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EQ-5D-3L health status and health state utilities of the oldest-old (85 +) in Germany: results from the AgeCoDe-AgeQualiDe study

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Abstract

Purpose To describe health status and health state utilities measured by the EQ-5D-3L in a population-based sample of individuals aged 85 + in Germany, and to analyze associations with basic socio-demographic variables.

Methods Cross-sectional data from follow-up wave 7 ($n = 761$) of the German AgeCoDe Study were used. The EQ-5D-3L questionnaire was used to record problems in five health dimensions, its visual analogue scale (EQ VAS) was used to record self-rated health status, and the German EQ-5D-3L index was used to derive health state utilities.

Results Mean age of respondents was 88.9 years (SD 2.9; range 85 to 100), 67.4% were female. 81.9% reported problems in at least one of the EQ-5D dimensions, with 15.3% reporting extreme problems. Most frequent were problems with pain/discomfort (64.8%), followed by mobility (62.5%), usual activities (42.6%), self-care (28.2%), and anxiety/depression (20.5%). Mean EQ VAS score was 62.4 (SD 18.8), and mean EQ-5D index was 0.77 (SD 0.24). Multiple regression analysis showed associations of problem frequency in various EQ-5D dimensions with age, gender, living situation, marital status, and education. The EQ VAS score was negatively associated with age ($\beta = -0.56$; $p < 0.05$) and female gender ($\beta = -3.49$; $p < 0.05$). The EQ-5D index was negatively associated with not living in the community ($\beta = -0.10$; $p < 0.001$) and being single ($\beta = -0.09$; $p < 0.05$).

Conclusions The results show a substantially impaired health status of the oldest-old population. The data can be used for comparing health status of population groups as well as for health economic models.

Keywords Health-related quality of life · EQ-5D · Oldest-old · Health state utilities

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Introduction

In the course of demographic aging, many industrialized countries experience an enormous growth in the population of oldest-old people, commonly defined as individuals aged 85 years and above (85 +) [1, 2]. In Germany, the number of individuals aged 85 + increased 12-fold from 0.2 million in 1950 to 2.4 million in 2019, while in the same period the number of individuals aged 65 and above not even tripled from 6.8 million to 18.1 million [3]. In fact, the oldest-old have been the fastest growing population, and growth is expected to continue in the future: It has been projected by the German Federal Statistical Office that in 2050 about 5.4 million individuals will be aged 85 + which constitutes a 27-fold increase within one century [4].

In the oldest-old population, morbidity, functional impairment, and need for health care tend to be very high, and a disproportionally great share of health care resources is spent on individuals aged 85 + [5]. Hence, it is of particular importance to evaluate the effectiveness and the cost-effectiveness of health care for this population group.

Evaluation of health care usually involves the measurement of health status. The EQ-5D-3L is a simple generic measure designed to record key aspects of health status independent of disease category and severity [6]. Thus, it can be used to compare health status of patient groups across different diseases as well as different populations. Furthermore, the EQ-5D-3L allows valuation of health status based on the respondent's preferences as well as societal preferences. The use of societal preferences for the valuation of health states has been recommended by health economists for the calculation of quality-adjusted life years (QALYs) in cost utility analysis [7]. In fact, societal preference weights for EQ-5D-3L health states, often called utilities, are most frequently used for the calculation of QALYs in economic evaluations of health care [8], and have been recommended for this purpose by methodological guidelines for conducting economic evaluations [9–11].

The EQ-5D-3L has been used frequently to describe health status of general population samples, and population reference data for EQ-5D-3L scores are available for various countries [12, 13]. Besides illustrating the frequency and severity of health problems in the general population, reference data can be used to compare health status of patients suffering from specific conditions with health status of the average person in the general population in similar socio-demographic groups, defined, e.g., by age and gender. Such comparisons can help to identify the disease burden in a particular patient population. Furthermore, age- and gender-specific reference values for utilities might be used to value average population health states in health economic models, such as Markov models used for economic evaluations.

Yet, the number of oldest-old individuals in general population surveys using the EQ-5D-3L has mostly been rather small, and data specific for the general population aged 85 + have rarely been reported [12, 14–18]. Therefore, the purpose of the study was to describe health status and health state utilities based on the EQ-5D-3L in a large population-based sample of individuals aged 85 + in Germany, and to analyze the associations with basic socio-demographic variables.

Methods

Data

We used cross-sectional data of the AgeQualiDe Study ("Study on needs, health service use, costs and health-related quality of life in a large sample of oldest-old primary care patients (85 +)), a large multicenter prospective cohort study which continues and extends the AgeCoDe Study ("German Study on Ageing, Cognition and Dementia in Primary Care Patients"). For the AgeCoDe Study, $n = 3327$ individuals (initial response rate 50.3%) were recruited back in 2003/2004 via their general practitioners' (GP) offices in six cities across Germany (Bonn, Düsseldorf, Hamburg, Leipzig, Mannheim, Munich). Inclusion criteria for recruitment were age 75 and above, absence of dementia and at least one contact with the GP during the last year. Individuals were excluded from recruitment if they were an irregular patient of the participating practice, consulted their GP only via home visits, resided in a nursing home, suffered from a severe illness the GP would deem fatal within 3 months, had insufficient German language skills, were blind or deaf, or were unable to provide informed consent. Participants were interviewed at their homes by trained interviewers (e.g., physicians or psychologists) at baseline (January 2003 to November 2004) and every 18 months thereafter. Details regarding the AgeCoDe cohort have been reported elsewhere [19]. For the present analysis we used data of participants in follow-up (FU) wave 7 of the AgeCoDe cohort (which corresponds to the baseline of the AgeQualiDe Study) collected between January 2014 and September 2015. Altogether, $n = 861$ out of 3327 individuals recruited for AgeCoDe participated in FU wave 7. The main reasons for non-participation were death (52.1%) or refusal/drop-out/inability to participate (21.8%). The response rate at FU wave 7 was 90.1%. For the analysis we included $n = 761$ individuals with no missing values in EQ-5D scores.

EQ-5D-3L

The EQ-5D-3L questionnaire consists of five items referring to current problems in the dimensions 'mobility', 'self-care',

'usual activities', 'pain/discomfort', and 'anxiety/depression' [6]. For each dimension, the 3L-version records responses on an ordinal scale with three levels coded (1) no problems, (2) moderate problems, (3) extreme problems/unable to, resulting in EQ-5D-3L health state profiles coded by five-digit numbers. For example, the state '22211′ indicates moderate problems in mobility, self-care, and usual activities, but no pain/discomfort and no anxiety/depression. The questionnaire also contains a visual analogue scale (EQ VAS) which records self-rated health based on the respondent's preferences, ranging from 0 = worst imaginable health to 100 = best imaginable health (EQ VAS score). Furthermore, particularly developed to be used as preference weight to calculate QALYs in cost utility analysis, there also exist value sets based on societal preferences which provide an index score (EQ-5D-3L index) for each of the $3^5 = 243$ EQ-5D-3L health states, with the best state (11111) and 'death' being assigned values of 1 and 0, respectively. These value sets were derived from general population surveys in various countries. The value set used in the present study was obtained from a random sample of the German general population ($n = 334$) where the Time Trade-Off (TTO) method was used to derive preference weights for given EQ-5D-3L health states (called EQ-5D index-DE thereafter) [20]. In addition, the TTO-based value set from the United Kingdom [21] was used (called EQ-5D index-UK thereafter), because it was derived in a much larger general population sample ($n = 2997$) and has been used in numerous international studies (e.g., [22–24].).

Socio-demographic variables

We considered the following socio-demographic variables: Age (years), sex, living situation (community-dwelling (i.e., living in private household); institutionalized (i.e., living in nursing home or old people's home)), marital status (single; married; divorced; widowed), and education (grouped into 'primary', 'secondary', and 'tertiary' according to the Comparative Analysis of Social Mobility in Industrial Nations (CASMIN) classification) [25].

Statistical analysis

The proportion of respondents reporting problems in EQ-5D dimensions as well as mean EQ VAS and EQ-5D index scores were calculated for the total sample as well as stratified by sex and two age groups (85–89 years; 90 years and over). Chi-square tests were used to test for differences in proportions and t tests for differences in means between groups. Furthermore, the association of socio-demographic variables with problems in EQ-5D dimensions was analyzed using logistic regressions (no problems vs. moderate/extreme problems combined into one category). Multiple linear regressions with cluster-robust standard errors were used to analyze the association between socio-demographic variables and EQ VAS as well as EQ-5D index scores. The level of significance was set at $\alpha = .05$. Calculations were performed using Stata Release 15.1 (Stata Corp., College Station, Texas).

Results

Sample characteristics

Table 1 shows socio-demographic characteristics for the total sample as well as stratified by sex and age group. Of the 761 respondents, 67.4% were female. Mean age was 88.9 years (SD 2.9), ranging from 85 to 100 years, with 35.9% aged 90 and above. 80.7% of the total sample lived in the community, 63.4% were widowed, and 55.4% had primary education only. Compared to men, the proportion of women living in nursing or old people's homes (22.0% vs. 13.7%), being widowed (75.8% vs. 37.9%), and having only primary education (59.5% vs. 47.2%) was considerably higher. In the older age group (90 years and above), the proportion of women (73.1% vs. 64.2%) and of widowed individuals (73.7% vs. 57.6%) was higher than in the younger age group (85–89 years).

Descriptive statistics

Of the total sample, 81.9% reported problems in at least one of the EQ-5D dimensions, with 15.3% reporting extreme problems (Table 2). Most frequent were problems with pain/discomfort (64.8%), followed by mobility (62.5%), usual activities (42.6%), self-care (28.2%), and anxiety/depression (20.5%). Extreme problems were most frequent with pain/discomfort (8.2%) and usual activities (6.0%), and least frequent with mobility (1.0%). The mean EQ VAS score was 62.4 (SD 18.8), the mean EQ-5D index-DE was 0.77 (SD 0.24), and the mean EQ-5D index-UK was 0.68 (SD 0.28).

Stratification by sex showed that women reported problems more frequently than men in all EQ-5D dimensions, with the differences being statistically significant except for self-care and anxiety/depression. 85.8% of women and 73.8% of men reported problems in at least one of the EQ-5D dimensions ($p < 0.001$). The mean EQ VAS score (61.0 vs. 65.4; $p = 0.002$) and the mean EQ-5D index scores (EQ-5D index-DE: 0.75 vs. 0.80, $p = 0.003$; EQ-5D index-UK: 0.65 vs. 0.72; $p < 0.001$) were significantly lower in women than in men.

Stratification by age group revealed that, compared to respondents aged 85–89 years, respondents aged 90 years and over reported significantly more often problems with usual activities, self-care, and mobility, but not with anxiety/

Table 1 Socio-demographic characteristics of respondents at FU wave 7; total sample and stratified by sex and age group

Variables	Total ($n=761$)	Women ($n=513$)	Men ($n=248$)	85 to 89 years ($n=486$)	90 years and over ($n=275$)
Age: mean (SD); range	88.9 (2.9); 85–100	89.1 (3.0); 85–99	88.5 (2.9); 85–100	–	–
Gender: *N* (%)					
Female	513 (67.4%)	–	–	312 (64.2%)	201 (73.1%)
Male	248 (32.6%)	–	–	174 (35.8%)	74 (26.9%)
Living situation: *N* (%)					
Community dwelling	614 (80.7%)	400 (78.0%)	214 (86.3%)	418 (86.0%)	196 (71.3%)
Institutionalized	147 (19.3%)	113 (22.0%)	34 (13.7%)	68 (14.0%)	79 (28.7%)
Marital status: *N* (%)					
Single	54 (7.1%)	51 (10.0%)	3 (1.2%)	33 (6.8%)	21 (7.7%)
Married	191 (25.1%)	49 (9.5%)	142 (57.3%)	151 (31.1%)	40 (14.6%)
Divorced	33 (4.4%)	24 (4.7%)	9 (3.6%)	22 (4.5%)	11 (4.0%)
Widowed	482 (63.4%)	388 (75.8%)	94 (37.9%)	280 (57.6%)	202 (73.7%)
Education: *N* (%)					
Primary	422 (55.4%)	305 (59.5%)	117 (47.2%)	268 (55.2%)	154 (56.0%)
Secondary	232 (30.5%)	168 (32.7%)	64 (25.8%)	143 (29.4%)	89 (32.4%)
Tertiary	107 (14.1%)	40 (7.8%)	67 (27.0%)	75 (15.4%)	32 (11.6%)

depression and pain/discomfort. There was no significant difference between age groups in the proportion of respondents reporting problems in at least one of the EQ-5D dimensions, nor in the mean EQ-5D index scores. The mean EQ VAS score was significantly lower in the older age group (60.5 vs. 63.5, $p=0.034$).

Regression analysis of problems in EQ-5D dimensions

Multiple logistic regression analysis (Table 3) confirmed the association of female sex with frequency of problems in any EQ-5D dimension (OR 1.99; 95%CI 1.26 to 3.13). However, the association between female sex and problem frequency was not significant for the single EQ-5D dimensions. Older age (in years) was significantly associated with more problems in self-care (OR 1.14; 95%CI 1.08 to 1.21), usual activities (OR 1.12; 95%CI 1.06 to 1.18), and mobility (OR 1.10; 95%CI 1.04 to 1.17), but also with significantly less problems in anxiety/depression (OR 0.90; 95%CI 0.84 to 0.97). Respondents who lived in a nursing or old people's home reported significantly more often problems in all dimensions except for pain/discomfort: self-care (OR 2.79; 95%CI 1.88 to 4.13), anxiety/depression (OR 1.79; 95%CI 1.16 to 2.78), usual activities (OR 1.73; 95%CI 1.18 to 2.53), mobility (OR 1.59; 95%CI 1.04 to 2.43), any EQ-5D dimension (OR 1.84; 95%CI 1.02 to 3.31). Compared to being married, being single was associated with significantly more problems in mobility (OR 2.81; 95%CI 1.26 to 6.24). With respect to education, tertiary education was significantly associated with less problems in self-care (OR 0.48; 95%CI 0.27 to 0.87) compared to primary education.

Regression analysis of EQ VAS score and EQ-5D index scores

Multiple linear regression (Table 4) showed that the EQ VAS score was significantly negatively associated with age ($\beta=-0.56$; $p<0.05$) and female gender ($\beta=-3.49$; $p<0.05$). The EQ-5D index scores were significantly negatively associated with living in a nursing or old people's home (EQ-5D index-DE: $\beta=-0.10$, $p<0.001$; EQ-5D index-UK: $\beta=-0.13$; $p<0.001$) and with being single (EQ-5D index-DE: -0.09, $p<0.05$; EQ-5D index-UK: $\beta=-0.10$, $p<0.05$; ref.: being married).

Discussion

In this study, we report EQ-5D-3L scores for a population-based sample of 761 oldest-old individuals in Germany. 81.9% of all respondents aged 85 + reported problems in at least one EQ-5D dimension, with almost two-thirds each reporting problems with pain/discomfort and with mobility, and 15.3% reporting extreme problems in at least one EQ-5D dimension. Not surprisingly, this frequency of problems is much higher than found in a survey of the German general adult population aged 18 and above where only about one-third of respondents reported any problems on the EQ-5D-3L descriptive system, also most frequently

Table 2 Problems in EQ-5D dimensions, EQ VAS score, and EQ-5D index scores ($n = 761$); total sample and stratified by sex and age group

	Total	Women	Men	*p* value	85 to 89 years	90 years and over	*p* value
EQ-5D dimension							
Mobility: *N* (%)				.002			.001
No problems	285 (37.5%)	172 (33.5%)	113 (45.6%)		206 (42.4%)	79 (28.7%)	
Moderate problems	468 (61.5%)	337 (65.7%)	131 (52.8%)		275 (56.6%)	193 (70.2%)	
Extreme problems	8 (1.0%)	4 (0.8%)	4 (1.6%)		5 (1.0%)	3 (1.1%)	
Self-care: *N* (%)				.085			< .001
No problems	546 (71.8%)	355 (69.3%)	191 (77.0%)		381 (78.4%)	165 (60.2%)	
Moderate problems	186 (24.5%)	137 (26.8%)	49 (19.8%)		94 (19.3%)	92 (33.6%)	
Extreme problems	28 (3.7%)	20 (3.9%)	8 (3.2%)		11 (2.3%)	17 (6.2%)	
Usual activities: *N* (%)				.014			< .001
No problems	436 (57.4%)	275 (53.7%)	161 (64.9%)		311 (64.0%)	125 (45.6%)	
Moderate problems	278 (36.6%)	203 (39.7%)	75 (30.2%)		151 (31.1%)	127 (46.4%)	
Extreme problems	46 (6.0%)	34 (6.6%)	12 (4.8%)		24 (4.9%)	22 (8.0%)	
Pain/discomfort: *N* (%)				.037			.411
No problems	268 (35.2%)	166 (32.4%)	102 (41.1%)		164 (33.7%)	104 (37.8%)	
Moderate problems	431 (56.6%)	300 (58.5%)	131 (52.8%)		279 (57.4%)	152 (55.3%)	
Extreme problems	62 (8.2%)	47 (9.1%)	15 (6.1%)		43 (8.9%)	19 (6.9%)	
Anxiety/depression: *N* (%)				.054			.069
No problems	603 (79.5%)	394 (77.1%)	209 (84.3%)		373 (76.9%)	230 (83.9%)	
Moderate problems	143 (18.8%)	106 (20.7%)	37 (14.9%)		103 (21.2%)	40 (14.6%)	
Extreme problems	13 (1.7%)	11 (2.2%)	2 (0.8%)		9 (1.9%)	4 (1.5%)	
Any dimension: *N* (%)				< .001			
No problems[a]	138 (18.1%)	73 (14.2%)	65 (26.2%)		96 (19.8%)	42 (15.3%)	.226
Moderate problems[b]	507 (66.6%)	352 (68.6%)	155 (62.5%)		321 (66.0%)	186 (67.6%)	
Extreme problems[c]	116 (15.3%)	88 (17.2%)	28 (11.3%)		69 (14.2%)	47 (17.1%)	
EQ VAS score				.002			.034
Mean (SD)	62.4 (18.8)	61.0 (18.1)	65.4 (19.9)		63.5 (19.2)	60.5 (17.9)	
Median (25–75% percentile)	60 (50–80)	60 (50–75)	70 (50–80)		60 (50–80)	60 (50–70)	
EQ-5D index-DE				.003			.062
Mean (SD)	0.77 (0.24)	0.75 (0.24)	0.80 (0.22)		0.78 (0.24)	0.75 (0.24)	
Median (25–75% percentile)	0.79 (0.70–0.90)	0.79 (0.70–0.90)	0.89 (0.79–1.00)		0.80 (0.79–0.90)	0.79 (0.70–0.90)	
EQ-5D index-UK				< .001			.083
Mean (SD)	0.68 (0.28)	0.65 (0.28)	0.72 (0.27)		0.69 (0.28)	0.65 (0.28)	
Median (25–75% percentile)	0.73 (0.59–0.85)	0.73 (0.59–0.81)	0.75 (0.66–1.00)		0.73 (0.62–0.85)	0.70 (0.59–0.81)	

[a]No problems in any dimension;

[b]Moderate problems in at least one dimension but no extreme problems in any dimension;

[c]Extreme problems in at least one dimension

with pain/discomfort (27.9%) and mobility (16.6%), and only 2.3% reported extreme problems [26]. Problem frequency in the present study was very similar to what was found in a much smaller representative sample of $n = 253$ community-dwelling individuals aged 85 + from six European countries (Belgium, France, Germany, Italy, the Netherlands and Spain) where 81.1% reported any problems on the EQ-5D-3L descriptive system, with problems with mobility (67.8%) and pain/discomfort (61.7%) being most frequent, and 13.4% reporting extreme problems [14]. Yet, compared to the European sample, problem frequency in our sample was considerably lower for self-care (28.2% vs. 38.0%) and usual activities (43.6% vs. 60.5%), but higher for anxiety/depression (20.5 vs. 11.7%). In a representative sample of community-dwelling individuals stratified by age from Switzerland, problem frequency on the EQ-5D-3L descriptive system in the age strata 85 to 89 years ($n = 418$) and 90 + years ($n = 319$) was considerably lower than in the respective age strata of our sample in all EQ-5D dimensions except for anxiety/depressions where problems tended to be more frequent [16]. Moreover, in a large sample of $n = 1435$ community-dwelling

Table 3 Results of multiple logistic regressions with problems in EQ-5D dimensions used as dependent variable

Independent variables	Problems in dimension mobility	Problems in dimension self-care	Problems in dimension usual activities	Problems in dimension pain/discomfort	Problems in dimension anxiety/depression	Problems in any dimension
Age	1.10*** (1.04–1.17)	1.14*** (1.08–1.21)	1.12*** (1.06–1.18)	0.96 (0.92–1.02)	0.90** (0.84–0.97)	1.06 (0.99–1.14)
Gender: female (ref.: male)	1.32 (0.91–1.93)	1.15 (0.74–1.78)	1.27 (0.87–1.87)	1.38 (0.95–2.02)	1.32 (0.82–2.12)	1.99** (1.26–3.13)
Living situation: institutionalized (ref.: community dwelling)	1.59* (1.04–2.43)	2.79*** (1.88–4.13)	1.73** (1.18–2.53)	1.04 (0.70–1.54)	1.79** (1.16–2.78)	1.84* (1.02–3.31)
Marital status: single (ref.: married)	2.81* (1.26–6.24)	2.00 (0.96–4.20)	1.96 (0.98–3.92)	1.47 (0.71–3.02)	1.18 (0.51–2.77)	4.34 (0.97–19.31)
Divorced	1.42 (0.63–3.19)	1.44 (0.62–3.33)	1.40 (0.64–3.05)	0.81 (0.37–1.76)	1.69 (0.69–4.17)	0.63 (0.25–1.56)
Widowed	1.21 (0.80–1.81)	0.83 (0.51–1.34)	1.05 (0.69–1.60)	1.19 (0.79–1.80)	1.28 (0.76–2.16)	0.94 (0.58–1.52)
Education: medium education (ref.: low education)	0.91 (0.64–1.28)	1.01 (0.70–1.46)	0.93 (0.67–1.30)	0.96 (0.68–1.34)	0.82 (0.55–1.23)	0.93 (0.61–1.43)
High education	0.96 (0.60–1.53)	0.48* (0.27–0.87)	0.71 (0.44–1.14)	1.08 (0.68–1.72)	0.55 (0.29–1.04)	1.05 (0.60–1.86)
Constant	0.00*** (0.00–0.03)	0.00*** (0.00–0.00)	0.00*** (0.00–0.00)	31.48 (0.30–3,271.06)	1,329.57* (3.29–538,093.74)	0.01 (0.00–5.55)
Observations	760	759	759	760	758	760
Pseudo R^2	0.04	0.09	0.05	0.01	0.03	0.05

Odds ratios are reported; 95% CI in parentheses; ***$p < 0.001$, **$p < 0.01$, *$p < 0.05$

Table 4 Results of multiple linear regressions with EQ VAS score and EQ-5D index scores used as dependent variables

Independent variables	EQ VAS score	EQ-5D index-DE	EQ-5D index-UK
Age (years, centered)	−0.56* (0.23)	−0.00 (0.00)	−0.00 (0.00)
Gender: female (ref.: male)	−3.49* (1.72)	−0.03 (0.02)	−0.05 (0.03)
Living situation: institutionalized (ref.: community dwelling)	−2.48 (1.76)	−0.10*** (0.03)	−0.13*** (0.03)
Marital status: single (ref.: married)	−5.47 (2.98)	−0.09* (0.04)	−0.10* (0.05)
Divorced	−4.03 (3.56)	0.04 (0.04)	0.04 (0.05)
Widowed	0.71 (1.92)	0.00 (0.02)	0.00 (0.03)
Education:—medium education (ref.: low education)	0.18 (1.57)	0.01 (0.02)	0.01 (0.02)
High education	1.02 (1.94)	0.03 (0.02)	0.05 (0.03)
Constant	65.11*** (1.79)	0.80*** (0.02)	0.72*** (0.02)
Observations	752	758	758
R^2	0.03	0.06	0.07

Unstandardized beta-coefficients are reported; robust standard errors in parentheses; ***$p < 0.001$, **$p < 0.01$, *$p < 0.05$

individuals aged 85 + from the Netherlands [17], problem frequency in all dimensions of the EQ-5D-3L descriptive system (including anxiety/depression) was much lower than in our sample and even lower than in the Swiss sample. However, the Dutch sample consisted of participants in a randomized controlled trial for a pneumococcal vaccine and was—as the authors state—probably fitter and healthier than the general Dutch elderly population. Also, a study conducted in a representative sample of 780 community-dwelling individuals aged 85 + from China [18] using the EQ-5D-3L reported much lower problem frequencies for the dimensions mobility and pain/discomfort than found in our sample. However, except for our study, none of the cited studies included institutionalized individuals which might be one reason for the lower problem frequency reported by them.

With a mean value of 62.4, the EQ VAS score in our sample was considerably lower than in the general adult population in Germany (77.4) [26] or in any of 18 countries reviewed by Janssen and Szende (ranging from 75.0 in Spain to 83.7 in Denmark) [27], but very similar to the European sample aged 85 + mentioned above (60.5) [14]. However, the mean EQ VAS score was lower than in the samples aged 85 + of the above-mentioned studies conducted in Switzerland (age 85–89: 68.9; age 90 +: 71.2) [16] and the Netherlands (76.4) [17], but similar to the sample from

China (males: 66.1, females 64.3) [18] and another sample of community-dwelling individuals ($n = 58$ aged 85 +) from Korea (61.3) [15]. The mean value of the EQ-5D index-DE in our sample (0.77) was much lower than mean EQ-5D index values (all based on country-specific TTO value sets for the EQ-5D-3L) in 11 countries reported by Janssen et al. [13], ranging from 0.86 in England to 0.96 in Korea. It was also lower than the mean EQ-5D index value reported for the sample aged 85 + by the above-mentioned study from the Netherlands (0.86; Dutch TTO value set [17]), which might be due to the sample selection process mentioned. To our best knowledge, no other TTO-based EQ-5D index values for general population samples aged 85 + have been reported yet.

As our sample of oldest-old individuals was much larger than in former surveys using the EQ-5D-3L in Germany [26, 28, 29], we were able to report data stratified by age groups with the age group 90 + still containing 275 individuals. In the age group 90 +, the frequency of problems with usual activities, self-care, and mobility was substantially higher compared to the age group 85–89, whereas there was no increase in problems with pain/discomfort or anxiety/depression, and the EQ VAS score was slightly lower. These associations were confirmed by multiple regression analysis controlling for gender, living situation, marital status, and education. With respect to the associations of age group and problem frequencies, our results are in line with findings of the above-mentioned study from Switzerland [16] which—to our best knowledge—is the only other study reporting EQ-5D data stratified by the age groups 85–89 and 90 + of a general population sample. Yet, in the Swiss study the EQ VAS score did not decrease by age group.

As consistently reported by general adult population surveys using the EQ-5D [13, 16–18, 26], women tended to report more problems in EQ-5D dimension and lower EQ VAS scores than men, even after controlling for age, living situation, marital status, and education in multiple regression analyses.

Not surprisingly, compared to community-dwelling individuals, individuals living in nursing homes or old people's homes reported significantly more problems in all EQ-5D dimensions except for pain/discomfort, resulting in a significantly lower EQ-5D index scores in multiple regression analyses. This is in line with other studies reporting worse quality of life in institutionalized individuals compared to community-dwelling individuals which presumably is largely due to increased functional impairment of individuals living in nursing homes or old people's homes [30, 31]. Unadjusted mean EQ VAS, and EQ-5D index-DE and EQ-5D index-UK scores in institutionalized individuals vs. community-dwelling individuals were 59.2 (SD 18.0) vs. 63.2 (SD 18.9), 0.67 (SD 0.29) vs. 0.79 (SD 0.22), and 0.56 (SD 0.33) vs. 0.70 (SD: 0.26), respectively (always $p < 0.001$, data not shown in tables).

The negative associations found in our sample between high education and problems in self-care, and between being single and problems with mobility are difficult to explain as evidence from other studies is inconsistent [16, 32–36].

Strengths and limitations

To our best knowledge, this is the first study reporting EQ-5D scores for a large population-based sample of oldest-old individuals including institutionalized individuals. Recruiting representative samples of individuals aged 85 + for surveys is difficult because a substantial proportion of eligible persons might be reluctant to participate due to illness and impairment, might have cognitive problems to provide informed consent, or might be difficult to approach when living in nursing homes or old people's homes. In our study, we used a cohort which had been recruited 10 years earlier and to which a long-standing trustful relationship had been built up which, e.g., continued even after admission to a nursing home. The baseline sample of the AgeCoDe cohort was almost representative of older adults in Germany because subjects were recruited via GP offices which over 90% in this age bracket visit regularly [19, 37]. Yet, as the sample was recruited in six cities it might not be representative of the population living in rural areas. Due to exclusion criteria and possible participation bias, individuals in bad health states are likely to have been underrepresented at the time of recruitment (but might have had a high probability to die before FU wave 7). Furthermore, some attrition bias (e.g., individuals with severe cognitive impairment were more likely to drop out [38]) is likely to be present in the FU wave 7 used for the present analysis. However, the distribution of age, gender, and living situation was close to the general population aged 85 + in Germany: In our sample, 67% were female, 36% were aged 90 +, and 19% were institutionalized, whereas in the German general population aged 85 and above 69% were female, 32% aged 90 +, and 18% institutionalized in 2015 [39].

We used the British EQ-5D-3L value set in addition to the German one because the available German TTO-based value set was derived in a much smaller sample of the German general population ($n = 334$) [20]. Probably due to a lack of statistical power in the regression model used to estimate the German value set, moderate or severe problems in the dimension usual activities and moderate problems in the dimension anxiety/depression lead to no decrement in the valuation of respective health states. This methodological shortcoming, as well as possible cultural differences in preferences for health states between the German and the British population, resulted in substantially higher values of the German EQ-5D index compared to the British index.

Interestingly, differences between subgroups and regression coefficients tended to be similar for both value sets.

R^2 values reported in regression analyses tend to be rather low which indicates that socio-demographic factors explain only a small proportion of variance in health status. While other factors like chronic conditions, cognitive function, physical activity, or social network might increase R^2 values of regression models, we only included basic socio-demographic variables as these are likely to be available for population samples which our results might be compared to. Furthermore, it is worth stressing that the R^2 values have some major drawbacks. For example, they do not tell us whether the model is correctly specified or whether the coefficients are consistent [40].

In 2011, a five-response level version of the EQ-5D (EQ-5D-5L) [41] was introduced in order to increase sensitivity and to reduce potential ceiling effects of original three-level version, and respective EQ-5D-5L value sets have been published recently [42, 43]. However, the EQ-5D-3L is still being used frequently, and the British National Institute for Health and Care Excellence still recommends the 3L value set instead of the 5L value set for reference case analyses [44].

Conclusion

Based on a large population-based sample of oldest-old individuals, this study provides EQ-5D scores for the oldest-old population in Germany. The results show a substantially impaired health status of the oldest-old population. The data can be used for comparing health status of population groups as well as for health economic models.

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Compliance with ethical standards

Conflict of interests All authors declare that they have no potential conflicts of interest.

Ethics approval The AgeCoDe and the AgeQualiDe study have been approved by the ethics committees of all participating study centers (Approval Numbers: Hamburg: OB/08/02, 2817/2007, MC-390/13; Bonn: 050/02; 174/02, 258/07, 369/13; Mannheim: 0226.4/2002, 2007-253E-MA, 2013-662N-MA; Leipzig: 143/2002, 309/2007, 333-1318112013; Düsseldorf: 2079/2002, 2999/2008, 2999; Munich: 713/02, 713/02 E) and comply with the ethical standards of the Declaration of Helsinki of 1975, as revised in 1983.

Informed consent All participants gave written informed consent prior to participation.

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