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ORIGINAL ARTICLE

Impact of depressive symptoms on prosthetic status—results of the study of health in Pomerania (SHIP)

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Abstract
Objectives Previous investigations have confirmed that every fifth dental patient suffers from clinically significant depressive symptoms. However, the putative impact of depressive symptoms on the prosthetic status has not been addressed in these studies. The objective of this study was to investigate the association between depressive symptoms and prosthetic status based on data from the Study of Health in Pomerania (SHIP-0).
Methods Data from 2,135 participants aged 30 to 59 years were analyzed. A classification (six classes regarding the number and position of missing teeth per jaw) was used to identify the degree of prosthetic status (no/suboptimal/optimal tooth replacement). The presence of depressive symptoms was assessed with a modified version of von Zerssen's complaints scale. Screening for lifetime diagnoses of mental disorders was performed with the Composite International Diagnostic-Screener (CID-S). Multivariable logistic regressions including several confounders were calculated.
Results A significant protective dose–response effect of depressive symptoms on prosthetic status was found only in men for the lower jaw [0–1 depressive symptoms: odds ratio (OR)=3.84, 95 % confidence interval (CI, 1.65–8.92), $p<0.01$; 2–3: OR=2.87 (CI, 1.22–6.74), $p<0.05$; reference, ≥8; adjusted for age, school education, smoking status, household income, marital status, living without a partner, risky alcohol consumption, obesity, diabetes, and physical activity]. There was no such association in women or for the upper jaw. The analyses using the CID-S confirmed these results.
Conclusions In the lower jaw, men with depressive symptoms had a better prosthetic status than men without depressive symptoms suggesting a higher level of concern regarding their personal health.

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Clinical relevance If dentists might have an opportunity to identify men with depressive symptoms they can provide a wide range of treatment options that may enhance patients' self-esteem and contribute to the patient' well-being. Furthermore, depressive symptoms could indicate a discrepancy between self-perception of the dental health and the actual status which influence the dentists' treatment decision making.

Keywords Depressive symptoms · Mental health problems · Epidemiology · Prosthetic status · SHIP

Introduction

The loss of teeth is often associated with high levels of functional limitations and physical disability, affecting oral health-related quality of life [1, 2]. The quality of life is reduced in terms of disturbances of jaw function, food intake, phonetics, or aesthetics [3].

However, missing teeth can be replaced by prostheses. The type and extension of prosthodontic treatment depends on several factors, including the number and position of the remaining teeth, decisions on treatment needs determined by the dentist, and the individual patient demand.

Social behavioral and social network variables have an essential influence on prosthetic status (subject treatment need) [4, 5]. When adapted to patient's dental treatment needs, dental health care can affect the social acceptance and positive self-esteem by different pathways, e.g., raising self-esteem results in a higher health-related quality of life [6, 7] or reduction in the lack of desire to socialize because of missing unreplaced teeth and oral discomfort.

Mental disorders are a major public health problem across all age groups with prevalence rates of up to 30 % [8, 9]. The lifetime prevalence of mood disorders increases across all generations [9]. Depression negatively affects individuals' physical functioning and well-being [1]. In general, depression is associated with increased use of medical utilization in cross-sectional studies, but there is a lack of longitudinal studies to establish a causal relationship [10–12]. One in every five dental patients experiences clinically significant symptoms of depression [3]. An association between depressive symptoms and oral quality of life has been shown [1, 13] . Mental illness [14, 15] and related diseases [16–18] were associated with an increased need for dental health. Several studies have shown that depressive patients have difficulties adapting to new complete dentures [19–21]. To the best of our knowledge, however, an association between depressive symptoms and prosthetic status has yet to be investigated.

The objective of this study was to determine whether depressive symptoms affect the prosthetic status. We used data from the population-based Study of Health in Pomerania (SHIP-0). Our hypothesis was that subjects with depressive symptoms have a higher level of prosthetic status because of a higher level of worry concerning their personal health.

Materials and methods

Data collection

The study of Health in Pomerania (SHIP-0) is a population-based survey in northeast Germany [22] [23]. In 1995, the population in this area was 212,157. The sample was selected using the population registries in which all German citizens must be recorded. The two-stage cluster sampling method was adopted from the World Health Organization Monitoring Trends and Determinants in Cardiovascular Disease (MONICA) project in Augsburg, Germany [24]. First, the three cities (17,076 to 65,977 inhabitants) and the 12 towns (1,516 to 3,044 inhabitants) of the region were selected, and then, 17 of the 97 smaller towns (<1,500 inhabitants) were selected at random. Second, from each of these towns, German subjects with a primary residence in the area were selected at random, proportional to each community population size, and then stratified by age and sex. Thus, a representative sample of 7,008 adults aged 20 to 79 years (in 12 5-year age strata for both sexes, each including 292 individuals) was invited to participate. The net sample (without migrated or deceased persons) comprised 6,265 eligible subjects. Of all the subjects who agreed to participate, 4,308 (68.8 %) were Caucasian. Data were collected between October 1997 and May 2001. The medical and dental examinations took place in two medical/dental facilities in the cities of Greifswald and Stralsund, Germany.

The examination was performed by calibrated licensed dentists (alternating daily). Further details about the study [25] and the dental examinations [22] have been described previously. The study was approved by the Ethics Committee of the University of Greifswald, and all participants gave informed written consent to all study procedures.

Data assessment

Outcome and exposure measures

Oral examinations included the assessment of the dental and prosthetic status [22]. The maximum number of teeth was set to 32. A classification [26] was used to identify the degree of prosthetic replacement of missing teeth (no, suboptimal, optimal) as the dependent variable. Dental status was classified into six classes regarding the number and position of missing teeth per jaw (Table 1) [26].

Men and women with complete dentate or exclusively molars are missing (class 5 jaws) were excluded because a

Table 1 Classification and types of prosthetic replacement within the classes (Mundt et al. [26])

Class	0	1	2	3	4	5
Number and position of missing teeth per jaw	Edentulous	1–3 remaining teeth	Extended tooth bounded space (>3 posterior teeth or >4 anterior teeth are missing) or shortened dental arch with at least one missing premolar	Small anterior tooth bounded space (s) with 1–4 missing teeth	Small posterior tooth bounded space (s) with 1–3 missing teeth including at least 1 premolar	Remaining jaws (complete dentate or exclusively molars are missing)
Optimal prosthetic replacement	Complete denture	RPDP with metal framework	RPDP with metal framework	FDP	FDP	Prosthetic replacement not necessary
Suboptimal prosthetic replacement		RPDP without metal framework	RPDP without metal framework	RPDP	RPDP	

FDP fixed dental prostheses, *RPDP* removable partial dental prostheses

prosthetic replacement was not essential. Subjects with suboptimal (acrylic dentures in the classes 1 and 2 and all removable partial dental prostheses (RPDP) in the classes 3 and 4) or no replacement in classes 0 to 4 were considered to be cases. A jaw was also categorized as not replaced if a gap occurs in the anterior or premolar region of the prosthesis.

To analyze the association between depressive symptoms and prosthetic status, we used the von Zerssen scale as well as the Composite International Diagnostic -Screener (CID-S). Depressive symptoms were assessed with a self-administered questionnaire that included a modified version of the von Zerssen's complaints scale [27–29]. This scale was used to assess psychological and somatic symptoms by self-report on 38 items. The scale demonstrated a high internal consistency with Cronbachs alpha=0.927 and a split-half reliability of 0.912 (Spearman–Brown Coefficient; n=4,286) [30]. The severity of each symptom was rated on a four-point scale (none/mild/moderate/severe). From the eight factors of the scale reported in Konerding et al. [31], we chose the depressive/anxiety factor. To specify depressive symptoms, a psychiatrist (H.G.) excluded two items that typically assess anxiety symptoms (anxiety and irritability). The five items in our analyses comprised inner restlessness, insomnia, inner tension, dejection/depression, and brooding. The sum of these five items was used to generate the current "depression symptoms score". To overcome the assumption of a (log-) linear relation between depressive symptoms and the outcome, the score was grouped into five categories that were equally spaced except for eight or more depressive symptoms.

Lifetime depressed mood was assessed by the following two items of the CID-S referring to depression [32]: 1. "Did you ever in your life suffer from feelings of sadness or depressed mood for a period of at least two weeks?", and 2. "Did you ever in your life suffer from lack of interest, tiredness or loss of energy for a period of at least two weeks?". A priori, we restricted our analyses to the first question because the second question is related to exhaustion rather than depression.

Design options used to prevent confounding

Because of the important relationship between depressive symptoms and prosthetic status, we stratified the study sample by sex and excluded the data of 13 individuals who did not have an oral examination (Fig. 1). We included only participants aged 30 to 59 years to enhance homogeneity regarding the dental status and living conditions. Need for prosthodontic treatment was rare among the 20- to 29-year-old participants. The proportion of retired persons increased from <20 % among the 55- to 59-year-old participants to 90 % among the 60- to 64-year-old participants. Thus, participants older than 59 years were excluded because some psychosocial conditions change considerably upon retirement [33]. We additionally excluded subjects who did not live in the former German Democratic Republic (GDR) before 1989 to enhance homogeneity regarding the dental treatment options in the past (or over the life course), did not have prosthodontic treatment needs, with implants to enhance homogeneity regarding the prosthodontic treatment, and those with acrylic partial dentures which were not older than 1 year because the treatment seems not be completed, because these could be served as interim RPDPs after tooth extractions (misclassification; see Fig. 1 for more detail). Additionally, we excluded subjects who had missing data for potential confounders including dental history and depressive symptoms (von Zerrsen, CID-S).

Furthermore, we excluded participants who took antidepressants because we intended to determine depressive symptoms rather than manifested depression [34, 35]. The final study population for the analyses consisted of 1,299 participants for

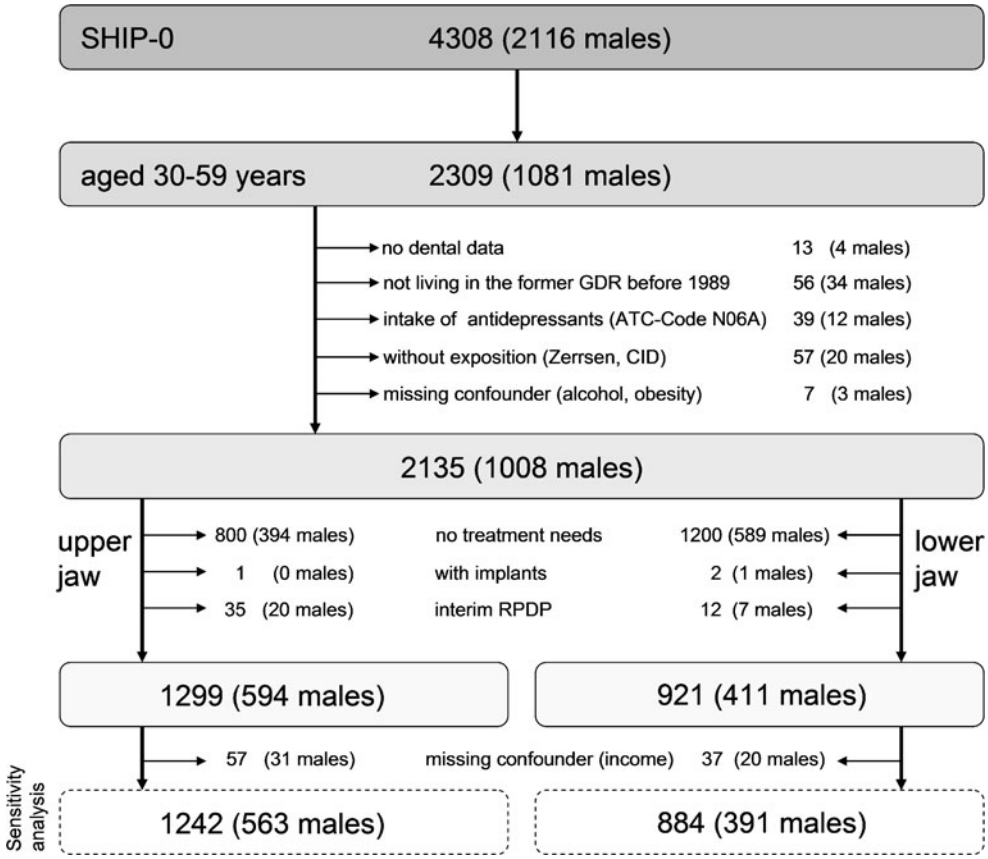

Fig. 1 Study population

the upper jaw and 921 subjects for the lower jaw. Because of missing data regarding income, which is a potential confounder, we excluded a total of 57 subjects for the upper jaw and 37 subjects for the lower jaw from sensitivity analyses.

Measurement of confounders

The following sociodemographic variables were selected from a computer-aided interview: gender, age, school education (<10 years of school, 10 years of school, >10 years of school), smoking status (never, ex-smoker, and current smoker), income per person living in the household (continuous variable, German marks; 1 Euro = 1.956 German Marks; divided by the square root of the number of people living in the household), marital status, and living without a partner. Risky alcohol consumption (>20 g/day alcohol per day for women and >30 g/day for men), self-reported physicians' diagnosis of diabetes mellitus, and level of physical activity (regularly, more than 1 h per week over the summer or winter) were also determined from the interview. During the medical examinations, height and weight were measured to calculate the body mass index (BMI). Obesity was defined as a BMI ≥30 kg/m^2. The following variables were taken from the oral interview and were included in the oral examination: reason for the last dental appointment (pain) and the last dental appointment (during the last 12 months, more than 1 year ago).

Statistical analyses

All analyses were performed using STATA/MP software, version 10.1 (StataCorp LP, College Station, TX, USA). The data on the quantitative characteristics are expressed as the mean and standard deviation. The data on the qualitative characteristics are expressed as percent values or absolute numbers as indicated. For continuous data, groups were compared using the Mann–Whitney *U* test, and nominal data were compared using Fisher's exact test.

Logistic regression analyses were performed to investigate the association between symptoms of depression and prosthetic status. The models were adjusted for potential confounders. We used the change in the coefficient of interest to estimate the effect of a confounder on the relationship between symptoms of depression and prosthetic status. A substantial change was considered to be present if the inclusion in the model led to a ≥10 % change in the odds ratio (OR) of the symptoms of depression. The first model was adjusted for age. The second model was additionally adjusted for school education, household income, and smoking status. Marital status, living without a partner, risky alcohol consumption, diabetes, physical activity, and obesity were additionally included as confounders in the third model. The proportion of missing values was higher than 5 % for the potentially important confounder of household income

(Table 3). Therefore, models with and without reported household income are presented.

The odds ratios and their 95 % confidence interval (CI) were calculated. A p value ≤0.05 was considered statistically significant.

Effects of gender differences on the relationship between prosthetic status and depressive symptoms were estimated by biological interaction, which is measured by departure from an additive model [36]. For the quantification of the magnitude of an interaction effect, the Relative Excess Risk due to Interaction (RERI) was calculated [37]. If the lower bound of the 95%CI of RERI was >0, then the two-sided p value for the interaction was significant at an α level of 0.05.

Results

Participant characteristics

Men with no or suboptimal prosthetic replacement in the upper jaw (n=273) or lower jaw (n=255) were younger, less educated (only upper jaw, Table 2), had a lower income (only lower jaw, Table 3), and had more frequent risky alcohol consumption than men with an optimal prosthetic treatment. With respect to dental status, men with no or suboptimal prosthetic replacement had fewer dental checks during the last year and had visited the dentist more often because of pain compared with men with optimal prosthetic replacement (Tables 2 and 3).

Differences in current depressive symptoms according to the von Zerssen's complaint list and lifetime depressive symptoms according to the CID-screening question were only observed in men for the lower jaw.

Women with no or suboptimal prosthetic replacement in the upper jaw (n=207) or lower jaw (n=234) were less physically active, more often obese, less educated (only lower jaw), and visited the dentist more often because of pain than women with an optimal prosthetic replacement. Neither groups differed significantly in any of the depressive symptoms.

Main analyses

We revealed a significant association between depression and no or suboptimal prosthetic status in the lower jaw in men (Table 4). In detail, the odds of no or suboptimal prosthetic status increases with decreasing number of depressive symptoms [0–1 symptoms: OR=3.80 (95%CI, 1.66–8.67); 2–3 symptoms: OR=2.92 (1.27–6.73); 4–5 symptoms: OR=2.00 (0.88–4.54); 6–7 symptoms: OR=2.23 (0.92–5.41); p_{trend}<0.01; reference, ≥8 symptoms; fully adjusted model for men without reported income]. Similar results were found in men with reported income (Table 4). No significant association was revealed for the lower jaw in women and for the upper jaw in both genders (Table 4).

Associations between depressive symptoms and no or suboptimal prosthetic status of the upper and lower jaw (Table S1) were indicated for the von Zerssen's complaint list and CID-S with p values for additive interaction for subjects with reported income and without reported income.

A significant association between depressive symptoms (assessed with CID-S) and the prosthetic status was observed in the lower jaw with an OR of 1.89 (95%CI, 1.06-3.36, p<0.01, age adjusted) in men but not in women (Table S2). We found no significant associations for the upper jaw in either genders (Table S2).

Ancillary analyses

Sensitivity analyses, including only subjects with reported income data, confirmed the main results of our analyses. The ORs increased following additional adjustment for the classification according to Mundt (data not shown: 0–1 symptoms: OR=6.51 (CI, 2.57–16.60), p<0.01; 2–3 symptoms: OR=3.98 (1.60–9.90), p<0.01; 4–5 symptoms: OR=2.53 (1.04–6.14), p<0.01; 6–7 symptoms: OR=2.79 (1.06–7.30), p<0.01, fully adjusted; without reported income).

Discussion

The present study investigated the possible associations of depressive symptoms and prosthetic status. We observed a strong effect with increasing numbers of depressive symptoms on prosthetic status in men. Our findings were specific for the lower jaw.

These findings are plausible for the following reasons. First, subjects with depressive symptoms may have a higher level of prosthodontic status because they worry more about their personal health. Second, in a depression model, an oral deficit has been described [38], which was associated with increased need of care, relationship, increased attention, and best possible care. Aesthetic appearance is more important in the upper jaw than in the lower jaw, which may explain, why patients with and without symptoms of depressions do not differ with respect to the prosthodontic status of the upper jaw. For the lower jaw, the aesthetic factor is not as important. Other factors have more influence. Depressive subjects might feel tooth loss as a mental and physical downfall. Tooth loss was found to have a negative impact on enjoying life and to perpetuate a negative self-image [39]. Therefore, patients with depressive symptoms may be more critical and dissatisfied with their own appearance and be more interested in receiving optimal prosthodontic replacement in order to increase the subjective rehabilitation and improvement of their well-being. Hence, our results indicate, that the effects associated with depressive

Table 2 Baseline characteristics for subjects with prosthetic treatment needs in the upper jaw

	Women			Men		
	No or suboptimal prostheses			No or suboptimal prostheses		
	No (n=498)	Yes (n=207)	p[a]	No (n=321)	Yes (n=273)	p[a]
Depressive symptoms (von Zerssen)	4.7±3.2	4.6±3.2	0.92	3.8±3.0	3.6±2.6	0.52
Depressive symptoms (CID-S)	135 (27.1)	57 (27.5)	0.93	51 (15.9)	37 (13.6)	0.49
Age (years)	47.4±8.3	46.4±8.3	0.15	47.9±8.2	46.5±8.3	0.05
School education (years)			0.31			<0.01
<10	152 (30.5)	57 (27.5)		102 (31.8)	102 (37.4)	
10	283 (56.8)	130 (62.8)		166 (51.7)	149 (54.6)	
>10	63 (12.6)	20 (9.7)		53 (16.5)	22 (8.1)	
Household income	N=483	N=196		N=304	N=259	
Continuous (German Marks [DM])	1,866±898	1,747±880	0.12	2,038±1,038	1,910±1,103	0.08
1st quartile (<1,150)	109 (22.6)	51 (26.0)	0.54	64 (21.0)	72 (27.8)	0.25
2nd quartile (1,150–1,735)	126 (26.1)	56 (28.6)		69 (22.7)	59 (22.8)	
3rd quartile (1,736–2,440)	136 (28.2)	51 (26.0)		74 (24.3)	59 (22.8)	
4th quartile (>2,440)	112 (23.2)	38 (19.4)		97 (31.9)	69 (26.6)	
Marital status			0.06			0.57
Married	358 (71.9)	153 (73.9)		239 (74.4)	199 (72.9)	
Married but separated	17 (3.4)	7 (3.4)		4 (1.2)	5 (1.8)	
Single, never married	42 (8.4)	12 (5.8)		37 (11.5)	41 (15.0)	
Divorced	63 (12.6)	18 (8.7)		36 (11.2)	26 (9.5)	
Widowed	18 (3.6)	17 (8.2)		5 (1.6)	2 (0.7)	
Living without a partner	98 (19.7)	38 (18.4)	0.75	51 (15.9)	43 (15.8)	1.00
Smoking status (cigarettes per day [cpd])			0.64			0.14
Never smoker	208 (41.8)	89 (43.0)		56 (17.4)	45 (16.5)	
Ex-smoker <1	59 (11.8)	29 (14.0)		20 (6.2)	33 (12.1)	
Ex-smoker 1–14	38 (7.6)	11 (5.3)		17 (5.3)	16 (5.9)	
Ex-smoker ≥15	25 (5.0)	10 (4.8)		87 (27.1)	54 (19.8)	
Current smoker <1	20 (4.0)	7 (3.4)		9 (2.8)	10 (3.7)	
Current smoker 1–14	82 (16.5)	41 (19.8)		34 (10.6)	28 (10.3)	
Current smoker ≥15	66 (13.2)	20 (9.7)		98 (30.5)	87 (31.2)	
Risky alcohol consumption (women: >20 g/day; men: >30 g/day)	35 (7.0)	13 (6.3)	0.87	76 (23.7)	97 (35.5)	<0.01
Diabetes mellitus	20 (4.0)	7 (3.4)	0.83	17 (5.3)	19 (7.0)	0.49
Physical activity	145 (29.1)	44 (21.3)	0.03	86 (26.8)	73 (26.7)	1.00
Obesity	118 (23.7)	69 (33.3)	0.01	82 (25.6)	86 (31.5)	0.12
Classification acc. to Mundt			<0.01			<0.01
0 Edentulous	89 (17.9)	1 (0.5)		53 (16.5)	9 (3.3)	
1 1–3 remaining teeth	30 (6.0)	6 (2.9)		16 (5.0)	18 (6.6)	
2 Extended space	89 (17.9)	30 (14.5)		64 (19.9)	48 (17.6)	
3 Small anterior space	94 (18.9)	49 (23.7)		81 (25.2)	59 (21.6)	
4 Small posterior space	196 (39.4)	121 (58.4)		107 (33.3)	139 (50.9)	
Last dental visit because of pain	40 (8.0)	38 (18.4)	<0.01	36 (11.2)	53 (19.5)	<0.01
No dental check-up during the previous year	46 (9.2)	22 (10.6)	0.58	36 (11.2)	61 (22.4)	<0.01

Continuous data are presented as the mean (standard deviation); nominal data are presented as total numbers (percentage)

[a] Mann–Whitney U test and Fisher's exact test

Table 3 Baseline characteristics for subjects with prosthetic treatment needs in the lower jaw

	Women			Men		
	No or suboptimal prostheses			No or suboptimal prostheses		
	No (n=276)	Yes (n=234)	p[a]	No (n=156)	Yes (n=255)	p[a]
Depressive symptoms (von Zerssen)	4.7±3.4	4.6±3.1	0.97	4.3±3.0	3.3±2.7	<0.01
Depressive symptoms (CID-S)	82 (29.7)	63 (26.9)	0.49	28 (18.0)	28 (11.0)	0.05
Age (years)	48.8±7.8	46.0±8.0	<0.01	49.3±8.0	46.9±8.3	<0.01
School education (years)			<0.01			0.16
<10	102 (37.0)	66 (28.2)		60 (38.5)	99 (38.8)	
10	139 (50.4)	149 (63.7)		69 (44.2)	128 (50.2)	
>10	35 (12.7)	19 (8.1)		27 (17.3)	28 (11.0)	
Household income	N=266	N=227		N=146	N=245	
German Marks [DM]	1,893±1,097	1,762±933	0.26	2,075±1,129	1,786±1,037	0.02
1st quartile (<1,150)	61 (22.9)	63 (27.8)	0.58	30 (20.6)	71 (29.0)	0.03
2nd quartile (1,150–1,735)	75 (28.2)	58 (25.6)		40 (27.4)	67 (27.4)	
3rd quartile (1,736–2,440)	72 (27.1)	63 (27.8)		28 (19.2)	57 (23.3)	
4th quartile (>2,440)	58 (21.8)	43 (18.9)		48 (32.9)	50 (20.4)	
Marital status			0.33			0.33
Married	200 (72.5)	167 (71.4)		116 (74.4)	195 (76.5)	
Married but separated	9 (3.3)	5 (2.1)		1 (0.6)	2 (0.8)	
Single, never married	13 (4.7)	20 (8.6)		20 (12.8)	27 (10.6)	
Divorced	36 (13.0)	32 (13.7)		15 (9.6)	30 (11.8)	
Widowed	18 (6.5)	10 (4.3)		4 (2.6)	1 (0.4)	
Living without a partner	57 (20.6)	44 (18.8)	0.66	28 (18.0)	36 (14.1)	0.33
Smoking status (cigarettes per day [cpd])			0.56			0.11
Never smoker	119 (43.1)	93 (39.7)		25 (16.0)	40 (15.7)	
Ex-smoker <1	32 (11.6)	37 (15.8)		6 (3.8)	19 (7.4)	
Ex-smoker 1–14	18 (6.5)	14 (6.0)		15 (9.6)	15 (5.9)	
Ex-smoker ≥15	14 (5.1)	6 (2.6)		44 (28.2)	64 (25.1)	
Current smoker <1	11 (4.0)	7 (3.0)		5 (3.2)	1 (0.4)	
Current smoker 1–14	46 (16.7)	45 (19.2)		16 (10.3)	26 (10.2)	
Current smoker ≥15	36 (13.0)	32 (13.7)		45 (28.8)	90 (35.3)	
Risky alcohol consumption (women: >20 g/day; men: >30 g/day)	20 (7.2)	16 (6.8)	1.00	38 (24.4)	89 (34.9)	0.03
Diabetes mellitus	15 (5.4)	7 (3.0)	0.20	8 (5.1)	14 (5.5)	1.00
Physical activity	76 (27.5)	53 (22.6)	0.22	38 (24.4)	61 (23.9)	1.00
Obesity	74 (26.8)	63 (26.9)	1.00	38 (24.4)	80 (31.4)	0.14
Classification acc. to Mundt			<0.01			<0.01
0 Edentulous	28 (10.1)	1 (1.3)		20 (12.8)	2 (0.8)	
1 1–3 remaining teeth	22 (8.0)	6 (2.6)		25 (16.0)	6 (2.4)	
2 Extended space	119 (43.1)	65 (27.8)		45 (28.8)	62 (24.3)	
3 Small anterior space	23 (8.3)	17 (7.3)		18 (11.5)	34 (13.3)	
4 Small posterior space	84 (30.4)	143 (61.1)		48 (30.8)	151 (59.2)	
Last dental visit because of pain	26 (9.4)	27 (11.5)	0.47	16 (10.3)	43 (16.9)	0.08
No dental check-up during the previous year	22 (8.0)	34 (14.5)	0.02	18 (11.5)	51 (20.1)	0.03

Continuous data are presented as the mean (standard deviation); nominal data are presented as total numbers (percentage)

[a] Mann–Whitney U test and Fisher's exact test

Table 4 Association of number of depressive symptoms (von Zerssen's complaint list) and prosthetic status of the upper and lower jaw

	Odds ratio (95 % confidence interval) of prosthetic status									
	Women					Men				
	Number of depressive symptoms (ref.: ≥8)									
	0–1	2–3	4–5	6–7	p_{trend}	0–1	2–3	4–5	6–7	p_{trend}
Upper jaw										
Without reported income (women: n=705; men: n=594)										
Number of subjects	127	152	156	129			151	149	155	84
Model 1	1.11 (0.65–1.88)	0.95 (0.57–1.59)	0.95 (0.57–1.58)	1.11 (0.66–1.88)	0.95	1.54 (0.81–2.92)	1.44 (0.76–2.72)	1.40 (0.74–2.65)	1.81 (0.90–3.65)	0.55
Model 2	1.09 (0.64–1.86)	0.98 (0.58–1.64)	0.98 (0.58–1.64)	1.17 (0.69–1.98)	1.00	1.50 (0.78–2.89)	1.36 (0.70–2.61)	1.43 (0.74–2.75)	1.83 (0.89–3.74	0.72
Model 3	1.06 (0.61–1.83)	0.95 (0.56–1.62)	0.97 (0.57–1.65)	1.18 (0.68–2.03)	0.87	1.55 (0.79–3.03)	1.38 (0.70–2.70)	1.49 (0.76–2.91)	1.97 (0.94–4.11)	0.77
With reported income (women: n=679; men: n=563)										
Number of subjects	120	148	151	125			142	142	145	81
Model 2	1.10 (0.63–1.92)	1.06 (0.62–1.80)	1.07 (0.62–1.82)	1.28 (0.74–2.20)	0.99	1.61 (0.81–3.19)	1.60 (0.81–3.16)	1.77 (0.90–3.50)	2.12 (1.01–4.43)*	0.75
Model 2b	1.10 (0.63–1.92)	1.06 (0.62–1.80)	1.08 (0.63–1.84)	1.27 (0.74–2.20)	0.99	1.60 (0.81–3.17)	1.63 (0.82–3.22)	1.80 (0.91–3.57)	2.14 (1.02–4.50)*	0.78
Model 3	1.08 (0.61–1.91)	1.03 (0.60–1.78)	1.07 (0.62–1.86)	1.27 (0.73–2.22)	0.93	1.72 (0.85–3.48)	1.74 (0.86–3.51)	1.94 (0.96–3.93)	2.49 (1.15–5.36)*	0.81
Lower jaw										
Without reported income (women: n=510; men: n=411)										
Number of subjects	100	100	109	100			113	100	100	61
Model 1	0.79 (0.44–1.40)	1.38 (0.79–2.44)	0.90 (0.51–1.57)	1.27 (0.72–2.24)	0.56	3.62 (1.66–7.91)†	2.84 (1.29–6.23)†	1.69 (0.78–3.68)	2.05 (0.89–4.76)	<0.01
Model 2	0.79 (0.44–1.42)	1.54 (0.86–2.75)	0.98 (0.55–1.74)	1.32 (0.75–2.35)	0.63	3.73 (1.68–8.30)†	2.78 (1.24–6.22)*	1.89 (0.85–4.19)	2.01 (0.86–4.73)	<0.01
Model 3	0.77 (0.42–1.39)	1.51 (0.84–2.73)	0.93 (0.52–1.67)	1.29 (0.72–2.31)	0.60	3.80 (1.66–8.67)†	2.92 (1.27–6.73)*	2.00 (0.88–4.54)	2.23 (0.92–5.41)	<0.01
With reported income (women: n=493; men: n=391)										
Number of subjects	93	95	107	98			112	94	90	58
Model 2	0.83 (0.46–1.51)	1.55 (0.86–2.78)	1.04 (0.58–1.85)	1.35 (0.76–2.41)	0.76	3.72† (1.66–8.29)	2.77* (1.22–6.26)	2.05(0.91–4.62)	2.08 (0.87–4.94)	<0.01
Model 2b	0.80 (0.44–1.46)	1.58 (0.87–2.85)	1.04 (0.58–1.85)	1.33 (0.74–2.37)	0.74	3.74† (1.67–8.42)	2.79* (1.23–6.32)	2.08 (0.92–4.72)	2.06 (0.86–4.91)	<0.01
Model 3	0.77 (0.42–1.43)	1.54 (0.85–2.82)	0.98 (0.55–1.77)	1.30 (0.72–2.35)	0.68	3.84† (1.65–8.92)	2.87* (1.22–6.74)	2.16 (0.92–5.08)	2.39 (0.96–5.97)	<0.01

Logistic regression analysis; dependent variable: prosthetic status. Model 1: adjusted for age; model 2: model 1+school education, smoking status, and household income (model 2b: only in subjects with income); model 3: model 2+marital status, living without a partner, risky alcohol consumption, obesity, diabetes, physical activity, and household income

*p<0.05; †p<0.01

symptoms may differ from the effects caused by a major depression disorder. Especially in severe depressive episodes, the loss of energy and feelings of hopelessness might prevent patients from consulting a dentist.

In addition, we have selected two exposure measures that differed in their time frame. The von Zerssen's complaints scale assessed the presence of depressive symptoms, whereas the CID-S reflected the subject's lifetime depressive symptoms. Using both the von Zerssen scale and the CID-S an effect of depressive symptoms on prosthetic status of the lower jaw was found in men but not in women. We presently cannot provide an adequate explanation for the observed sex- and jaw-specific effect. The association between depressive symptoms and prosthetic status, however, was found only in the group with the lowest proportion of optimal prosthetic replacement (38 % in the lower jaw in men). For proportions of 54 % (in the lower jaw in women; in the upper jaw in men) or higher (70 % in the upper jaw in women), this association was no longer observed. Thus, the effect of depressive symptoms on replacement may be determined by unknown factors rather than modified by the patient's sex. Nevertheless, with respect to prosthetic replacement, it is possible that men may be more susceptible to high levels of depressive symptoms than women as the result of lifestyle factors or oral health expectations.

Previous studies have shown that a psychogenic incompatibility of prosthodontic replacement results in significant problems with dental treatment and dental public health and should be considered prior to dental treatment of depressive patients [19–21, 40–42]. Moreover, oral conditions [1, 20, 43–45] other than the incompatibility of prosthodontic status are associated with depressive symptoms because the mouth and teeth are a central area for communication and expression of emotions [45]. However, only few studies [20, 21] support the existence of an association between depressive symptoms and oral quality [1], or an association between depression and denture dissatisfaction [46].

Our study has limitations that are inherent to cross-sectional data. Because of the lack of time sequence, the reported relationship should not be readily interpreted as causal. Further limitations of our study merit comment. First, all of the subjects in this study were Caucasians, thus limiting the generalizability of our findings. Second, we did not have data to evaluate the role of the incompatibility of prosthodontic replacement on the studied associations. Third, although CID-S is an established screening tool for depression and anxiety, it does not generate the diagnoses of mental disorders but rather captures typical symptoms. Finally, information bias and unmeasured confounding factors could have influenced our results.

There are important strengths of our study. First, we analyzed data from a large population-based sample, allowing for a high degree of generalizability of the findings for Caucasian women and men. Second, we excluded subjects with an interim RPDP. Third, we investigated the relationship of interest using two different exposure measures.

In summary, we only found an association between depressive symptoms and prosthetic status of the lower jaw in men. The CID-S, which was used in our study, can be recommended for clinical settings. These two screening items have already proven their power in predicting health care utilization and costs 5 years from baseline in a previous study [10]. Further investigations (of the interrelationships between oral health and mood) should not be restricted to the subject's self-estimate of the incompatibility of prosthodontic reconstruction but should be based on an objective clinical assessment.

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Conflict of interest The authors declare that they have no conflicts of interest.

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