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Reference data among general population and known-groups validity among hypertensive population of the EQ-5D-5L in Vietnam

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Abstract

Purpose This study aims to provide EQ-5D-5L population norms among the general population in Vietnam and to test EQ-5D-5L' construction validity among people living with hypertension there.

Methods Descriptive statistics of the five dimensions and five levels, EQ-VAS and EQ-5D-5L indexes were categorised into gender and age groups for the EQ-5D-5L population norms. Known-groups testing was set for lower EQ-5D-5L outcomes among people who were aware of their hypertensive status, females, people with more comorbidities, less education, older ages, and higher body mass indexes. Level of confident interval was 95%.

Results The mean EQ-VAS and EQ-5D-5L indexes were 81.10 (SD: 13.35) and 0.94 (SD: 0.09) among the general population. The EQ-5D-5L outcomes were better among younger people, males, people with more education, employees, and single people. Respondents reported fewer problems with self-care and usual activities and tend to have problems at higher levels across older ages. The known-group testing showed statistically significant results. The mean EQ-VAS and EQ-5D-5L indexes of people in the diagnosed hypertensive group (71.48 and 0.94, respectively) were statistically significantly smaller than they were in the non-hypertensive and undiagnosed hypertensive group (76.65 and 0.97; 76.95 and 0.96 accordingly). Statistically significant associations of lower EQ-5D-5L indexes and EQ-VAS were found among people diagnosed for hypertension, people suffering from an incremental comorbidity, and obese people.

Conclusion This study has provided EQ-5D-5L population norms for the general population and evidence for known-groups validity of the EQ-5D-5L instrument among hypertensive people in Vietnam.

Keywords EQ-5D-5L population norms · EQ-5D-5L reference data · EQ-5D-5L validity · EQ-5D-5L known-groups validity

Introduction

High blood pressure is a silent killer associated with approximately 9.4 million cases of death a year worldwide [1]. The mortality rate from hypertensive heart disease has increased by 16.4% in the most recent decade in Vietnam [2]. The prevalence of Vietnamese aged 25–64 years living with hypertension has increased from 15.3 to 20.3% from 2010 to 2015, respectively [3]. The burden of the disease is spread out across socio-economic groups [4]. Vietnam's Ministry of Health (MOH) is upgrading their system to provide sufficient healthcare services for people living with long-term illnesses, including hypertension [5]. Presently, the cost of more than 50 drugs for controlling high blood pressure have been completely covered by national health insurance in Viet Nam [6]. With a limited budget, the MOH is now applying evidence-based medicine to upgrade the national health

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insurance benefit package with cost-effective drugs [7]. Those facts imply a demand to promote evidence-informed policymaking in the national healthcare system, initially in health insurance. Nevertheless, efficient measures to evaluate the effectiveness of healthcare programmes/interventions are still in need [8]. Intermediate outcomes (e.g. levels of systolic/diastolic blood pressure—SBP|DBP) and natural measures (e.g. number of deaths or averted cases) are sometimes not adequate to reflect the effectiveness of interventions for the hypertensive population [9]. Hence, multi-dimensional health outcomes, such as the health-related quality of life (HRQOL), are now getting more attention for identifying additional health gains/losses offered by interventions on the hypertensive population [10]. Vietnam's MOH has taken the first steps to make use of the HRQOL metric by requesting such outcomes and quality adjusted life years (QALY) in health technology assessments (HTA), especially pharmaeconomic [7]. These outcomes have also been requested by other countries when it comes to HTA [11–13]. In Vietnam, EQ-5D-5L is currently the only instrument that can produce the HRQOL metric that is based on preferences of the general Vietnamese population [14]. The EQ-5D-5L has also been suggested for the national HTA guidelines, yet there are still two big concerns regarding the instrument.

The first one is that Vietnam needs reference data allowing HRQOL comparisons between people with different characteristics (e.g. ages, sexes, illness status). The HRQOL reference data derived from EQ-5D-5L is normally referred to in name as "EQ-5D-5L population norms" [15]. The population norms typically provide three outcomes, including the reference data of descriptive five dimensional five levels and mean values of EQ-VAS, EQ-5D-5L indexes. The EQ-5D-5L population norms were developed globally, from Western countries [16–22] to Asian countries [23–29]. A Vietnamese population norms using the EQ-5D-5L has been done elsewhere, but the study included an urban population only, and furthermore, used Thai preferences [29]. Since Vietnam now has a country-specific value set [14], this is timely to develop the country-specific EQ-5D-5L population norms for the general population.

The second concern is whether EQ-5D-5L can be justified for use in Vietnam. Psychometric properties of the EQ-5D-5L have been proven in several countries and for several disease areas, including the instrument's reliability and convergent and/or known-groups validation [30–37]. A study on the reliability and convergent validation of the EQ-5D-5L in Vietnam was conducted among HIV/AIDS patients [38], yet construction validation among people with hypertension is still limited. The approaches of construction validation for EQ-5D-5L commonly refer to convergent validation (estimating correlations of related dimensions of EQ-5D-5L and other instruments) [36, 37] and/or known-groups validation (evaluating the sensitiveness of the instrument by yielding distinct results among different groups of patients) [34, 36]. To fill the research gaps, this study aims to provide (1) HRQOL reference data using EQ-5D-5L among the general population and (2) construction validity tests for EQ-5D-5L instrument among people living with hypertension in Vietnam. Due to the shortage in HRQOL data measured by different instruments, only known-group validity tests were included in this article.

Methodology

Data presented in this article was pooled from two separate studies. Data to derive the HRQOL reference data was taken from a Vietnam EQ-5D-5L valuation study which was conducted in the general population in 2017 [14]. The validity test was conducted using data from a survey from the "Evaluation of the Ho Chi Minh City Communities for Healthy Hearts" CH2 project, which was conducted in 2019 [39].

Samples and data collection

All participants were recruited using the door-to-door approach. Interviewers at both studies had public health specialty and they carried out face-to-face interviews to collect the data at the households.

The HRQOL reference data

A general population sample of 1200 adults from the EQ-5D-5L valuation study [14] was selected to develop EQ-5D-5L population norms. A multi-stage, stratified, cluster probabilistic quota-based sampling method was applied. The first stage was to determine an urban and a rural cluster from six provinces of six different geographical regions. The next stage was to determine quotas for each cluster. The probabilistic quotas were developed based on the fractions of the population's regions, residency, age groups (18–29 years old, 30–44 years old, 45–59 years old, and 60+ years old) and sex (male and female). Details of the sampling have been published elsewhere [14]. Data used for developing the population norms were participants' demographic characteristics and self-reported health statuses using the EQ-5D-5L.

The validity testing of the EQ-5D-5L

A sample of 1296 adults aged 40 and above from the CH2 post-evaluation community survey [39] was used for the analysis of known-groups validity of the EQ-5D-5L. The sample was collected from eight districts of Ho Chi Minh City, the biggest megacity in the south of Vietnam. A combination of multistage, cluster, random sampling techniques was employed [39]. Data presented in this article included

participants' background, history on hypertension (physician diagnosed status and comorbidities), the EQ-5D-5L, and physical measurement outcomes (height, weight, blood pressure or BP). The trained interviewers brought along height-weight measures and BP monitors to households, and they conducted physical measurements of all participants after the interview [39]. All participants were asked to rest in the armchair for at least 15 min before the BP measurement and each participant had BP measurements taken twice on their left arm [39]. Average results of the BP measurements were reported in this study. Procedures concerning the physical measurements in the CH2 study adhered to the MOH's guidelines on general health check-ups and physical measurements [40].

Analysis

Generally, differences on distributions of the five dimensions, five levels among sub-groups were tested using Pearson Chi square tests. Due to the ceiling effect of the EQ-5D-5L instrument, non-parametric tests were used to test the differences of the EQ-VAS and EQ-5D-5L indexes among sub-groups, including Mann–Whitney tests for two-group categorical variables and Kruskal Wallis *H* Tests for more-than-two-group categorical variables. The Post-hoc analysis was performed to examine differences among multiple pairwise comparisons. A significance level of 0.05 was used for all statistical tests. Data was analysed using STATA version 17 software.

The EQ-5D-5L population norms

The EQ-5D-5L population norms were derived from the data given by the general population sample. The analysis on EQ-5D-5L population norms followed the standardised method recommended by the EuroQol Group [41]. Descriptive statistics of the five dimensions, five levels, EQ-VAS and EQ-5D-5L indexes, were categorised into gender and age groups. Among these, percentages of answers for the five dimensions, five levels were presented: EQ-VAS and EQ-5D-5L indexes were reported in means, standard deviations, ranges of min–max, and inter-quartiles, respectively. Differences of the EQ-5D-5L' outcomes were statistically tested.

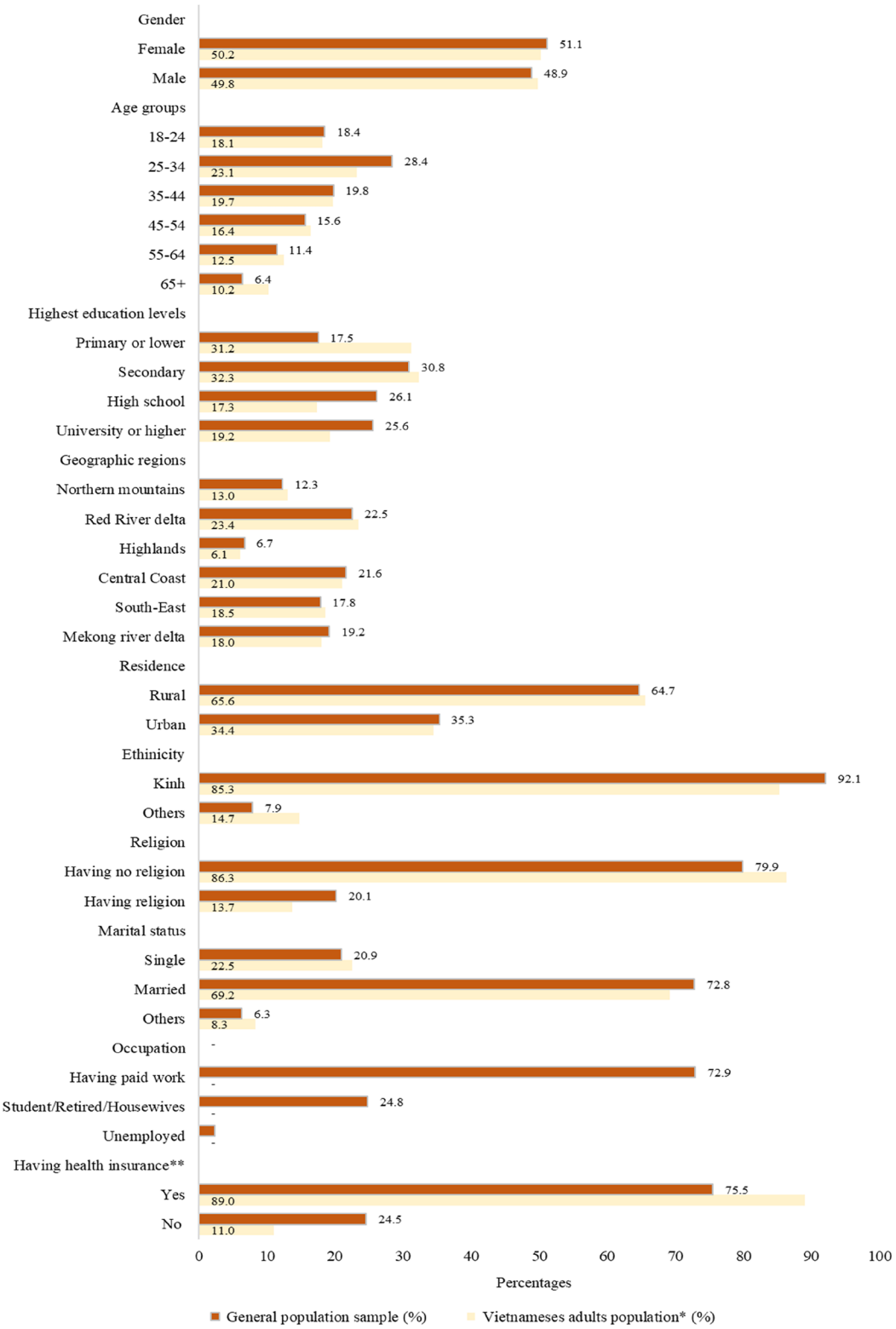
The known-groups validation

Literature suggested that the presence of hypertension and comorbidities was associated with lower HRQOL metrics [42–44]. Also, patients who were aware of their hypertensive status reported a poorer quality of life [45, 46]. Three groups were created based on the results of BP measurements and individual hypertension history. The first was a non-hypertensive group, which included 577 individuals who had never been diagnosed for hypertension by a physician and their average BP was below the World Health Organization's threshold for hypertension (meaning SBP|DBP $\leq$ 140|90 mmHg) [47]. The second was a diagnosed-hypertension group, including 477 hypertensive patients, meaning that they were once diagnosed for hypertension by physician(s) and were prescribed medication. According to the impact of medication, the average BP of individuals in this group was possibly at both below and above the hypertension threshold. The third was an un-diagnosed for hypertension group of 242 individuals who had never been diagnosed for hypertension by a physician, but their average BP (from physical measurements) was above the threshold for hypertension (meaning SBP|DBP $\geq$ 140|90 mmHg). Correspondingly, the known-group validation was tested, meaning, to see if EQ-VAS and EQ-5D-5L indexes would be higher among non-hypertensive people and among people with an undiagnosed hypertensive status than those of the hypertension-diagnosed group would. In addition, HRQOL of hypertensive people was often suggested to be lower among females, people with more comorbidities, less education, older ages, and higher body mass indexes (BMI) [48, 49]. Hence, these known-groups validations were tested for: gender, age, education, marital status, BMI classifications, and number of comorbidities. Associations of these known-groups with the EQ-VAS and EQ-5D-5L indexes were tested using a multivariate linear regression model.

Results

Figure 1 shows characteristics of the general population sample. Overall, the sample distribution was similar among sub-groups of genders, age groups, geographic regions, and education levels. Socio-demographic characteristics of the present sample were in line with those of the national adult population. Nevertheless, this sample included younger and highly educated people than the national average.

Generally, the percentage of participants that reported having full health was 54.4% and such indexes decreased by age (Table 1). Respondents reported fewer problems in self-care and usual activities than the other dimensions. The number of individuals that reported having problems at higher levels increased for the subsequent age groups. Females reported to have more problems in mobility, pain/discomfort, anxiety/depression than males in all age groups. Details of the five dimensions, five levels for females-males in urban–rural subgrouping by age are presented in Table 1a|b in online resource.



*Notes: *Data from the General Statistic Book 2019 for the general population of adults (age ≥ 18 years) in Vietnam. **Statistically significant difference between study sample and Vietnamese general adult population (chi2, p-value<0.05).*

Fig. 1 Pattern of the general population sample and Vietnamese general adult population

Table 1 Percentage of a general population sample reporting the five dimensions by age groups

		18–24 *n* = 220	25–34 *n* = 342	35–44 *n* = 237	45–54 *n* = 187	55–64 *n* = 137	65 + *n* = 77	Total *n* = 1200
Mobility	No problems	98.2%	95.9%	93.2%	83.4%	81.0%	68.8%	90.4%
	Slight problems	1.8%	4.1%	5.5%	15.0%	16.8%	26.0%	8.5%
	Moderate problems			0.4%	0.5%	1.5%	2.6%	0.5%
	Severe problems			0.8%	1.1%	0.7%	2.6%	0.6%
	Unable to walk							
	Pearson chi^2 (Pr)*	100.9 (**< 0.01**)						
Self-care	No problems	100%	99.4%	98.7%	97.9%	94.9%	94.8%	98.3%
	Slight problems		0.6%	0.4%	2.1%	5.1%	3.9%	1.4%
	Moderate problems			0.8%			1.3%	0.3%
	Severe problems							
	Unable to wash or dress							
	Pearson chi2 (Pr)*	32.9 (**< 0.01**)						
Usual activities	No problems	98.6%	96.2%	95.3%	95.2%	92.0%	88.3%	95.3%
	Slight problems	1.4%	3.8%	3.0%	4.8%	8.0%	10.4%	4.3%
	Moderate problems			1.7%				0.3%
	Severeproblems						1.3%	0.1%
	Unable to do usual activities							
	Pearson chi2 (Pr)*	48.7 (**< 0.01**)						
Pain/discomfort	No pain	76.4%	78.0%	65.4%	49.2%	52.6%	45.4%	65.7%
	Slight pain	21.3%	19.9%	31.2%	41.7%	39.4%	39.0%	29.3%
	Moderate pain	2.3%	2.1%	2.1%	6.4%	5.1%	15.6%	4.0%
	Severe pain			1.3%	2.7%	2.9%		1.0%
	Extreme pain							
	Pearson chi2 (Pr)*	113.2 (**< 0.01**)						
Anxiety/depression	Not anxious	76.4%	83.5%	80.2%	82.9%	75.9%	80.5%	80.3%
	Slightly anxious	20.4%	15.0%	15.6%	13.4%	19.0%	14.3%	16.3%
	Moderately anxious	3.2%	0.6%	2.5%	2.1%	2.9%	5.2%	2.3%
	Severely anxious		0.6%	1.3%	1.6%	2.2%	0.0%	0.9%
	Extremely anxious		0.3%	0.4%	0.0%	0.0%	0.0%	0.2%
	Pearson chi2 (Pr)*	23.3 (0.27)						
Reporting full health		61.1%	64.2%	53.6%	42.2%	46.7%	37.7%	54.4%
	Pearson chi2 (Pr)*	40.4 (**< 0.01**)						

Bold values denote statistical significance at the $p < 0.05$ level

n number of individuals

*Results from Pearson Chi square Tests.

The EQ-5D-5L population norms

Overall, the mean EQ-VAS and EQ-5D-5L indexes were 81.10 (SD: 13.35) and 0.94 (SD: 0.09) (Table 2), respectively. The mean EQ-VAS and EQ-5D-5L indexes were statistically significantly higher among younger people, males, people having an education level at high school or higher, or those not being unemployed, or single (p value ≤ 0.05). By geographical region, the EQ-VAS was shown to be statistically lower among people living in the Central Coast areas. Results of EQ-VAS, EQ-5D-5L indexes among females-males in urban–rural subgrouping by age are presented in Table 2alb and the Post-hoc analysis is presented in Table 2cld in online resource.

Known-groups validation

The sample of the diagnosed hypertensive group was older and had more comorbidities than the non-hypertensive, non-diagnosed hypertensive group (Table 3). The smallest percentage of "full health" was 62.68% among the diagnosed group. The mean EQ-VAS and EQ-5D-5L indexes of people in the diagnosed hypertensive group (71.48 and 0.94, respectively) were statistically significantly smaller than they were

Table 2 EQ VAS, EQ−5D−5L indexes among the Vietnamese general population

	EQ VAS			EQ-5D-5L values		
	Mean (SD)	Min–Max; IQR	*p* value	Mean (SD)	Min–Max; IQR	*p* value
Total	81.10 (13.35)	10–100; 20		0.94 (0.09)	0.29–1; 0.08	
Gender*						
Female	80.38 (13.70)	10–100; 20	**0.05**	0.93 (0.09)	0.29–1; 0.08	**< 0.01**
Male	81.84 (12.94)	30–100; 11		0.95 (0.08)	0.36–1; 0.08	
Age group**						
18–24	83.96 (10.26)	50–100; 10	**< 0.01**	0.96 (0.06)	0.76–1; 0.08	**< 0.01**
25–34	84.36 (11.04)	40–100; 10		0.96 (0.06)	0.68–1; 0.07	
35–44	81.75 (13.80)	20–100; 15		0.94 (0.09)	0.29–1; 0.08	
45–54	78.73 (13.69)	50–100; 20		0.92 (0.1)	0.56–1; 0.15	
55–64	74.82 (15.93)	10–100; 15		0.91 (0.11)	0.49–1; 0.15	
65+	73.36 (15.44)	40–100; 10		0.89 (0.12)	0.42–1; 0.15	
Highest education**						
Primary and lower	77.67 (16.10)	20–100; 20	**< 0.01**	0.92 (0.12)	0.29–1; 0.08	**< 0.01**
Secondary	79.84 (14.06)	10–100; 20		0.93 (0.09)	0.49–1; 0.08	
High school	82.56 (11.59)	50–100; 10		0.95 (0.07)	0.62–1; 0.08	
Undergraduate and higher	83.43 (11.34)	40–100; 10		0.95 (0.06)	0.57–1; 0.08	
Geographic regions**						
Northern mountains	80.10 (13.01)	35–100; 20	**< 0.01**	0.93 (0.10)	0.36–1; 0.13	0.26
Red River delta	82.05 (11.79)	40–100; 11		0.95(0.07)	0.67–1; 0.08	
Highlands	80.06 (13.08)	50–100; 20		0.94 (0.09)	0.49–1; 0.08	
Central Coast	77.80 (15.35)	20–100; 20		0.93 (0.11)	0.29–1; 0.08	
South-East	82.43 (11.89)	50–100; 10		0.95 (0.07)	0.57–1; 0.08	
Mekong river delta	83.43 (13.56)	10–100; 10		0.95 (0.08)	0.56–1; 0.08	
Residence*						
Rural	80.70 (13.63)	20–100; 20	0.25	0.94 (0.09)	0.29–1; 0.08	0.78
Urban	81.80 (12.82)	10–100; 15		0.94 (0.08)	0.49–1; 0.08	
Ethnicity*						
Kinh (as majority)	81.24 (13.39)	10–100; 20	0.10	0.94 (0.08)	0.29–1; 0.08	**0.01**
Others	79.34 (12.86)	40–100; 20		0.92 (0.11)	0.36–1; 0.15	
Religion*						
Having no religion	81.34 (13.23)	10–100; 20	0.24	0.94 (0.09)	0.29–1; 0.08	0.75
Having a religion	80.11 (13.81)	30–100; 20		0.94 (0.09)	0.56–1; 0.08	
Marital status**						
Single	83.47 (11.28)	50–100; 10	**< 0.01**	0.96 (0.06)	0.68–1; 0.08	**< 0.01**
Married	80.70 (13.69)	10–100; 20		0.94 (0.09)	0.29–1; 0.08	
Separated/widowed/divorced	77.68 (14.70)	40–100; 20		0.91 (0.11)	0.42–1; 0.15	
Occupation**						
Having paid work	81.85 (12.88)	20–100; 15	**< 0.01**	0.95 (0.08)	0.29–1; 0.08	0.06
Student/retired/housewives	79.93 (14.06)	10–100; 20		0.93 (0.09)	0.56–1; 0.08	
Unemployed	69.26 (14.46)	40–90; 20		0.89 (0.16)	0.42–1; 0.15	
Having health insurance*						
No	80.41 (13.72)	30–100; 20	0.34	0.95 (0.08)	0.57–1; 0.08	**0.01**
Yes	81.31 (13.23)	10–100; 20		0.94 (0.09)	0.29–1;0.08	

Bold values denote statistical significance at the $p < 0.05$ level

*Results from Mann–Whitney tests; **Results from Kruskal Wallis H-Tests *SD* Standard Deviation, *IQR* interquartile range

Table 3 EQ VAS, EQ−5D−5L indexes across hypertensive groups

	Non-hypertensive group			Diagnosed with hypertension group			Un-diagnosed with hypertension group		
	n (%)	VAS (mean; SD)	Value (mean; SD)	*n* (%)	VAS (mean; SD)	Value (mean; SD)	*n* (%)	VAS (mean; SD)	Value (mean; SD)
N	**577**			**477**			**242**		
Reporting full health	415 (71.92)			299 (62.68)			174 (71.90)		
Age group									
40–49	268 (46.45)	77.39 (14.43)	0.97 (0.06)	88 (18.45)	75.52 (14.63)	0.95 (0.11)	92 (38.02)	75.48 (13.65)	0.97 (0.07)
50–59	200 (34.66)	76.86 (14.47)	0.96 (0.07)	164 (34.38)	72.07 (17.55)	0.94 (0.11)	90 (37.19)	77.91 (12.93)	0.96 (0.1)
60+	109 (18.89)	74.45 (14.39)	0.97 (0.05)	225 (47.17)	69.51 (16.11)	0.93 (0.14)	60 (24.79)	77.76 (17.03)	0.97 (0.05)
p value**		0.11	0.08		**< 0.01**	0.43		0.29	0.98
Gender									
Female	341 (59.10)	77.12 (14.96)	0.96 (0.07)	341 (59.10)	70.73 (16.75)	0.92 (0.14)	70 (28.93)	77.9 (13.32)	0.95 (0.1)
Male	236 (40.90)	75.97 (13.69)	0.98 (0.05)	236 (40.90)	72.25 (16.21)	0.95 (0.11)	172 (71.07)	76.55 (14.7)	0.97 (0.07)
p value*		0.22	**0.02**		0.31	**0.01**		0.69	**0.13**
Marital status									
Single	30 (5.20)	75.97 (14.1)	0.96 (0.06)	22 (4.61)	69 (26.66)	0.93 (0.12)	10 (4.13)	80.8 (15.87)	0.96 (0.06)
Married	467 (80.94)	76.72 (14.16)	0.97 (0.06)	373 (78.20)	72.19 (15.71)	0.94 (0.13)	207 (85.54)	77.05 (14.42)	0.97 (0.06)
Separated/ divorce/ widow	80 (13.86)	76.5 (16.33)	0.96 (0.08)	82 (17.19)	68.96 (16.34)	0.93 (0.09)	25 (10.33)	74.6 (12.74)	0.91 (0.16)
p value**		0.79	0.90		0.22	0.34		0.48	0.06
Highest education									
Primary and lower	246 (42.63)	76.09 (16.25)	0.96 (0.07)	210 (44.03)	69.72 (16.76)	0.92 (0.14)	106 (43.80)	78.06 (15.08)	0.97 (0.09)
Secondary	167 (28.94)	76.08 (12.77)	0.97 (0.05)	139 (29.14)	72.07 (17.18)	0.95 (0.09)	70 (28.93)	75.58 (12.73)	0.97 (0.06)
High school and higher	164 (28.42)	78.07 (13.13)	0.98 (0.05)	128 (26.83)	73.72 (15.01)	0.95 (0.12)	66 (27.27)	76.63 (14.63)	0.96 (0.07)
p value**		0.45	0.12		**0.05**	0.24		0.25	0.44
Body Mass Index									
< 18.5 (under-weight)	51 (8.84)	71.08 (14.88)	0.96 (0.06)	26 (5.45)	68.27 (14.14)	0.95 (0.1)	13 (5.37)	74.62 (13.46)	0.98 (0.04)
18.5–24.9 (normal)	421 (72.96)	76.79 (14.36)	0.97 (0.06)	293 (61.43)	71.63 (16.79)	0.94 (0.11)	166 (68.60)	77.02 (15.08)	0.97 (0.06)
< 25 (over-weight/ obesity)	105 (18.20)	78.81 (14.08)	0.97 (0.06)	158 (33.12)	71.74 (16.31)	0.93 (0.15)	63 (26.03)	77.26 (12.37)	0.95 (0.11)
p value**		**< 0.01**	0.41		0.58	0.94		0.97	0.91
Occupation									
Unem-ployed	29 (5.03)	73.62 (15.11)	0.97 (0.05)	70 (14.68)	68.86 (18.96)	0.89 (0.18)	30 (12.40)	72.76 (16.23)	0.95 (0.10)

Table 3 (continued)

	Non-hypertensive group			Diagnosed with hypertension group			Un-diagnosed with hypertension group		
	n (%)	VAS (mean; SD)	Value (mean; SD)	*n* (%)	VAS (mean; SD)	Value (mean; SD)	*n* (%)	VAS (mean; SD)	Value (mean; SD)
Having a paid job	548 (94.97)	76.81 (14.41)	0.97 (0.06)	407 (85.32)	71.94 (16.00)	0.94 (0.11)	212 (87.60)	77.53 (13.95)	0.97 (0.07)
p value*		0.26	0.80		0.18	0.04		0.15	0.77
Having comorbidity									
No	510 (88.39)	77.05 (14.28)	0.97 (0.06)	311 (65.20)	72.58 (15.36)	0.95 (0.11)	219 (90.50)	77.72 (13.58)	0.97 (0.08)
Yes	67 (11.61)	73.66 (15.51)	0.95 (0.07)	166 (34.80)	69.44 (18.27)	0.91 (0.15)	23 (9.50)	69.78 (18.68)	0.96 (0.09)
p value*		0.07	**< 0.01**		0.06	**< 0.01**		**0.03**	**0.76**
Hypertension status	EQ-VAS (mean; SD)			EQ-5D-5L index (mean; SD)					
Non-hypertensive	76.65 (14.45)			0.97 (0.06)					
Un-diagnosed for hypertension	76.95 (14.29)			0.96 (0.08)					
Diagnosed for hypertension	71.48 (16.48)			0.94 (0.12)					
p value**	**< 0.01**			**< 0.01**					

Bold values denote statistical significance at the $p < 0.05$ level

*Results from Mann–Whitney tests; **Results from Kruskal Wallis *H* Tests

SD Standard Deviation

in the other two groups (p value < 0.05). Results of EQ-VAS and EQ-5D-5L indexes were reported comparably between people from the non-hypertensive and undiagnosed hypertensive group (76.65 and 0.97; 76.95 and 0.96 accordingly). Results of the Post-hoc analysis for CH2 sample are presented in Table 3alb, Online resource.

Results show statistically significant decreases in the EQ-VAS among people diagnosed for hypertension, higher numbers of comorbidities, and those underweight (Table 4). Statistically significant associations of lower EQ-5D-5L indexes were found among people diagnosed for hypertension, people of older ages, females, people suffering from an incremental comorbidity, and obese people. People with higher education levels may associate with higher both EQ-VAS and EQ-5D-5L indexes.

Discussion

This study has provided EQ-5D-5L reference data in Vietnam, which was presented with regards to age and gender for the descriptive part of the five dimensions, five levels, EQ-VAS and EQ-5D-5L indexes. Additionally, this study demonstrated the validity of the EQ-5D-5L instrument among people living with hypertension. EQ-5D-5L was shown to be possible to capture changes in HRQOLs among participants with less desirable health statuses.

A strength of this study's EQ-5D-5L population norms was the neutral context sample. Responses were pooled across the country by geographical regions, gender, age, and residence settings. In a previous EQ-5D-5L population norms study, results were derived from the data of an urban population and EQ-5D-5L indexes were calculated using a Thai value set [29]. However, EQ-5D-5L indexes in the present study were estimated using the Vietnamese preference-based value set. In addition, the percentage reporting full health in the previous study was about 67.4%, which was 13% higher than the present study. Findings here of EQ-5D-5L population norms, therefore, could be perceived as more neutral context HRQOL reference data. The mean EQ-5D-5L value for Vietnamese adults was about 0.94, which was in line with the range of indexes across countries, from 0.89 in Poland [16] to 0.96 in China [23]. Patterns of the EQ-5D-5L reference data found in the present study were

Table 4 Factors associate with the EQ-VAS and EQ-5D-5L indexes

	EQ VAS			EQ-5D-5L index		
	Coeff.	Std. Err.	95% CI	Coeff.	Std. Err.	95% CI
Hypertensive group (Ref: Non-hypertensive)						
Diagnosed with hypertension group	− 3.731	1.035	**[− 5.76; − 1.701]**	− 0.022	0.006	**[− 0.034; -0.009]**
Un-diagnosed with hypertension group	0.143	1.197	[− 2.206; 2.491]	− 0.006	0.007	[− 0.021; 0.008]
Age	− 0.076	0.046	[− 0.167; 0.015]	− 0.001	0.000	**[− 0.001; 0]**
Gender (Ref: Male)						
Female	0.082	0.898	[− 1.68; 1.844]	− 0.017	0.005	**[− 0.028; -0.007]**
Education (Ref: primary school)						
Secondary school	0.117	1.012	[− 1.869; 2.102]	0.015	0.006	**[0.003; 0.027]**
High school and higher	1.839	1.032	[− 0.186; 3.863]	0.014	0.006	**[0.002; 0.026]**
Relationship (Ref: Doesn't have a partner)						
Has a partner	0.985	1.119	[− 1.21; 3.18]	0.002	0.007	[− 0.012; 0.015]
Number of comorbidities	− 2.678	0.599	**[− 3.852; − 1.503]**	− 0.013	0.004	**[− 0.02; -0.006]**
BMI (Ref: Normal from 18.5 to 24.9)						
Underweight (BMI < 18.5)	− 4.164	1.698	**[− 7.494; − 0.833]**	0.000	0.010	[− 0.02; 0.02]
Overweight or Obesity (BMI > 25)	0.928	0.998	[− 1.03; 2.887]	-0.009	0.006	[− 0.021; 0.003]
Constant	79.850	2.945	[74.073; 85.628]	1.007	0.018	[0.97; 1.04]
R^2	0.056			0.059		
n	1285			1296		

Bolded 95% CI represents statistically significant differences in sub-groups

Coeff Coefficient, *Std.Err.* Standard error. *95% CI* 95% confident interval, *BMI* Body Mass Index, *n* number of individuals

similar with a previous Vietnamese EQ-5D-5L population norms study [29], China [23], Hong Kong [25], Indonesia [26] and Spain [19]; for example, the EQ-5D-5L indexes were reported to be lower for females than males, or higher for people having an education from high school and higher. The EQ-5D-5L indexes in this study showed a linear relationship with age for both genders. Nevertheless, the linear relationship was inconsistent for females, i.e., the mean EQ-5D-5L value was slightly lower among younger females aged 18-24 years than those in the age group of 25-34 years. EQ-5D-5L population norms in Australia [18] and Hong Kong [25] also reported similar linear relationships between the EQ-5D-5L value and age. Moreover, results showed statistically significant differences of EQ-VAS across the six geographical regions, where seemingly people from mountainous or poorer regions (e.g., the Central coast, the Highlands, the northern mountainous areas) were more likely to have lower EQ-VAS and EQ-5D-5L indexes than the others. This may have implied a hint of inequity in people's HRQOL overall, in examples regarding education status, residential areas, occupation, marital status, ethnicity, and more.

With respect to the known-groups validation, the EQ-5D-5L performed in such a way that better HRQOL was more frequently reported by both people living with better health and people not being aware of their disease. The rates of people at full health, the EQ-VAS and EQ-5D-5L indexes, were similar between the two groups of non-hypertensive and undiagnosed hypertensive individuals, while such indicators were lower among those with diagnosed hypertension. Similar findings were also found in a study in Rio [50]. The presence of a clinical diagnosis for hypertension was statistically associated with 0.03 lower EQ-5D-5L indexes and 5 points lower for the EQ-VAS, which was in line with a similar study in China [49]. Moreover, the EQ-VAS and the EQ-5D-5L indexes were proven to be higher among people who did not have any comorbidity, as in previous literature [43, 51]. Generally, the known-groups validity of the EQ-5D-5L instrument has been verified among Vietnamese living with hypertension. Whilst higher EQ-5D-5L indexes were associated with people who have completed college or higher, the lower EQ-5D-5L indexes were associated with older age, being female, having BMI classified as obese, and having more comorbidities among people diagnosed for hypertension. Such findings aligned with both international [42–45] and national [51–53] literature.

With respect to the use of EQ-5D-5L population norms as a reference to compare HRQOL, the results found in this study appear to suggest that people with hypertension may have lower EQ-VAS points, but higher EQ-5D-5L indexes than the general population. EQ-VAS among diagnosed and undiagnosed groups for hypertension were at 71.48 and 76.96, whereas the EQ-VAS among the general population at the same age (40 years and above) ranged from 73.36 to 78.73. For the EQ-5D-5L indexes, the range of the general

population was from 0.89 to 0.92, whilst it was 0.96 among the hypertension-undiagnosed group, and 0.94 among the diagnosed group. The average HRQOL of non-hypertensive people from the CH2 project was also reported to be higher than that of the general population. However, the higher HRQOL of people from the CH2 cohort in comparison with the general population can be explained by the better living conditions of the CH2 population, as 95% of participants from the CH2 project had a paid job, and their residence had received investment from the Head of the Ho Chi Minh City's People Committee with several urban infrastructure and healthcare interventions.

Several limitations are found in this study. First, the sample for implementing the validation test was not contextually neutral. When the EQ-5D-5L population norms sample included all six country regions and residence types, the validation tests were taken from a study conducted in a megacity in South Vietnam and including only an urban population. In addition, the lack of HRQOL measurements from different instruments and at different time points limited the ability to test the reliability and sensitivity of the EQ-5D-5L instrument. Hence, this present study touched only a trivial part of the psychometric properties of the EQ-5D-5L.

Conclusion

This study has provided EQ-5D-5L population norms for the general population and evidence for known-groups validity of the EQ-5D-5L instrument among hypertensive people in Vietnam. Findings from this study have addressed two main literature gaps in Vietnam, which were: (1) the population norms in context neutral HRQOL reference data, and (2) the known-groups validity of the EQ-5D-5L having been tested among people with different statuses of hypertension.

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