

# How Does Gender Influence Oral Health and Quality of Life?

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## Research

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# **Abstract**

## **Background**

In recent years, there has been an increase in the number of ageing people and women have a longer life expectancy compared to men. This study aims to compare oral health parameters and conduct a psychometric assessment using standardised questionnaires in a group of the elderly of both gender aged 65 and more.

## **Methods**

The survey involved 500 residents of Wroclaw, aged 65 and older, of both gender.

There was an oral and questionnaire examination performed. QoL was evaluated using Euro-Quality of Life, Oral Health Impact Profile-14 and Patient Health Questionnaire, which were validated for the Polish population. The relationship strength between psychometric scale scores and sociodemographic and clinical factors was determined by calculating Spearman's linear correlation coefficient values and regression coefficient values.

## **Results**

The prevalence of xerostomia assessed by the Challacombe scale was diagnosed significantly more frequently in women than men. (36.9% vs. 25.5%; p = 0.076). The men were significantly more likely to have high treatment needs (36.1% vs. 26.9%; p = 0.032) and they required urgent dental treatment (7.2% vs. 2.8%; p = 0.022). There were no statistically significant differences in terms of QoL evaluated by EQ-5D, EQ-5D VAS or OHIP-14 questionnaires in both subgroups ( $6.7 \pm 1.9$  vs.  $7.1 \pm 2.2$ ,  $66.1 \pm 18.6$  vs.  $67.9 \pm 20.9$ ,  $8.5 \pm 14.0$  vs.  $7.2 \pm 12.9$ ; p > 0.05). Only women had higher severity of depressive symptoms measured using the PHQ-9 questionnaire ( $4.0 \pm 4.1$  vs.  $2.8 \pm 3.8$ ; p < 0.001).

## **Conclusion**

It can be concluded that the independent predictors which significantly affect the high QoL scores on the EQ-5D scale were found to be female gender, age below 75, high or middle income, independence in daily life, a low number of comorbidities, lack of oral treatment needs.

## **Background**

Quality of life is a broad, multifaceted concept that is of interest not only in the field of psychology, philosophy, and also medicine. The concept of quality of life (QoL) encompasses several important criteria that have a significant impact on the evaluation of its level, including physical, material, social, emotional well-being as well as satisfaction with one's own productivity. A person's QoL is also affected by their health and psychological well-being. This is because illness can affect a sense of QoL on many simultaneous levels [1, 2, 3].

In recent years, there has been an increase in the number of ageing people, especially in highly developed countries. It is conditioned by the increasing length of life as a result of civilisation progress with a simultaneous decline in births, resulting in an increase in a percentage of the population of the elderly compared to younger persons. Life expectancy is a demographic data element that is frequently used and analysed in all countries. It represents the average life expectancy at birth and it results from the overall health of a country's population. Women have a longer life expectancy compared to men. The reason for this variation is not fully explained; biological factors have been suggested, as well as the fact that men more often undertake work of a particularly hazardous nature or pursue riskier activities [4, 5]. Currently in Poland, the average life expectancy for women is 80.2 years and for men – 71.5 years (a difference of 8.7 years) [6, 7, 8].

As overall health and oral health deteriorate with age, the WHO has for many years advocated for actions on health promotion for the elderly population as a target group. Hence, active ageing is about healthy ageing, active participation in society, fulfilment in professional life and independence in daily life [9]. As regards scientific grounds for longer survival expectancy for women, the presence or absence of differences between individuals of both sexes in terms of basic oral health parameters, as well as in terms of perception of QoL, overall health and emotional state, seems to be an interesting issue. Although the assessment of basic oral health parameters seems certain by routinely used clinical indicators of hard tissue diseases and periodontal diseases, the evaluation of QoL and selection of appropriate tools may be more problematic. A vast number of standardised questionnaires were developed to examine QoL, with particular emphasis on health [9, 10, 11].

This study aims to compare oral health parameters and conduct a psychometric assessment using standardised questionnaires in a group of the elderly of both gender aged 65 and more.

## Methods

### Study design

The presented observational study was carried out as part of the project "Oral Health and Quality of Life in Old Age: A Cross-Sectional Pilot Project in Germany and Poland" in cooperation between Municipal Council and the University Hospital Carl Gustav Carus in Dresden, Germany. The Polish population was examined over the period of 24 months after obtaining the consent of the Bioethics Committee of Wroclaw Medical University. The study was supported by Municipal Council resources as part of the project "Oral Health and Quality of Life of Elderly Residents of Wroclaw" (financial agreement P/ZJU/1/2015-2017) in accordance with the STROBE guidelines (Strengthening the Reporting of Observational Studies in Epidemiology) [12].

### Participants

The study involved randomly selected participants ( $n = 1338$ ), both men and women, aged between 65 and 99. However, 41.0% ( $n = 549$ ) did not respond to the study invitation, 6.6% ( $n = 88$ ) did not provide

written consent to take part in the study and 15.0% ( $n = 201$ ) were excluded due to the presence of systemic diseases in which periodontal probing, leading to transient bacteremia, might have posed a risk to the patient's overall health, particularly in the subjects diagnosed with cardiovascular diseases (patients with heart valves, after a heart transplant, with congenital heart diseases or infective endocarditis), blood diseases (thrombocytopenia, haemophilia, von Willebrand disease), viral diseases (B and C type hepatitis, AIDS/HIV), as well as subjects with Multi-Drug Resistant Organisms (MDRO). That is why 500 participants were ultimately included in the study (Fig.1).

The inclusion criteria consisted of age – 65 and more, place of living (local resident), the ability to communicate and provision of written consent to participate in the survey. The exclusion criteria included concurrent systemic diseases, in which periodontal probing, leading to transient bacteremia, might have posed a risk to the patient's overall health, failure to provide written consent to participate in the survey and the occurrence of mental disorders which render the completion of a questionnaire impossible. All participants involved were obliged to provide written informed consent and completed questionnaire, as well as demonstrate cooperation during the clinical oral examinations. Participants who did not fulfil the inclusion criteria were excluded from the study.

#### Ethical permission

The study protocol was approved by the Bioethics Committee of Wroclaw Medical University (permission no. KB 420/2015) under the Declaration of Helsinki. Participation in the study was voluntary and anonymous, and the collected data were treated confidentially.

#### Sample size estimation

Data on the total number of residents aged 65 and more were derived from Statistics Poland (Demographic Yearbook of Poland 2015) [13]. The sample size was calculated based on the data concerning the number of individuals in this age group who live in the city. With such an assumption, a 95% level of confidence and  $\pm 5\%$  margin of error, a minimum sample size consisted of 384 participants[14].

#### Oral examination

Evaluation of oral health was conducted by two examiners. Each examiner was asked to study the same group of 10 patients. The findings were then compared with those of the experienced supervisor. The value of the inter-examiner kappa coefficient amounted to 0.874 while the intra-examiner kappa coefficient was 0.870.

Oral examination was performed using artificial light, a plane dental mirror and a ball-ended probe (WHO CPI probe). Coronal and root caries were evaluated according to the World Health Organisation (WHO) criteria, DMFT values and their components. Periodontal health was assessed in individuals who had more than 2 natural teeth by measuring bleeding on probing (BoP) of 6 sites, gingival pocket depth (PD), clinical attachment loss (CAL) [15] and tooth mobility according to the Miller index. Dental prosthetic

status was assessed by taking into account the number of functional tooth units of natural and artificial teeth on implant-supported and fixed prostheses (non-functional tooth units), as well as the information on whether the participants wore partial or complete removable dentures. Based on the clinical oral examination, a patient's treatment needs were determined and categorised on a 5-grade scale: no treatment need, preventive treatment, prompt treatment, immediate treatment or referral.

Moreover, xerostomia (oral dryness) was examined using the Challacombe scale (Clinical Oral Dryness Score, CODS). The level of dryness was categorised based on the number of symptoms observed as mild (1-3), moderate (4-6), or severe (7- 10) [16, 17].

#### Questionnaire study

QoL was evaluated using three inventories – Euro-Quality of Life (EQ-5D-3L), Oral Health Impact Profile-14 (OHIP-14) and Patient Health Questionnaire (PHQ-9), which were validated for the Polish population [18,19, 20].

EQ-5D-3L is a brief, five-item instrument (mobility, self-care, usual activities, pain/discomfort, anxiety/depression) with three response options (no problems, some problems, extreme problems), resulting in 243 health states. Moreover, a visual analogue scale (EQ-VAS) was used for the evaluation of the health-related quality of life (HRQoL) [18, 21].

OHIP-14 consisted of 14 questions related to problems occurring within 1 year: 1) trouble with pronouncing words, 2) worsened taste, 3) pain, 4) discomfort while eating, 5) self-consciousness, 6) emotional tension, 7) unsatisfactory diet, 8) interrupted meals, 9) difficulty with relaxing, 10) embarrassments, 11) irritability, 12) inability to complete everyday tasks, 13) reduced satisfaction with life, 14) complete inability to function. The questions corresponded to 7 dimensions: functional limitation, pain, psychological discomfort, physical disability, psychological disability, social disability and handicap. The frequency of occurrence within 1 year was assessed using the five-point Likert scale: 0 – never, 1 – rarely, 2 – occasionally, 3 – frequently, 4 – very often. All values were summed to calculate the total OHIP-14 score which could vary between 0 and 56; whereby the higher the OHIP-14, the poorer the OHRQoL [22].

PHQ-9 is a questionnaire consisting of 9 basic questions and one additional question. The answer to each question is scored on a scale ranging from 0 to 3, depending on the frequency of occurrence of a given symptom in the last 2 weeks (3 points indicate the most frequent occurrence of the symptom). The Polish version of PHQ-9, used in the presented study, is available at <http://www.phqscreeners.com> by Pfizer Inc. Diagnosis includes the following severity stages: 0-4 - none, 5-9 - mild depression, 10-14 - moderate depression, 15-19 - moderately severe depression, 20-27 - severe depression [23].

#### Statistical analysis

The obtained questionnaire results and results of clinical trials were statistically analysed using STATISTICA v. 12 software (StatSoft, Inc.). Qualitative, nominal and ordinal variables are shown in tables

in terms of sample size (n), set size (N) and proportion (%). The Pearson's chi-squared ( $\chi^2$ ) test of independence was used for the assessment of the relationship strength between nominal and ordinal variables. In the case of quantitative variables, arithmetic means (M), standard deviations (SD), medians (Me), lower quartiles (Q1) and upper quartiles (Q3) were calculated and ranges of values from smallest to largest were provided. The normality based on the empirical distributions of the quantitative variables was checked using the Kolmogorov-Smirnov test. Hypotheses concerning the lack of differences between the mean values in two subgroups (women/men) were verified using the non-parametric Mann-Whitney U test of significance. The relationship strength between the EQ-5D-3L, EQ-VAS, OHIP-14, and PHQ-9 psychometric scale scores and sociodemographic and clinical factors was determined by calculating Spearman's linear correlation coefficient values (rho) and regression coefficient values (b). A t-test based on the Student's t-distribution with n-1 degrees of freedom was used for verifying the significance of the Pearson's correlation coefficient. Furthermore, the reliability analysis of each psychometric scale used in the study was conducted by calculating both the Cronbach's alpha coefficient value and the mean correlation between the items and the final score. In all statistical tests,  $p<0.05$  was taken as the critical value.

## Results

### 1. Characteristics of the surveyed patient group

The survey involved 500 residents of Wroclaw, aged 65 and older, of both gender. The mean age of the respondents was 74.4 years. The division of the survey participants according to gender was based on the personal questionnaire and ticking the appropriate box by the respondent. Women made up 64% of the total number of the surveyed group and their mean age was 74.6 years. Most respondents lived together with relatives (female-64.1%, male-58.3%) and did not require assistance with daily activities (female-91.3%, male-90%). Individuals who live alone made up approximately 40% of the total respondents in both subgroups. Individuals with secondary education (female-55.3%, male-43.3%,  $p = 0.03$ ) and average income per household (female-48.4%, male-39.4%) prevailed in the surveyed subgroups (Table 1).

Table 1  
Sociodemographic characteristic of participations

Variable	female	male	P value
Age (years):	320(64.0%)	180(36.0%)	p > 0.05
$M \pm SD$	74.6	73.9	
Living with:			
Alone	115 (35.9%)	75 (41.7%)	p > 0.05
Other people	205 (64.1%)	105 (58.3%)	
Living conditions:			
Home without help	292 (91.3%)	162 (90%)	p > 0.05
Home with help or residence	28 (8.7%)	18 (10%)	
Income:			
Low	80 (25%)	48 (26.7%)	p > 0.05
Medium	155 (48.4%)	71 (39.4%)	
High	80 (25%)	57 (31.7%)	
No answer	5 (1.6%)	4 (2.2%)	
Education level:			
Low	45 (14.1%)	36 (20%)	p = 0.03
Medium	177 (55.3)	78 (43.3%)	
High	98 (30.6)	66 (36.7%)	
Number of comorbidities			
$x \pm SD$	1.9 ± 3.0	2.2 ± 3.0	p = 0.006
M - arithmetic means;			

SD - standard deviation;

Me - median;

Q1 - lower quartile (25th percentile);

Q3 - upper quartile (75th percentile);

Min - the smallest value;

Max - the largest value;

(%) - percentage.

Women suffered from fewer comorbidities compared to men ( $1.9 \pm 3.0$  vs.  $2.2 \pm 3.0$ ;  $p = 0.006$ ) and were more likely to suffer from hyperthyroidism (22.2% vs. 4.4%;  $p < 0.001$ ) while men were significantly more likely to receive treatment due to genitourinary diseases (15.6% vs. 6.3%;  $p = 0.001$ ) (Table 2).

Table 2  
Frequency of systemic diseases

Systemic disease	female		male		P value
	n/N	%	n/N	%	
Cardiovascular	211/320	65.9%	108/180	60.0%	0.219
Diabetes	70/320	21.9%	39/180	21.7%	0.953
Respiratory system	29/320	9.1%	8/180	4.4%	0.086
Digestive system	44/320	13.8%	19/180	10.6%	0.372
Blood disease	1/320	0.3%	2/180	1.1%	0.295
Thyroid disease	71/320	22.2%	8/180	4.4%	< 0.001
Genitourinary system	20/320	6.3%	28/180	15.6%	0.003
Bone structure	21/320	6.6%	6/180	3.3%	0.184
Rheumatoid diseases	49/320	15.3%	24/180	13.3%	0.639
Cancer	18/320	5.6%	11/180	6.1%	0.821
Pearson's chi-square test of independence;					

U Mann-Whitney significance test

## 2. Clinical trial

### 2.1 DMFT index

There were no statistically significant differences between men and women in terms of the number of healthy, extracted, and filled teeth ( $4.4 \pm 4.7$  vs.  $4.8 \pm 5.4$ ,  $19.0 \pm 9.6$  vs.  $19.1 \pm 9.5$ ,  $7.4 \pm 6.4$  vs.  $6.3 \pm 6.3$ ;  $p > 0.05$ ) and DMFT index ( $27.6 \pm 4.7$  vs.  $27.2 \pm 5.4$ ;  $p > 0.05$ ). At the same time, the mean number of decayed teeth was significantly higher in men ( $1.2 \pm 2.4$  vs.  $1.9 \pm 3.2$ ,  $p = 0.034$ ).

### 2.2 Periodontal status

There were no statistically significant differences between men and women in terms of tooth mobility ( $p > 0.05$ ), gingival pocket depth ( $p > 0.05$ ) and the level of clinical attachment loss ( $p > 0.05$ ).

### 2.3 Oral hygiene

The mean BoP index (according to Ainamo and Bay, 1975) was  $53.0\% \pm 100.0$  in women and  $60.08 \pm 100.0$  in men, indicating poor oral hygiene.

#### 2.4 Oral dryness

In the case of the evaluation of the prevalence of xerostomia (dry mouth), mild xerostomia evaluated by the Challacombe scale was diagnosed significantly more frequently in women (36.9% vs. 25.5%;  $p = 0.076$ ). Its most typical sign was dental mirror sticking to the buccal mucosa, which also occurred significantly more frequently in the female group (30.6% vs. 18.3%;  $p < 0.01$ ).

#### 2.5 Prosthetic status

Women did not differ significantly from men in terms of the frequency of use of removable dentures ( $p > 0.05$ ). Moreover, the mean number of own teeth in the maxilla (including teeth located under prosthetic crowns, pontics and implants) in contact with the mandibular (lower) teeth was similar in both subgroups (Table 3).

Table 3  
Oral health parameters

Gender	female $x \pm SD$	male $x \pm SD$	P value
Number of natural teeth	13.0 ± 9.6	13.0 ± 9.5	0.954
DMFT	27.6 ± 4.7	27.2 ± 5.4	0.826
DT	1.2 ± 2.4	1.9 ± 3.2	0.034
MT	19.0 ± 9.6	19.1 ± 9.5	0.954
FT	7.4 ± 6.4	6.3 ± 6.3	0.073
Teeth wear number	5.6 ± 9.0	6.5 ± 10.5	0.321
Number of occluding teeth	4.8 ± 9.0	4.6 ± 9.0	0.741
Bleeding on Probing (% sites)	53.0 ± 100.0	60.8 ± 100.0	0.113
Pocket Depth	3.7 ± 4.1	3.7 ± 4.1	0.579
CAL (mm)	4.2 ± 5.0	4.2 ± 5.0	0.492
Movable teeth number	0.6 ± 0.0	0.8 ± 0.0	0.209
	n/N (%)	n/N (%)	
Partial movable prosthesis in maxilla	104/320 (32.5%)	50/180 (27.8%)	0.480
Partial movable prosthesis in mandible	86/320 (26.9%)	44/180 (24.4%)	0.856
Total movable prosthesis in maxilla	80/320 (25.0%)	45/180 (25.0%)	0.917
Total movable prosthesis in mandible	77/320 (24.1%)	36/180 (20.0%)	0.469
Oral dryness	118/320 (36.9%)	46/180 (25.5%)	0.076
The chi-square statistic with Yates correction			

## 2.6 Treatment needs

When assessing treatment needs in the surveyed group, it was found that men were significantly more likely to have high treatment needs (36.1% vs. 26.9%; p = 0.032) and they required urgent dental treatment (7.2% vs. 2.8%; p = 0.022) (Table 4).

Table 4  
Treatment needs

Code	Intervention urgency	female		male		P value
		n/N	%	n/N	%	
0	no treatment need	39/320	12.2%	13/180	7.2%	0,011
1	preventive treatment	185/320	57.8%	89/180	49.4%	
2	prompt treatment	86/320	26.9%	65/180	36.1%	
3	immediate treatment	9/320	2.8%	13/180	7.2%	
4	referral	1/320	0.3%	0	0.0%	

### 3. Questionnaire survey

There were no statistically significant differences in terms of QoL evaluated by EQ-5D, EQ-5D VAS or OHIP-14 questionnaires in both subgroups ( $6.7 \pm 1.9$  vs.  $7.1 \pm 2.2$ ,  $66.1 \pm 18.6$  vs.  $67.9 \pm 20.9$ ,  $8.5 \pm 14.0$  vs.  $7.2 \pm 12.9$ ;  $p > 0.05$ ). Only women had higher severity of depressive symptoms measured using the PHQ-9 questionnaire ( $4.0 \pm 4.1$  vs.  $2.8 \pm 3.8$ ;  $p < 0.001$ ) (Table 5).

Table 5  
Average values of psychometric tests

	female	male	P value
EQ-5D			
$M \pm SD$	$6.7 \pm 1.9$	$7.1 \pm 2.2$	0.089
$Me [Q_1; Q_3]$	6 [5; 8]	7 [5; 9]	
$Min - Max$	5–13	5–15	
EQ-5D VAS			
$M \pm SD$	$66.1 \pm 18.6$	$67.9 \pm 20.9$	0.174
$Me [Q_1; Q_3]$	70 [50; 80]	70 [50; 80]	
$Min - Max$	20–100	5–100	
OHIP-14			
$M \pm SD$	$8.5 \pm 14.0$	$7.2 \pm 12.9$	0.280
$Me [Q_1; Q_3]$	1 [0; 10]	0 [0; 8]	
$Min - Max$	0–56	0–56	
PHQ-9			
$M \pm SD$	$4.0 \pm 4.1$	$2.8 \pm 3.8$	< 0.001
$Me [Q_1; Q_3]$	3 [0; 7]	2 [0; 4]	
$Min - Max$	0–21	0–17	
M - arithmetic means;			

SD - standard deviations;

Me - median;

Q1 - lower quartile (25th percentile);

Q3 - upper quartile (75th percentile);

Min - the smallest value;

Max - the largest value;

p – significance level according to the non-parametric U Mann-Whitney test

When considering the relationships between the questionnaires used, a positive correlation was observed between the OHIP-14 questionnaire and the questionnaires such as EQ-5D ( $\rho = 0.242$ ,  $p < 0.001$ ), EQ-5D VAS ( $\rho = -0.123$ ,  $p = 0.01$ ) and PHQ-9 ( $\rho = 0.334$ ,  $p < 0.001$ ).

### 3.2 Linear regression analyses

In the case of the univariate analysis, the predictors of the better QoL assessed using the EQ-5D questionnaire included female sex, age below 75, independence in daily life, a low number of comorbidities (less than 2), as well as high or middle income and higher or secondary level of education. As regards the oral health parameters, the predictors of the better QoL using the EQ-5D questionnaire included low OHIP-14 scores, lack of xerostomia, no treatment need or preventive treatment need.

According to the results of the multivariate linear regression analysis between QoL assessed using the EQ-5D questionnaire and significantly differentiating parameters, the independent predictors which significantly affect high QoL scores on the EQ-5D scale included female gender, age below 75, living at home without required assistance, mild depression assessed using the PHQ-9 questionnaire, high or medium income, no oral treatment needs (Table 6). The fit of the proposed model to the measurement results is satisfactory:  $F(7.492) = 38.9$ ,  $p < 0.001$ ; the multiple correlation coefficient of the model is  $R = 0.597$ , the mean of squared residuals is  $MSE = 2.70$ .

Table 6  
Predictors of QoL assessed by EQ-5D questionnaire – values of linear regression coefficients

Predictors	Univariate		Multivariate	
	regression <b>b</b>	regression <b>p</b>	regression <b>beta</b>	regression <b>p</b>
Female	0.188	0.049	<b>0.284</b>	<b>&lt; 0.001</b>
Age lower than 75 years	0.582	< 0.001	<b>0.297</b>	<b>&lt; 0.001</b>
Living home without help	1.226	< 0.001	<b>0.845</b>	<b>&lt; 0.001</b>
Income medium or high	0.556	< 0.001	<b>0.284</b>	<b>0.001</b>
Frequency of systemic diseases	0.600	< 0.001	<b>0.422</b>	<b>&lt; 0.001</b>
No treatment or preventive treatment need	0.403	< 0.001	<b>0.232</b>	<b>0.004</b>
OHIP-14	0.022	0.001	-	> 0.05
PHQ-9	0.197	< 0.001	<b>0.147</b>	<b>&lt; 0.001</b>

## Discussion

Population ageing is a global phenomenon. With advances in medicine and prolonged life expectancy, the proportion of the elderly population will continue to grow worldwide. According to the United Nations prognosis, the number of the elderly population (aged 65 and more) between 2019 and 2050 will grow worldwide approximately by 120% (from 9.5–15.9%), while in Europe and Northern America approximately by 48% (from 18.0–26.1%) [24]. Conventionally, the elderly population is defined as people aged 65 and more [25]. In Poland, the proportion of the elderly population in 2008 was 13.5% and 10 years later it increased up to 17.5% [26]. In subsequent years, compared to 2010, the number of people aged 80 and older will increase significantly in Poland (2010–4.46%, 2060–13.08%). Similar demographic changes will occur in 27 EU countries (2010–4.66%, 2020–5.70%, 2060–12.13%) [5, 6, 7, 8].

The increase in the elderly population caused by prolonged life expectancy requires special attention to various health-related variables that influence their QoL [27]. Old age is related to an increase of chronic diseases and disabilities, oral and dental problems as well as some physiological changes. The main oral diseases (dental caries and periodontal diseases) are usually progressive and cumulative with age. It has been evidenced by the close bi-directional relationship between oral and overall health, as well as by an impact of oral health on QoL. That is why the oral health-related quality of life, OHRQoL, is an integral part of overall health and psychological well-being. It is a multidimensional construct that includes a subjective evaluation of an individual's oral health, functional well-being, emotional well-being, expectations and satisfaction with care, and sense of self [28].

The available standardised questionnaires, measuring QoL including health status, allow choosing an adequate tool for the psychometric assessment of a specific research group. Questionnaires are divided into general and specific. The former questionnaires are used for the assessment of the relationship between the patient's health status and numerous factors such as family relationships, emotional state, occupational activity. The latter questionnaires are divided into two categories. The first category analyses specific spheres of the patient's functioning (*domain-specific*). The second category analyses factors resulting from the disease itself (*disease-specific*). This category is important because of its ability to assess the patient's well-being, the severity of symptoms, the impact of the disease on both emotional state and daily – social and occupational – activities [29]. There are numerous questionnaires available for measuring OHRQoL, however, the most frequently used questionnaires include Geriatric Oral Health Assessment Index (GOHAI) and Oral Health Impact Profile (OHIP) containing 49 or 14 items (OHIP-49, OHIP-14). In the literature, the studies concerning gender differences in terms of oral health showed that women exhibited more positive oral health attitude and oral health behaviour (tooth brushing frequency; using dental floss; regular dental visits) [30]. This confirms the conclusions obtained in the present study in which the male respondents had greater oral treatment needs [31, 32] compared to the group consisting of older women. Despite a complex etiopathogenesis of two main oral diseases, studies showed higher caries rates in women [33] and higher prevalence of gingivitis and periodontitis in men [34].

In contrast, the present study found that men had a significantly higher mean number of decayed teeth and the assessment of periodontal parameters of the elderly of both gender showed no statistically

significant differences. Similarly, in their study concerning the periodontal status among the Indian elderly, Marya et al. [35] observed no significant differences in the periodontal status among men and women. There were no statistically significant differences between both gender in terms of the prevalence of gingival bleeding, periodontal PD, and tooth mobility in the surveyed population.

Oral diseases adversely affect the overall health and QoL. A well-functioning dentition is crucial for the elderly since it supports main functions such as eating, speaking, smiling and socialising. The consequences of untreated dental caries and periodontal diseases are related to overall health and psychological well-being [36]. The results of the presented study showed that low OHIP-14 scores and female gender were predictors of QoL assessed using the EQ-5D questionnaire. These study results are in contrast to Marya et al.'s [35] who observed that OHRQoL was better in men.

The study conducted at another Polish university centre and involving a similar age group of older people showed a correlation between OHIP-14 for both gender and age, several extracted teeth, DMF, several present teeth [37]. A study involving British 65-year-olds found that gender was not significantly related to OHIP-14 [38]. Saintrain et al. [39] and Chen Yu-Fen [40] observed no significant differences in OHIP-14 scores for both gender either. The similar results were obtained by Saxena et al. [41] who found no significant differences between men and women in individual OHIP – 14 domains. Dallasta et al. [42] who studied women aged 60 and more, recorded the highest values for "physical pain" =  $1.98 \pm 1.41$ , "psychological distress" =  $1.83 \pm 1.92$  and "physical disability" =  $1.63 \pm 1.53$ .

In our study, women were found to have higher severity of depressive symptoms measured using the PHQ-9 questionnaire. Besides, the predictors which significantly affect HQoL scores on the EQ5D scale were identified as low levels of depression assessed using the PHQ-9 questionnaire.

When it comes to the PHQ-9 scale, other Polish studies involving a younger age group, with a mean age of 41 years, found no significant differences in scores obtained by 54 women and 45 men [20]. In contrast to the above-mentioned studies, Shin et al.'s [43] study involving a Korean population of men and women of different ages found that mean PHQ-9 scores were significantly lower in men in all age groups and there was an upward trend in the mean PHQ-9 scores as age increased in studied age groups. The study results concerning Korean women aged 19 and older also showed a correlation between PHQ-9 and EQ-5D, which coincides with the results of the present study.

Several limitations need to be taken into account in a discussion concerning the results of the present study. Firstly, the study was conducted using a self-reported questionnaire to report data such as EQ-5D, PHQ-9, OHIP-14, which might have led to identification bias. However, some studies proved that the questionnaire could be used as a valid and reliable method. Secondly, the use of survey data did not allow us to explain temporal relationships nor to show inferences on causality. Thirdly, when analysing the obtained results, it is essential to bear in mind a possible self-selection error of the study participants – those who participated in the study were concerned about their dental problems or were aware of those problems and they were looking for help. Moreover, some persons may have refused to participate in the study due to their dental fear. Another interfering factor was related to the use of exclusion criteria. The

study was limited by the exclusion of patients with concurrent systemic diseases in whom periodontal probing, leading to transient bacteremia, might have posed a risk to their overall health. That exclusion criterion involved many patients in this age group. Finally, the exclusion of patients with a mental disorder might have constituted another interfering factor.

## Conclusions

A study conducted on a group of the Polish elderly population showed significant differences in education and income levels between men and women, which were found to be positive predictors for the evaluation of QoL using the EQ-5D questionnaire. Furthermore, male respondents suffered from more systemic diseases compared to women, as well as they had greater oral treatment needs and a statistically more decayed teeth. Depression and xerostomia were most frequently diagnosed in women. Low levels of depression assessed using the PHQ-9 questionnaire were related to high QoL scores on the EQ-5D scale. It can be concluded that the independent predictors which significantly affect the high QoL scores on the EQ-5D scale were found to be female gender, age below 75, high or middle income, independence in daily life, a low number of comorbidities, lack of oral treatment needs.

In recent years, we have been observing an increasing number of the elderly in society, especially older single woman. That indicates the need to identify activities improving quality of life people in post-production age.

## Abbreviations

QoL - Quality of Life

OHRQoL - Oral Health-Related Quality of Life

EQ-5D-3L - Euro-Quality of Life

PHQ-9 - Patient Health Questionnaire

OHIP-14 - Oral Health Impact Profile 14

DMFT- Decayed Missing Filled teeth index

DT- Number of Decayed Teeth

MT- Number of Missing Teeth

FT-Number of Filled Teeth BoP- bleeding on probing

PD- gingival pocket depth

CAL- clinical attachment loss

SES – socioeconomic status

## Declarations

### ETHICS APPROVAL

The study protocol was approved by the Bioethics Committee of Wroclaw Medical University (permission no. KB 420/2015) in accordance with the Declaration of Helsinki.

### CONSENT TO PARTICIPATE

All participants involved were obliged to provide written informed consent. Participants who did not fulfil the inclusion criteria were excluded from the study.

### CONSENT FOR PUBLICATION

Not applicable

### AVAILABILITY OF DATA MATERIAL

The datasets used and analysed during the current study is available from the corresponding author on reasonable request.

### COMPETING INTERESTS

The authors declare that they have no competing interests.

### FUNDING

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### AUTHORS' CONTRIBUTIONS

K S-M designed the study, analysed and interpreted the data, gathered and reviewed literature, drafted the work and approved the final version. U K revised the work critically for important intellectual content, and contributed to final approval of the version to be published. B M contributed to the acquisition, analysis and interpretation of data and final approval of the version to be published.

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## Figures

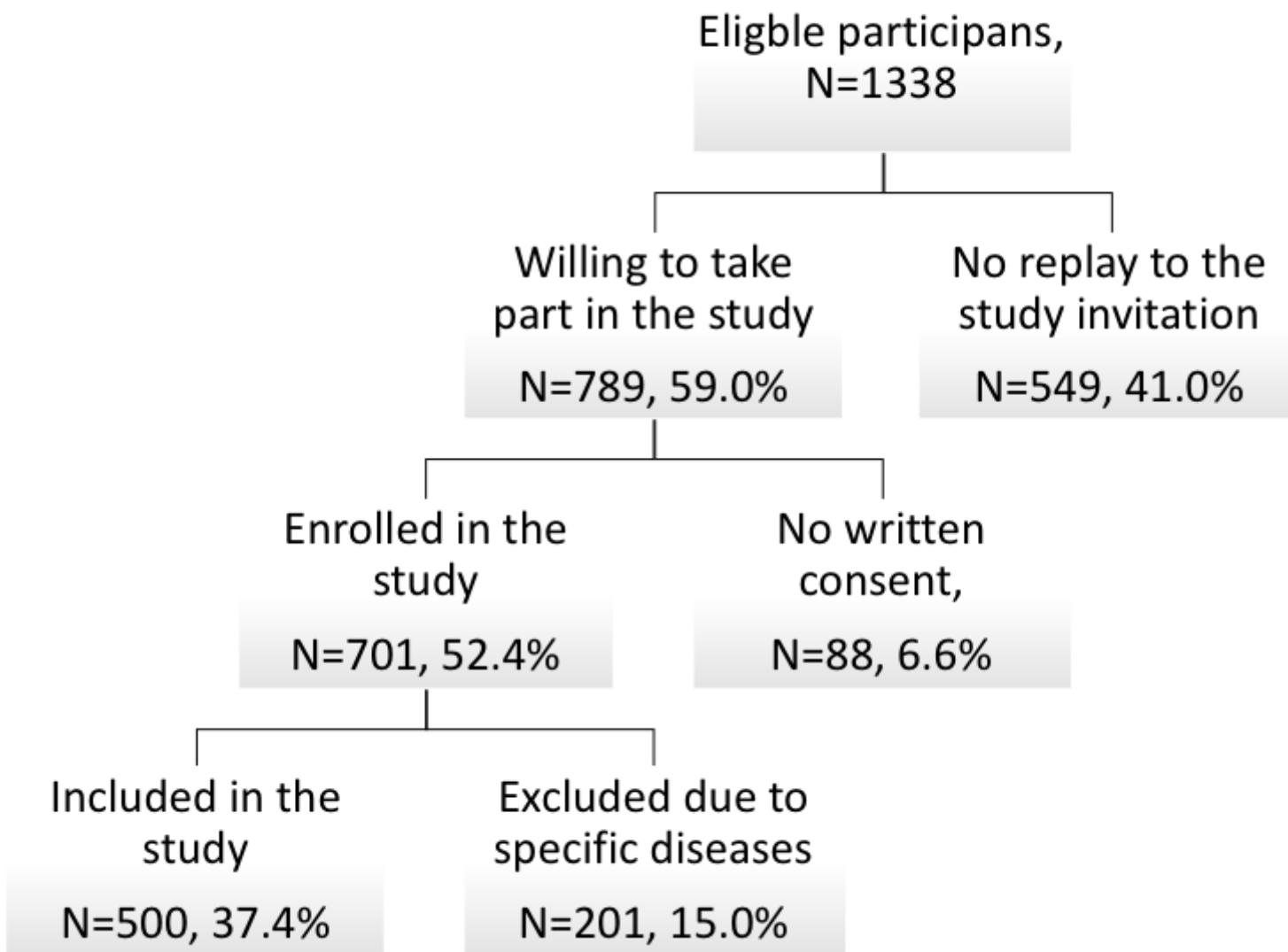


Figure 1

Flow of participants