brazilian heterogeneity.

The EQ-5D descriptive classification defines a total of 243 distinct health states each of which is labeled with a unique five digit code. For example 11111 represents the full health state defined as having no problems in any dimension while 33333 represents the worst health state with extreme problems on all five dimensions. The EQ-5D Brazilian language version was culturally adapted and provided by the EuroQoL Group. The interview protocol followed a revised version [43] of the original Measurement and Value of Health (MVH) study [44]. This protocol has already been applied in deriving French population values for EQ-5D [34] and in a Korean valuation study [37] . The Minas Gerais EQ-5D study [40] was designed so as to obtain values for 102 health states selected from the complete set of 243 states covering 3 broad severity categories defined by their proximity to the best possible health state. Mild states contain no level 3 problem on any dimension; severe states contain no level 1 problem on any dimension; moderate states lie within these two boundaries. These states were grouped into 26 blocks, with 6 health states in each comprising 2 mild, 2 moderate, and 2 severe states. Each individual evaluated one block of health states together with the logically best and worst health states (states 11111 and 33333 respectively) and the state “dead” – a total of 9 states. Health state descriptions were presented on printed set of cards which were handed to the participant.

Individuals were first asked to describe their own health in terms of the EQ-5D classification system and to rate it using a Visual Analogue Scale (VAS) with endpoints of 0 and 100 corresponding to the worst and best imaginable health states. They were then asked to rank order the set of 9 printed cards containing the health state descriptions from the best to worst. The cards were then shuffled and individuals were asked to rate them on the same 0-100 VAS scale used to rate their own health. Respondents were instructed that each health state would last for 10 years followed by death. These exercises were performed before TTO in order to familiarize individuals with the description of health states.

The TTO elicitation protocol has been fully described elsewhere [44]. It essentially involves presenting participants with choices between two alternatives that comprise varying levels of quantity and quality of life. Health states can be evaluated as either better or worse than death. A double-sided time board is used with one side for health states considered better than dead and the other side for health states worse than dead. For states evaluated better than dead individuals establish the number of years (x<10) in full health that provides them the same expected utility level as living ten years experiencing some specific health condition. TTO value (V) is obtained dividing the length of time in full health by ten, $V = \frac{x}{10}$. For states considered to be worse than dead individuals compare death with a choice that gives them 10-x years in some specific health state followed by x years (x<10) in full health. In this case TTO value is given by $V = \frac{-x}{(10-x)}$. Indifference points in the TTO protocol were effectively established in terms of 6 months increments yielding a range of values from -19 to 1. In order to treat the asymmetric distribution of negative values, a monotonic transformation $V_t = \frac{V}{(1-V)}, if\ V < 0$ was performed so as to alter the range of values to be -1 to 1[45].

Study Design

The target population was literate individuals aged between 18 and 64 years old living in urban areas of Minas Gerais. A sample-size definition was based on the 2010 Brazilian Demographic Census with a margin of error equal to 3%. In total, 3362 individuals were recruited. The sample is representative by age and sex for the whole state and for three different regional levels of Minas Gerais: Belo Horizonte,

metropolitan and non-metropolitan area. The sample was spatially distributed in order to take into account all macroregions of Minas Gerais and all planning areas of Belo Horizonte. Face–to-face interviews were conducted in households in which one individual was selected. Sociodemographic information was recorded on all participants. Economic incentives were not offered to interviewees. All health states were evaluated by more than 100 individuals as recommended by Chuang and Kind 2010 [46].

Modeling

Regression analysis was used to analyze the effect of health dimensions on individual EQ-5D health states valuation and to estimate the 243 EQ-5D health states. It should be noted that the states 11111 and dead are defined by virtue of the TTO procedure as having values of 1 and zero respectively. No inconsistent respondent data were excluded in the analysis. The choice of Random Effect model was based on the results of two tests, Hausman and Breush-Pagan tests[47]. Both Mean Absolute Error (MAE) and the number of health states with absolute residuals over 0.05 were computed to as goodness of fit statistics. Statistical analyses were conducted using Stata 11.0.

Dependent variable of all models was defined as 1 minus transformed TTO response (1-Vt). In order to evaluate which dimension and level of severity affect more the individual's health valuation, a set of 10 dummy variables for each level of severity and health dimensions were defined as follows:

- MO2 equals to 1 if mobility dimension is on level 2;
- MO3 equals to 1 if mobility dimension is on level 3;
- SC2 equals to 1 if self-care dimension is on level 2;
- SC3 equals to 1 if self-care dimension is on level 3;
- UA2 equals to 1 if usual activities dimension is on level 2;
- UA3 equals to 1 if usual activities dimension is on level 3;

- PD2 equals to 1 if pain/discomfort dimension is on level 2;
- PD3 equals to 1 if pain/discomfort dimension is on level 3 .
- AD2 equals to 1 if anxiety/depression dimension is on level 2;
- AD3 equals to 1 if anxiety/depression dimension is on level 3;

Other models including interaction terms were also tested:

- N2 equals to 1 if any dimension is on level 2;
- N3 equals to 1 if any dimension is on level 3;
- C3sq equals to the square of the number of dimensions at level 3;
- X5 equals to 1 if five dimensions are on level 2 or 3.

Results

Sample Characteristics

The socio-demographic and health characteristics of the achieved sample are displayed in Table 1. The sample is composed by literate individuals aged between 18 and 64 years old living in urban areas of Minas Gerais.

Sample weights were used to perform the frequency analysis. As the present study was based on quota sampling by age and sex, the distribution of these attributes is quite similar to the official surveys [40]. Around 45% of interviewed individuals have more than 11 years of schooling and 30% have less than 4 years. Distribution of health attributes are also similar to the results found elsewhere for the state of Minas Gerais [48].

This study is the first opportunity to analyze health conditions of a Brazilian population based on the EQ-5D descriptive system. The majority of individuals reported no problem in the five health dimensions: more than 90% of individuals do not have difficulties in performing self-care, usual activities, or any mobility problems; more than 55% do not have any pain/discomfort or anxiety/depression. The prevalence of moderate problems is higher for two dimensions - pain/discomfort (38%) and anxiety/depression (30%). Despite of the low prevalence, it is noticed that around 9% of

individuals reported moderate problems in mobility and performing usual activities. Severe problems in all dimensions are less prevalent in this population, lower than 5%.

Among the investigated chronic diseases, hypertension is the most prevalent condition in this population (25%) followed by spinal disease (18%). Only 5% of individuals reported having suffered from diabetes.

Descriptive analysis of observed TTO values for directly evaluated EQ-5D health states

The study sample comprised 3,362 individuals of whom 177 respondents evaluated fewer than seven states in the TTO exercise and 2 individuals had all health states with missing values. In the majority of cases, these missing values were due to mistakes made by the interviewers such as the repetition of cards or errors in recording the board marker. These individuals were included in the data analysis but their non-valid responses were omitted. Table 2 displays the summary descriptive statistics of non-transformed and transformed TTO values for the directly evaluated EQ-5D heath states.

Table 1. Socio-demographic and health characteristics of the achieved sample in the Minas Gerais EQ-5D Valuation Study (in percentage)

Sex		**Age Group**		**Educational Level**		**Private Health Insurance**		**Self-reported Health**	
Men	48.42	18-34 yrs	43.29	<4 yrs	29.23	Yes	31.36	Very Good	25.35
Women	51.58	35-49 yrs	33.95	4-10 yrs	24.55	No	68.64	Good	52.01
		50-59 yrs	16.25	11 yrs	37.65			Fair	20.49
		60+	6.50	12+	8.54			Bad	1.58
								Very Bad	0.49
EQ-5D descriptive system									
Mobility		**Self-care**		**Usual activities**		**Pain/discomfort**		**Anxiety/depression**	
No problem	91.23	No problem	97.59	No problem	89.85	No problem	57.71	No problem	64.92
Some problem	8.68	Some problem	2.06	Some problem	9.81	Moderate	38.35	Moderate	30.68
Incapacity	0.09	Incapacity	0.35	Incapacity	0.35	Extreme	3.94	Extreme	4.41
CHRONIC DISEASES PREVALENCE									
Hypertension	24.62	**Arthritis**	7.29	**Diabetes**	5.55	**Heart disease**	6.40	**Respiratory disease**	13.09
Depression	14.36	**Kidney disease**	2.83	**Spinal disease**	17.64	**Cirrhosis**	0.22	**Tuberculosis**	0.37

Source: Minas Gerais Valuation Study, 2011.

Table 2: Summary descriptive statistics for observed non-transformed and transformed TTO values

Health Condition	N	Transformed TTO		# worse than death valuations	Non-transformed TTO			Health Condition	n	Transformed TTO		# worse than death valuations	Non-transformed TTO		
		Mean	sd		Mean	sd	min			Mean	sd		Mean	sd	min
11112	255	0,840	0,244	4	0,767	1,264	-19,0	22232	127	0,331	0,567	36	-0,122	2,585	-19,0
11121	253	0,869	0,193	4	0,866	0,221	-1,2	22233	258	0,286	0,562	79	-0,385	3,279	-19,0
11122	258	0,783	0,254	3	0,778	0,280	-1,2	22313	129	0,455	0,447	15	0,208	1,911	-19,0
11123	127	0,758	0,327	4	0,469	2,488	-19,0	22323	257	0,332	0,537	63	-0,256	3,096	-19,0
11211	258	0,819	0,229	2	0,818	0,231	-0,3	22332	381	0,149	0,551	140	-0,512	2,979	-19,0
11212	258	0,799	0,244	3	0,797	0,253	-0,8	22333	257	0,199	0,532	89	-0,365	2,831	-19,0
11221	253	0,795	0,236	3	0,791	0,258	-1,0	23113	258	0,483	0,465	31	0,157	2,286	-19,0
11222	261	0,715	0,317	13	0,708	0,346	-1,0	23131	128	0,372	0,529	28	-0,125	2,666	-19,0
11223	129	0,640	0,407	9	0,544	0,839	-5,7	23132	129	0,334	0,504	24	-0,180	3,002	-19,0
11232	124	0,556	0,448	19	0,504	0,612	-3,0	23222	131	0,434	0,516	24	-0,235	3,471	-19,0
11312	128	0,665	0,337	6	0,658	0,365	-1,0	23223	257	0,254	0,548	78	-0,431	3,291	-19,0
11313	129	0,636	0,377	7	0,599	0,534	-3,0	23231	128	0,221	0,588	38	-1,124	4,775	-19,0
11323	127	0,602	0,398	7	0,399	1,882	-19,0	23232	256	0,207	0,560	89	-0,505	3,294	-19,0
11332	128	0,504	0,450	18	0,185	2,486	-19,0	23233	251	0,147	0,579	100	-0,752	3,708	-19,0
12111	255	0,794	0,279	6	0,710	1,289	-19,0	23311	127	0,349	0,550	28	-0,247	3,096	-19,0
12112	513	0,746	0,319	13	0,707	0,599	-5,7	23313	127	0,188	0,547	40	-0,857	4,208	-19,0
12121	258	0,755	0,288	5	0,742	0,359	-1,9	23321	129	0,340	0,539	31	0,071	1,335	-5,7
12122	256	0,724	0,344	11	0,558	1,813	-19,0	23322	254	0,183	0,553	93	-0,506	3,275	-19,0
12123	127	0,655	0,412	9	0,560	0,855	-5,7	23323	256	0,146	0,550	100	-0,617	3,179	-19,0
12211	256	0,737	0,314	7	0,655	1,284	-19,0	23332	255	0,115	0,553	96	-0,711	3,476	-19,0
12212	260	0,688	0,340	11	0,657	0,519	-4,0	23333	255	0,042	0,566	112	-1,227	4,330	-19,0
12221	257	0,718	0,334	8	0,605	1,386	-19,0	31131	129	0,283	0,518	32	-0,036	1,942	-19,0
12312	130	0,646	0,313	6	0,637	0,354	-1,5	31213	130	0,303	0,516	29	-0,131	2,546	-19,0
12313	128	0,530	0,435	14	0,230	2,472	-19,0	31222	129	0,289	0,530	35	-0,058	2,003	-19,0
12331	129	0,437	0,491	22	0,058	2,544	-19,0	31311	128	0,361	0,516	25	-0,034	2,523	-19,0
13123	127	0,548	0,423	14	0,363	1,822	-19,0	31313	125	0,168	0,553	44	-0,823	3,931	-19,0
13211	129	0,614	0,405	10	0,537	0,779	-5,7	32111	127	0,322	0,544	31	-0,191	2,672	-19,0
13222	129	0,470	0,478	20	0,266	1,837	-19,0	32123	130	0,185	0,555	40	-0,451	3,033	-19,0
13232	130	0,317	0,523	27	-0,363	3,442	-19,0	32223	255	0,091	0,571	108	-0,854	3,677	-19,0
21111	256	0,789	0,295	5	0,710	1,278	-19,0	32232	257	0,078	0,558	101	-0,667	2,939	-19,0

21112	259	0,732	0,332	9	0,498	2,173	-19,0	32233	256	0,060	0,513	110	-0,576	2,847	-19,0
21121	257	0,722	0,342	9	0,553	1,803	-19,0	32322	255	0,171	0,536	90	-0,368	2,623	-19,0
21122	257	0,718	0,299	5	0,699	0,430	-3,0	32323	258	-0,006	0,543	133	-0,620	2,370	-19,0
21123	128	0,569	0,482	20	0,347	1,897	-19,0	32332	255	-0,037	0,545	126	-1,154	3,840	-19,0
21133	127	0,676	0,371	8	0,591	0,870	-5,7	32333	254	-0,086	0,546	136	-1,689	4,745	-19,0
21211	258	0,737	0,302	9	0,730	0,330	-1,0	33121	129	0,270	0,536	38	-0,228	2,649	-19,0
21212	258	0,657	0,383	14	0,483	1,800	-19,0	33122	127	0,263	0,546	36	-0,487	3,507	-19,0
21221	257	0,679	0,354	14	0,637	0,568	-4,0	33211	124	0,223	0,526	38	-0,103	1,958	-19,0
21231	128	0,482	0,486	20	0,103	2,552	-19,0	33213	258	0,065	0,528	108	-0,693	3,252	-19,0
21311	130	0,683	0,343	7	0,640	0,653	-5,7	33221	129	0,092	0,584	51	-1,207	4,451	-19,0
21312	128	0,563	0,415	13	0,505	0,630	-3,0	33222	253	0,038	0,574	121	-0,901	3,531	-19,0
21313	127	0,575	0,413	11	0,369	1,858	-19,0	33223	253	0,039	0,548	112	-0,770	3,148	-19,0
21331	128	0,530	0,422	15	0,357	1,796	-19,0	33231	129	0,031	0,553	61	-0,974	3,811	-19,0
21332	128	0,402	0,520	27	0,112	1,945	-19,0	33232	254	0,023	0,550	115	-0,833	3,178	-19,0
22111	258	0,693	0,361	13	0,596	1,313	-19,0	33233	255	-0,055	0,562	130	-1,193	3,713	-19,0
22112	257	0,615	0,413	20	0,474	1,432	-19,0	33312	129	0,108	0,535	51	-0,546	3,051	-19,0
22113	124	0,583	0,410	11	0,501	0,793	-5,7	33313	126	0,048	0,534	54	-0,725	3,110	-19,0
22121	253	0,617	0,398	26	0,449	1,803	-19,0	33322	510	-0,070	0,540	261	-1,507	4,449	-19,0
22211	258	0,628	0,400	18	0,489	1,432	-19,0	33323	381	-0,046	0,556	188	-1,338	4,108	-19,0
22221	129	0,510	0,500	21	0,275	1,895	-19,0	33333	3328	-0,235	0,494	2105	-2,450	5,429	-19,0

Source: Minas Gerais Valuation Study, 2011.

All health states were evaluated by more than 124 individuals. Only the health state 33333 was evaluated by all individuals in the sample from which 34 presented non-valid information comprising 3328 evaluations.

Non-transformed TTO values show an asymmetric distribution: the mean values range from 0.866 to -2.450 and the minimum can be equal to -19. Therefore, while the values for better-than-death states vary from 0 to 1, the range for worse-than-death states is wider. To deal with this asymmetric distribution, worse-than-death states were transformed so as to be bounded by 0 and -1.

Mean transformed TTO values range from 0.869 (sd=0.193) to -0.235 (sd=0.494) for the 11121 and 33333 health states respectively. For mild health states, mean transformed TTO values vary from 0.869 (sd=0.193) to 0.615 (0.413). The percentage of individuals who classified mild health states as worse than death range from 1% (11211) to 10% (22121). For severe health states the maximum mean TTO value is 0.332 (sd=0.537) and the minimum is -0.235 (sd=0.494). Around 60% of individuals evaluated the health state 33333 as being worse than death. Values for moderate health states overlap both mild and severe ranges. The percentage of individuals who classified moderate health states as worse than death ranges from 3% (11123) to 47% (33231).

Overall, seven cards are given negative mean values indicating states worse than dead: 33333, 32333, 33322, 33233, 33323, 32332 and 32323. The standard deviation of transformed TTO values increases with the severity of the health state indicating greater heterogeneity in individual scores in poorer health states.

Table 3 displays the mean TTO health evaluation by each EQ-5D health dimension and level of severity for the whole sample and disaggregating by individual current health states. Individual health state is measured by the EQ-5D descriptive system and self-reported general health. The last indicator originally comprises five response categories that were re-classified into three groups: 1) very good/ good, 2) fair and 3) bad and very bad. For example, the first cell shows the average TTO evaluation (0.708) given by individuals with very good/good health to health states with mild mobility problems. It refers to average TTO value of all health states with 1 in the mobility dimension independently of the severity level observed for the other health dimensions. As expected, the mean TTO values decrease by increasing the level of severity for all dimensions. When the whole sample is taken into account, the results emphasize the importance of mobility dimension to the health valuation. On the one hand health states presenting severe mobility problem (being confined in bed) are the only conditions which TTO mean value is negative (-0.40), on the other hand health states without any mobility problems are given the highest weight (0.703) amongst all EQ-5D health dimensions/ level of severity.

Among individuals without any problem or with moderate problems in either dimension, the results are similar to those found for the whole sample: health states with severe mobility problems are given the lowest mean TTO values while health states without mobility problems are better evaluated. The lowest mean TTO value for severe mobility problems is given by individuals experiencing moderate anxiety/depression (-0.069) whereas the highest value is given by individuals with moderate mobility problems (0.023). The analysis for individuals with severe problems is more difficult since a small amount of individuals are classified in this health category across all dimensions.

In general, individuals reporting bad or very bad health tend to give lower evaluation to all health dimensions/ level of severity. For health states with severe and moderate problems, the highest mean TTO valuations are given by individuals with fair self-reported health.

Table 3. Mean TTO values for each health dimension/ severity by current individual health status

Health Dimension	Level of Severity	Mean Health State Evaluation														
		MO			SC			UA			PD			AD		
		Mild	Moderate	Severe	Mild	Moderate	Severe	Mild	Moderate	Severe	Mild	Moderate	Severe	Mild	Moderate	Severe
General Health States	Very good/ good	0.708	0.437	-0.045	0.661	0.424	0.023	0.645	0.391	0.059	0.593	0.397	0.021	0.597	0.411	0.071
	fair	0.691	0.459	-0.012	0.652	0.435	0.054	0.665	0.407	0.089	0.579	0.432	0.052	0.589	0.436	0.108
	bad/ very bad	0.613	0.374	-0.089	0.593	0.376	-0.056	0.485	0.359	0.009	0.527	0.307	-0.021	0.631	0.282	0.017
Individual MO	Mild	0.703	0.436	-0.045	0.659	0.421	0.020	0.647	0.393	0.056	0.589	0.399	0.020	0.595	0.412	0.071
	Moderate	0.697	0.485	0.023	0.638	0.471	0.110	0.635	0.400	0.152	0.585	0.435	0.103	0.612	0.430	0.149
	Severe	0.563	0.533	-0.021	0.588	0.275	0.130	0.600	0.563	0.168	0.610	0.406	0.121	0.450	0.325	0.323
Individual SC	Mild	0.703	0.439	-0.041	0.658	0.424	0.025	0.645	0.393	0.062	0.588	0.401	0.024	0.596	0.413	0.076
	Moderate	0.700	0.491	0.007	0.639	0.465	0.109	0.651	0.404	0.078	0.597	0.443	0.088	0.636	0.432	0.118
	Severe	0.635	0.569	0.155	0.624	0.447	0.250	0.743	0.391	0.339	0.571	0.454	0.286	0.529	0.513	0.289
Individual UA	Mild	0.702	0.434	-0.044	0.655	0.423	0.020	0.644	0.390	0.056	0.585	0.397	0.021	0.593	0.408	0.072
	Moderate	0.730	0.509	0.008	0.690	0.445	0.112	0.666	0.438	0.153	0.635	0.457	0.090	0.631	0.473	0.138
	Severe	0.432	0.484	-0.066	0.534	0.431	0.026	0.602	0.333	0.011	0.524	0.407	-0.026	0.587	0.327	0.070
Individual PD	Mild	0.703	0.444	-0.039	0.659	0.421	0.029	0.650	0.393	0.059	0.589	0.396	0.029	0.596	0.420	0.069
	Moderate	0.702	0.428	-0.047	0.652	0.428	0.015	0.641	0.387	0.062	0.584	0.407	0.015	0.594	0.397	0.081
	Severe	0.710	0.506	0.027	0.688	0.456	0.117	0.623	0.468	0.169	0.635	0.449	0.102	0.626	0.468	0.163
Individual AD	Mild	0.700	0.450	-0.025	0.661	0.432	0.036	0.655	0.395	0.073	0.590	0.404	0.040	0.608	0.418	0.084
	Moderate	0.714	0.419	-0.069	0.653	0.416	0.008	0.633	0.396	0.044	0.587	0.395	0.001	0.582	0.408	0.066
	Severe	0.662	0.434	-0.064	0.635	0.375	0.020	0.599	0.341	0.058	0.571	0.415	-0.006	0.520	0.378	0.055
Total		0.703	0.440	-0.040	0.657	0.425	0.027	0.646	0.393	0.064	0.588	0.402	0.026	0.596	0.413	0.077

Source: Minas Gerais Valuation Study, 2011.

Effect of health dimension and level of severity on EQ-5D health states valuation

Table 4 displays the results for RE models. As the Hausman test was not significant (Prob>chi2 = 0.2453), the null hypothesis was not rejected and the RE model can be safely accepted. The Breush-Pagan test rejects the null hypothesis of homoscedasticity (χ^2p<0.001). The presence of heteroscedasticity favours the use of RE models.

Table 4. Results of random effect models estimated for linear-transformed TTO

Variables	Model 1		Model 2		Model 3		Model 4		Model 5	
	Coef.	Std.	Coef.	Std.	Coef.	Std.	Coef.	Std.	Coef.	Std.
Mobility, 2	0.128 ***	0.007	0.135 ***	0.007	0.130 ***	0.007	0.119 ***	0.008	0.132 ***	0.007
Mobility, 3	0.404 ***	0.008	0.400 ***	0.008	0.407 ***	0.008	0.392 ***	0.009	0.396 ***	0.009
Self-care, 2	0.121 ***	0.007	0.128 ***	0.007	0.122 ***	0.007	0.111 ***	0.007	0.123 ***	0.007
Self-care, 3	0.247 ***	0.008	0.247 ***	0.008	0.249 ***	0.008	0.238 ***	0.008	0.238 ***	0.009
Usual Activities, 2	0.095 ***	0.007	0.102 ***	0.008	0.097 ***	0.008	0.087 ***	0.008	0.099 ***	0.008
Usual Activities, 3	0.205 ***	0.008	0.202 ***	0.008	0.209 ***	0.008	0.194 ***	0.008	0.198 ***	0.009
Pain/Discomfort, 2	0.067 ***	0.007	0.072 ***	0.007	0.068 ***	0.007	0.055 ***	0.007	0.069 ***	0.007
Pain/Discomfort, 3	0.200 ***	0.007	0.195 ***	0.008	0.203 ***	0.008	0.184 ***	0.009	0.190 ***	0.009
Anxiety/Depression, 2	0.062 ***	0.007	0.067 ***	0.007	0.064 ***	0.007	0.051 ***	0.008	0.064 ***	0.007
Anxiety/Depression, 3	0.113 ***	0.007	0.111 ***	0.008	0.117 ***	0.008	0.102 ***	0.008	0.106 ***	0.008
N2			-0.033 ***	0.011						
N3					-0.013 ns	0.009				
X5							0.036 ***	0.011		
C3sq									0.002 ***	0.001
Intercept	0.054 ***	0.010	0.077 ***	0.012	0.054 ***	0.010	0.079 ***	0.012	0.052 ***	0.010
R2 Overall	0.365		0.365		0.365		0.365		0.365	
Mean absolute error	0.035		0.034		0.035		0.034		0.035	
No(of 102)>0.05	25		21		24		24		24	

Source: Minas Gerais Valuation Study, 2011.
Legend: *** significant at 1% level.
Model 1: Parsimonious RE model (controlling for main effects)
Model 2: Controlling for main effects and dummy variable indicating presence of level 2 of severity in any dimension
Model 3: Controlling for main effects and dummy variable indicating presence of level 3 of severity in any dimension
Model 4: Controlling for main effects and dummy variable indicating that all five dimensions are on level 2 or 3
Model 5: Controlling for main effects and a variable that it is the square of the number of dimensions at level 3

Five different specifications of RE models were tested. The most parsimonious model (Model 1) is based on main effects and includes only dummy variables for each health dimension and level of severity. More complex forms of the models (Model 2 to Model 5) include additional dummy variables to take into account interaction effect of any dimension with moderate or extreme problems. All these models displayed similar results to the initial main effects specification with virtually identical goodness-of-fit statistics and the same number of states with a MAE exceeding 0.05. Because the results were very similar among the models, the basic specification including only dummy variables for each health dimension and level of severity was selected. Besides some of interaction models presented inconsistencies: N2 and N3 term were negative.

All dummy coefficients are positive and significant at the 1% level. Since dependent variable is defined as one minus TTO value, coefficients are interpreted as a utility decrement relative to the perfect EQ-5D health

state (11111). The constant is considered as an overall decrement independently of health dimension and level of severity. In that manner, health utility decreases by 5.4% due to any deviation from the perfect health state. The coefficients behave as expected showing a monotonic increase in value decrement with increasing severity for all health dimensions. The largest decrement is observed for severe mobility problems, which is around 40%. Being confined in bed decreases in a large amount individual's well-being. For three health dimensions (self-care, usual activities and pain/discomfort), having experienced severe problems decreases health utility by an amount of 20-25%. For severe anxiety/depression, the decrement is lower, around 11%. As for moderate problems, the utility decrements are around 12% for two dimensions (mobility and self-care) and 9% for usual activities. In case of pain/discomfort and anxiety/depression, having experienced moderate problems decreases utility by only 6%.

The full set of preference weights for the 243 EQ-5D health states estimated using the most parsimonious specification is given in Table 5. The results of estimated health parameters reflect the high decreases in utility due to mobility problems. All the eleven worse-than-death health states present severe mobility problem in their composition. Twenty health states with the lowest mean estimated TTO values is characterized by the presence of this condition. This number is more than the double (46) when moderate mobility problem is also taken into account. Among the 95 health states with the highest TTO mean values only one presents severe mobility problem but it is compensated by the absence of moderate/severe problems in the other dimensions.

Table5–Estimated mean preferences weights for 243EQ-5D questionnaire health states based on the RE model (main effects model)

EQ-5D questionnaire state	TTO value	95% CI lower bound	95% CI upper bound	EQ-5D questionnaire state	TTO value	95% CI lower bound	95% CI upper bound	EQ-5D questionnaire state	TTO value	95% CI lower bound	95% CI upper bound	EQ-5D questionnaire state	TTO value	95% CI lower bound	95% CI upper bound
11111	1.000	1.000	1.000	13131	0.499	0.521	0.478	22222	0.472	0.492	0.453	31313	0.224	0.246	0.202
11112	0.884	0.901	0.868	13132	0.437	0.461	0.413	22223	0.421	0.446	0.396	31321	0.270	0.292	0.249
11113	0.832	0.852	0.813	13133	0.386	0.407	0.364	22231	0.401	0.423	0.379	31322	0.209	0.228	0.189
11121	0.879	0.893	0.865	13211	0.604	0.625	0.583	22232	0.339	0.361	0.318	31323	0.157	0.179	0.135
11122	0.817	0.835	0.799	13212	0.542	0.563	0.521	22233	0.288	0.311	0.265	31331	0.137	0.162	0.113
11123	0.765	0.786	0.745	13213	0.490	0.514	0.466	22311	0.492	0.515	0.469	31332	0.076	0.098	0.053
11131	0.746	0.765	0.727	13221	0.537	0.556	0.518	22312	0.430	0.450	0.409	31333	0.024	0.044	0.004
11132	0.684	0.705	0.663	13222	0.475	0.495	0.455	22313	0.378	0.402	0.354	32111	0.421	0.441	0.401
11133	0.632	0.652	0.612	13223	0.423	0.447	0.400	22321	0.425	0.446	0.403	32112	0.359	0.379	0.340
11211	0.850	0.867	0.833	13231	0.404	0.424	0.383	22322	0.363	0.383	0.342	32113	0.308	0.328	0.287
11212	0.789	0.805	0.772	13232	0.342	0.363	0.321	22323	0.311	0.336	0.287	32121	0.354	0.373	0.335
11213	0.737	0.759	0.715	13233	0.290	0.311	0.270	22331	0.292	0.315	0.268	32122	0.292	0.312	0.272
11221	0.783	0.800	0.767	13311	0.494	0.518	0.471	22332	0.230	0.251	0.208	32123	0.241	0.262	0.220
11222	0.722	0.739	0.704	13312	0.432	0.455	0.410	22333	0.178	0.200	0.156	32131	0.221	0.245	0.197
11223	0.670	0.693	0.647	13313	0.381	0.405	0.356	23111	0.571	0.591	0.551	32132	0.159	0.184	0.134
11231	0.650	0.669	0.632	13321	0.427	0.448	0.406	23112	0.509	0.531	0.488	32133	0.108	0.130	0.086
11232	0.589	0.608	0.570	13322	0.365	0.386	0.344	23113	0.458	0.481	0.435	32211	0.326	0.347	0.304
11233	0.537	0.557	0.517	13323	0.314	0.337	0.291	23121	0.504	0.522	0.486	32212	0.264	0.283	0.244
11311	0.741	0.761	0.721	13331	0.294	0.316	0.272	23122	0.442	0.463	0.421	32213	0.212	0.235	0.190
11312	0.679	0.698	0.660	13332	0.232	0.254	0.211	23123	0.391	0.413	0.368	32221	0.259	0.279	0.238
11313	0.628	0.650	0.605	13333	0.181	0.200	0.161	23131	0.371	0.392	0.350	32222	0.197	0.217	0.177
11321	0.674	0.692	0.655	21111	0.818	0.833	0.803	23132	0.309	0.332	0.286	32223	0.145	0.168	0.122
11322	0.612	0.630	0.594	21112	0.756	0.772	0.740	23133	0.258	0.279	0.237	32231	0.126	0.150	0.101
11323	0.560	0.582	0.538	21113	0.705	0.724	0.685	23211	0.476	0.497	0.454	32232	0.064	0.087	0.041
11331	0.541	0.561	0.520	21121	0.751	0.766	0.736	23212	0.414	0.435	0.393	32233	0.012	0.035	-0.010
11332	0.479	0.499	0.459	21122	0.689	0.707	0.671	23213	0.362	0.387	0.338	32311	0.216	0.240	0.192
11333	0.427	0.447	0.408	21123	0.638	0.659	0.616	23221	0.409	0.429	0.389	32312	0.154	0.176	0.133
12111	0.825	0.840	0.809	21131	0.618	0.637	0.599	23222	0.347	0.367	0.327	32313	0.103	0.125	0.080
12112	0.763	0.780	0.745	21132	0.556	0.577	0.535	23223	0.295	0.320	0.271	32321	0.149	0.171	0.127
12113	0.711	0.731	0.691	21133	0.505	0.525	0.484	23231	0.276	0.297	0.255	32322	0.087	0.108	0.067
12121	0.757	0.773	0.742	21211	0.723	0.741	0.704	23232	0.214	0.235	0.193	32323	0.036	0.058	0.014
12122	0.696	0.715	0.677	21212	0.661	0.678	0.644	23233	0.162	0.183	0.141	32331	0.016	0.041	-0.009
12123	0.644	0.666	0.622	21213	0.609	0.632	0.586	23311	0.366	0.390	0.343	32332	-0.046	-0.023	-0.069
12131	0.624	0.645	0.604	21221	0.655	0.674	0.637	23312	0.305	0.327	0.282	32333	-0.097	-0.076	-0.118
12132	0.563	0.585	0.540	21222	0.594	0.612	0.575	23313	0.253	0.277	0.229	33111	0.296	0.317	0.274
12133	0.511	0.533	0.490	21223	0.542	0.566	0.518	23321	0.299	0.320	0.278	33112	0.234	0.256	0.211
12211	0.729	0.748	0.710	21231	0.522	0.543	0.502	23322	0.237	0.258	0.217	33113	0.182	0.204	0.161
12212	0.667	0.685	0.649	21232	0.461	0.480	0.441	23323	0.186	0.209	0.163	33121	0.229	0.248	0.209
12213	0.616	0.639	0.593	21233	0.409	0.431	0.388	23331	0.166	0.188	0.145	33122	0.167	0.188	0.145
12221	0.662	0.681	0.643	21311	0.613	0.634	0.592	23332	0.104	0.125	0.084	33123	0.115	0.136	0.095
12222	0.600	0.619	0.581	21312	0.551	0.570	0.532	23333	0.053	0.072	0.033	33131	0.096	0.119	0.072
12223	0.549	0.573	0.525	21313	0.500	0.523	0.477	31111	0.542	0.562	0.523	33132	0.034	0.059	0.009
12231	0.529	0.550	0.508	21321	0.546	0.566	0.526	31112	0.481	0.501	0.461	33133	-0.018	0.003	-0.038
12232	0.467	0.488	0.446	21322	0.484	0.503	0.465	31113	0.429	0.450	0.408	33211	0.200	0.222	0.178
12233	0.416	0.438	0.394	21323	0.433	0.455	0.410	31121	0.475	0.494	0.457	33212	0.138	0.159	0.118

12311	0.620	0.642	0.598	21331	0.413	0.434	0.392	31122	0.414	0.434	0.393	33213	0.087	0.109	0.065
12312	0.558	0.578	0.537	21332	0.351	0.371	0.331	31123	0.362	0.383	0.341	33221	0.133	0.153	0.114
12313	0.506	0.530	0.483	21333	0.300	0.320	0.280	31131	0.342	0.366	0.319	33222	0.071	0.091	0.052
12321	0.552	0.573	0.532	22111	0.697	0.713	0.680	31132	0.281	0.305	0.256	33223	0.020	0.041	-0.001
12322	0.491	0.511	0.470	22112	0.635	0.652	0.618	31133	0.229	0.251	0.207	33231	0.000	0.022	-0.022
12323	0.439	0.463	0.416	22113	0.583	0.604	0.563	31211	0.447	0.468	0.425	33232	-0.062	-0.040	-0.083
12331	0.419	0.442	0.397	22121	0.630	0.646	0.613	31212	0.385	0.405	0.366	33233	-0.113	-0.094	-0.132
12332	0.358	0.379	0.336	22122	0.568	0.587	0.549	31213	0.334	0.356	0.311	33311	0.091	0.115	0.067
12333	0.306	0.328	0.285	22123	0.516	0.538	0.494	31221	0.380	0.400	0.359	33312	0.029	0.051	0.007
13111	0.699	0.719	0.679	22131	0.497	0.518	0.476	31222	0.318	0.338	0.299	33313	-0.023	-0.001	-0.045
13112	0.637	0.660	0.615	22132	0.435	0.457	0.413	31223	0.267	0.289	0.244	33321	0.024	0.044	0.003
13113	0.586	0.609	0.563	22133	0.383	0.405	0.361	31231	0.247	0.270	0.223	33322	-0.038	-0.019	-0.058
13121	0.632	0.650	0.614	22211	0.601	0.622	0.581	31232	0.185	0.207	0.163	33323	-0.090	-0.070	-0.109
13122	0.570	0.592	0.548	22212	0.539	0.558	0.521	31233	0.134	0.155	0.112	33331	-0.109	-0.086	-0.132
13123	0.519	0.542	0.496	22213	0.488	0.512	0.464	31311	0.337	0.361	0.314	33332	-0.171	-0.150	-0.192
				22221	0.534	0.555	0.514	31312	0.276	0.296	0.255	33333	-0.223	-0.205	-0.240

CI. confidence interval; EQ-5D. EuroQol five-dimensional; RE. random effect; TTO. time trade-off.

Discussion

This paper analyzes the Brazilian societal preferences for EQ-5D health states. The objective is to evaluate which health dimensions and level of severity matter more to the Brazilian population. The main results reveal that the decrement in health utility increase with severity level. Regarding health dimension, mobility stands out as the most important EQ-5D dimension. Independently of severity levels of the other EQ-5D dimensions, the highest decrements in utilities are associated to severe mobility problem which is around 40%. On the other hand, the highest TTO mean values are given to health states without any mobility problem. These results are also verified when the analysis is disaggregated by current individual health condition pointing out that health preferences do not depend on disabling illness previously experienced by individuals.

The comparison with other countries valuation can give some clues whether these results are specifically to Brazilian population. In South America, only Argentina and Chile have thus far derived a set of social preference weights for use with EQ-5D [26, 38]. In Chile, different from Brazil, decrements in health utility are associated to the level of severity independently of the EQ-5D health dimension. The decrements are around 30-35% for all dimensions except anxiety/depression which decrement is around 25%. In Argentina, individuals tend to assign higher importance to three dimensions: mobility, self-care and pain/discomfort. In this country, utility decrements are higher to health conditions presenting severe problems in mobility followed by the other two aforementioned dimensions.

The understanding of societal preferences for health states is important especially taking into account the aging population process that Brazil has experienced. Some studies on longevity and health have shown that gains in life expectancy are not accompanied by an extension of life expectancy free of disabilities. In fact, gains in longevity have increased the number of years of life experiencing some chronic diseases or disabilities[49]. The results of the present paper reinforce the debate about the uncritical use of new health technologies that only affect the extension of life. New health technologies increase the survival of individuals but at the same time can have negative effects on wellbeing by increasing the prevalence of morbidities. Our results give evidences that health preferences of Brazilian population are strongly affected by prevalence of severe health problems in especial mobility conditions.

In Brazil, HTA has been a concern since the 1980s with important government initiatives being introduced since 2004 with the creation of the Department of Science and Technology (Departamento de Ciência e Tecnologia - DECIT) [50]. DECIT is responsible for formulating and promoting health technology assessment for the Unified Health System (Sistema Único de Saúde – SUS). In 2008, the Brazilian Network for HTA (Rede Brasileira de Avaliação de Tecnologias em Saúde – REBRATS) was created to subsidize the government in formulating HTA regulation and producing HTA research in Brazil. More recently, in 2011,

it was created the National Committee for Incorporation of Technologies in SUS (Comissão Nacional de Incorporação de Tecnologias no SUS – CONITEC) according to the Federal Law nº 12.401/11. All new technologies that will be supplied in the public healthcare system must be evaluated by CONITEC. This is a great advancement of Brazilian legislation since cost-effectiveness parameters are now taken into account to determine the incorporation of new technologies. One challenge for this Committee is to consider in the HTA health outcomes that take into account quality of life measures. The gains in longevity are not a guarantee to improve individual's wellbeing.

It is important to notice that the sample of this study includes only individuals aged less than 64 years old and living in urban areas of Minas Gerais. As the prevalence of severe health problems is high among elderly population, the exclusion of this age group can generate biased results. However the direction of the bias is not conclusive. The experience with severe health problems may affect individual evaluation in both directions. On the one hand, individuals with some severe health problems may be more adapted to their conditions and hence give higher scores to severe health states in TTO exercise. On the other hand as these individuals know better about the difficulties of living with restrictions, their scores may be lower.

The Minas Gerais EQ-5D study takes several steps forward from the design of the original MVH protocol. First, to the best of our knowledge this is only the second occasion that a larger number of health states (102) were directly investigated in a household survey using TTO exercise. Second, it is first time that only 9 health states are evaluated per individual. This innovation makes the evaluation exercise less demanding and individuals will be more likely to give responses that are not subject to fatigue or loss of attention. Finally, a large sample is investigated in a very heterogeneous population with representativeness for three different geographical areas. Hence, this study design allows the investigation of individual heterogeneity and differences among subgroups of population in evaluating health status using identical valuation procedures.

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