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The oral health condition and treatment needs of nursing home residents in Flanders (Belgium).

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***Objectives*:** A study was conducted of nursing home residents with limited access to regular oral health care services to evaluate their oral health status, to perform an assessment of the need for oral treatment and to determine the possible predicting value of age, gender, care dependency and income level on their oral health status and treatment needs. ***Materials and methods*:** Three experienced dentists collected clinical oral health data with a mobile dental unit in 23 nursing homes. Socio-demographic data were extracted from the residents' records in the nursing home. Besides the descriptive and bivariate analysis, a general linear mixed model analysis was also performed with the nursing home as random effect. ***Results*:** The study sample consisted of 1,226 residents with a mean age of 83.9 years, of which 41.9% were edentulous. The mean D_3MFt in the dentate group was 24.5 and 77% needed extractions or fillings. In the group of residents wearing removable dentures, 36.9% needed repair, rebasing or renewal of the denture. The mixed model analysis demonstrated that with each year a resident gets older, the oral health outcomes get worse and that men have worse oral health and higher treatment needs than women. However, the level of income and care dependency had a less extensive role in predicting the oral health outcomes. ***Conclusions*:** The nursing home residents presented a poor overall oral health status and high dental and prosthetic treatment needs. Gender and age were important predicting variables for the oral health outcomes.

Key words: *Oral health, treatment needs, nursing homes, elderly*

Introduction

Globally, the population aged 60 and above is the fastest growing one and is expected to more than double by 2050 and more than triple by 2100. Likewise, the proportion of the population of 60 years and above will rise in Belgium from 24.1% in 2015 to 32,6% in 2050 and the proportion of the population of 80 years and above will double from 5.5% to 10.6% (United Nations, 2015).

In general, aging goes hand in hand with a higher risk of comorbidities, frailty and care dependency. In Flanders (i.e. the northern part of Belgium), nursing homes are one of the residential forms of housing for care-dependent older people. Between 2010 and 2013, 1% of the Flemish population between 65 and 74 years old lived in a nursing home. This proportion increases with age up to 63% of the population aged 95 and above. As a result of the aging population, the number of nursing home beds in Flanders increased up to 118,338 dispersed over 1,453 nursing homes. Not only the number of beds, but also the proportion of nursing home residents with a high care dependency increases (Care and health agency of Flanders; Lafortune *et al*., 2007).

Among different aspects of care dependency, several studies have identified poor oral hygiene in nursing home residents across Europe as a result of their physical and cognitive deterioration and a lack of support from the caring staff in performing daily oral hygiene (Cohen *et al.*, 2006; Ferro *et al*., 2008; Gaszynska *et al*., 2014; Gluhak *et al*., 2010; Jäger *et al.*, 2009; Sweeny *et al*., 2007; Willumsen *et al*., 2012). Two studies in Belgian nursing homes reported mean dental plaque levels of 2.1 (Silness & Loë – range 0 to 3) and very poor denture hygiene (> 50% of surface covered with plaque) in 13.8 to 46.5% of the residents, depending on the study (De Visschere *et al.*, 2006; 2016). The amount of plaque increased with higher care-dependency levels.

A Belgian national survey on the oral health of people with special needs (NIHDH, 2011) revealed that nursing home residents had fewer dental visits compared to home-dwelling care-dependent elders. In addition, within the nursing homes, residents with a higher level of care dependency had even fewer dental visits. Whereas 91 to 98% of the nursing home residents had regular contact with their physician, only 2 to 21% had regular contact with their dentist (at least 4 visits in 4 different years throughout the 7-year period of observation). Almost half of the residents (45.8%) did not have a dental visit during the previous five years. If a dental visit took place, it mostly concerned an urgent treatment. For 64% of the nursing home residents, transport to the dental clinic was an important barrier.

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The high plaque levels among nursing home residents worldwide, in combination with their comorbidities, care dependency and limited professional oral care are the perfect breeding ground for deteriorating oral health and high treatment needs, which has been confirmed in several studies. In general, high levels of periodontal disease were reported, with 36 to 84% of the residents with a CPITN index (Community Periodontal Index of Treatment Needs) of 3 or and D_3MFt levels ranging from 23 to 27 (De Visschere *et al., 2016*; Gaszynska *et al*., 2014; Gluhak *et al*., 2010; Jäger *et al., 2009*; Samson *et al.*, 2008). The dental and prosthetic treatment needs, assessed by a dental professional, were also very high. Restorative treatment was necessary for 30-47% of the residents, half of the residents (45-54%) needed extractions, and 52 to 81% needed prosthetic treatment (Cohen *et al.*, 2006; Ferro *et al*., 2008; Gluhak *et al*., 2010; Jäger *et al., 2009*; Montal *et al.*, 2006). Although there are some data on the oral health status of nursing home residents in general, little is known about the specific group of residents with limited access to regular dental care or without a family dentist.

In October 2010, a mobile oral health care project called "Gerodent" was initiated in reaction to the poor oral health of care-dependent elderly and the lack of oral health care provision for nursing home residents in Flanders. The goal of this project is to support care staff of nursing homes with the implementation of an oral health care guideline and concomitant protocols (De Visschere *et al*., 2011; van der Putten *et al*., 2008) targeting the integration of oral health care into daily nursing care. As part of the project, two mobile dental clinics offer preventive and curative care to nursing home residents unable to visit their regular dentist due to cognitive or physical impairment or frailty. At the time of the study period, the mobile dental team operated in an oral health care network of 23 nursing homes in Flanders, though this project is still expanding and to date more than 60 nursing homes have already become part of this network.

The present research studied nursing home residents with limited access to regular oral services with the aim to evaluate their basic oral health status, to perform an oral treatment need assessment and to determine the possible predicting value of age, gender, care dependency and income level on their oral health status and treatment needs.

Materials and methods

The present study used a descriptive cross-sectional design and was approved by the Ethical Committee of Ghent University (B670201318461). The study population consisted of nursing home residents of East and West Flanders (two Belgian provinces) with limited access to regular oral health care due to physical or cognitive impairment. Residents were considered having limited access to regular oral health care based on an assessment of the nursing staff. The study sample was obtained from residents of the 23 nursing homes belonging to the Gerodent oral health care network during the study period. The nursing homes themselves requested to be included in the network; this inclusion rate was limited by the maximum working capacity of the dental team to be able to ensure preventive and curative treatment at a regular basis. The nursing home residents attended the consultation on a voluntary basis or as demanded by the family or caring staff in case of cognitive impairment.

Data were extracted from the oral health records of nursing home residents visiting the mobile dental clinic for a first consultation between October 2010 (the start of Gerodent) and April 2012. These records include an oral, medical, physical and cognitive assessment. The latter three were performed by the caring staff and physician of the nursing home; the oral assessment was performed by one of the three dentists of the Gerodent team (first, second and last author). All three dentists are experienced in geriatric dentistry and worked as a team. For the registration of the oral health status, the dentists used a fully equipped mobile dental unit with a portable dental operating light (Aseptico). A mobile x-ray device (Rextar EXO1414) was available to ensure a correct diagnosis and to draft the most suitable treatment plan.

The oral health status comprised the number of natural teeth, dental caries, residual roots, filled teeth, implants and ceramic crowns as well as information about the presence of denture-related pressure ulcers and removable dentures. Dental caries was scored on cavitation level and tooth level, related to visually obvious dental decay in the dentine of the tooth and indicated as D_3. When a tooth showed caries and a filling, it was considered to be decayed. The presence of removable dentures was categorized into 'no denture', 'partial denture', 'overdenture' or 'full denture'.

The objective oral treatment need(s) assessment was based on clinically observed conditions not taking into account the self-perceived needs of the residents. For dentate people, the treatment need assessment comprised the need for fillings at tooth level and extractions. A need for a filling was recorded when a tooth presented a carious cavitation which could be technically filled with a good prognosis. There was a need for extraction when one or more of the following conditions were met: the cavity was too extended to be filled with a good prognosis; the pulp was exposed or the tooth presented a peri-apical lesion, fistula or swelling and an endodontic treatment was impossible due to the physical or cognitive condition of the resident; the tooth hampered functionality; the tooth was the cause of traumatic injuries; the tooth presented high mobility (third degree according to the Miller classification) and signs of infection (bleeding, plaque, calculus); or it was impossible to brush the carious teeth due to resistant behavior of the resident. The total treatment need for natural teeth was defined as the sum of needed fillings and extractions. Finally, the treatment index ((F+M)/(D + M +F)) and the restorative index (F/ (D+F)) were also calculated.

The treatment need assessment for participants with removable dentures comprised the need for rebasing, repair or renewal of dentures. A rebasing was needed when the resident presented an unstable denture hampering normal functionality. Denture repair was needed if one or more of the following conditions was present: the denture was cracked or broken; a new clamp was needed for retention; or one or more teeth needed to be added to the denture. Renewal was needed if repair or rebasing was impossible because too many teeth were missing on the denture or there was not enough stability to make a good impression with the available denture. Wear of the occlusal surfaces of the denture was not a reason to consider renewal if the resident had no complaints.

Apart from the oral health status and treatment need(s) assessment, demographic data such as age, gender and nursing home of residence were collected. The physical and cognitive status of the residents was assessed by a care-dependency scale based on the KATZ index of Independence in Activities of Daily Living. (Table 1). In Belgium, this dependency scale is obligatory for each resident at the time of admission to a nursing home to assess the resident's ability to perform activities of daily living (bathing, dressing, toileting, transferring, continence, and feeding) and any cognitive impairment. During the stay, the resident's index is adapted according to changes in the physical and cognitive status. For the analysis, three levels of care dependency were defined: low (KATZ O and A), medium (KATZ B) and high (KATZ C and Cd). To explore the impact of social environment on the oral health condition and treatment needs, all oral outcome variables have been analyzed with a summary measure based on income level: the preferential tariff. This is a governmental measure for persons whose income is below a certain limit. They are entitled to an increased reimbursement for health care interventions, an initiative undertaken to improve access to the health care system. The age, gender, KATZ index and preferential tariff served as explanatory variables.

Table 1 Description of the KATZ care dependency scale[1].

Category	*Clinical criteria*
O	Nearly physically and cognitively independent individuals.
A	Physically dependent individuals: dependent for clothing and/or bathing. Cognitively dependent individuals: disorientated in space and time, and physically independent.
B	Physically dependent individuals: dependent for clothing and bathing, and dependent for transferring and/or toileting. Cognitively dependent individuals: disorientated in space and time, and physically dependent for clothing and/or washing.
C	Physically dependent individuals: dependent for clothing and bathing, and dependent for transferring and toileting, and dependent for eating and/or due to incontinence. Cognitively dependent individuals: disorientated in space and time, and physically dependent for clothing and bathing, and dependent for transferring and/or toileting.
Cd[2]	Cognitively dependent individuals: disorientated in space and time or with officially diagnosed dementia by a neurologist, psychiatrist or geriatrist, and physically dependent for clothing and washing, and for transferring and/or toileting and/or eating, and due to incontinence.

[1] Source: National Institute for Health and Disability Insurance (NIHDI)
[2] d = demented

Descriptive analyses were performed for all variables included in the oral health status (the number of natural teeth, dental caries, residual roots, filled teeth, implants, ceramic crowns and the presence of denture-related pressure ulcers and removable dentures), variables expressing the treatment need(s) assessment (need for fillings and extractions, the treatment index, the restorative index and the need for rebasing, repair or renewal of dentures) and explanatory variables. To explore the impact of the explanatory variables on the dependent variables defined as oral health status and the treatment need(s) of the dentate elderly, the nonparametric Mann-withney U and Kruskal Wallis tests were performed as the data did not meet the assumption of normality. If applicable, the outcome variables were corrected for the number of natural teeth. In this case, it has to be considered as part in its relation to the total number of remaining natural teeth. Finally, a general linear logistic mixed model analysis was performed with the nursing home as random effect. Age, gender, care dependency and preferential tariff were introduced as explanatory variables. The outcome variables were corrected for the number of natural teeth and dichotomized by median value. Tests resulting in P-values <0.05 were considered significant. All analyses were carried out using SPSS for windows version 22 (SPSS Inc., Chicago, IL, USA).

Results

During the study period, the mobile dental team was active in 23 nursing homes with a capacity between 64 and 200 beds (mean = 122.22; SD = 35.23). The mean number of residents per nursing home visiting the mobile dental team during the study period was 53.3 (SD 21.4; range 28-116).

The total study sample consisted of 1,226 residents with a mean age of 83.9 years (SD 8.5) of whom 858 (70.0%) were female. The level of care dependency was low for 218 (17.9%), medium for 328 (26.9%) and high for 675 (55.3%) individuals. With regard to the social environment, 835 participants (68.1%) were entitled to an increased allowance for health costs (preferential tariff). In total, 514 participants (41.9%) were edentulous, with a higher proportion of edentulousness in the female group (44%) than in the male group (37%, $p = 0.023$). Four hundred and fifteen residents (33.8%) were wearing a full upper and lower denture and 279 residents (22.8%) had a combination of natural teeth and removable dentures. Only 12 residents with implants were observed; in 10 of these cases the implants were supplied with abutments for an overdenture in the upper or lower jaw and in two cases for fixed crowns or bridges. (Table 2)

The mean number of natural teeth in dentate residents (n = 712) was 12.3 (SD 8.1; range 1-32), of which 1.9 (SD 3.4; range 0-27) were residual roots. Two hundred and eighty-five participants (40.4%) had carious lesions (excluding residual roots) with a mean number of 1.1 per person (SD 1.9, range 0-11). Considering all residual roots as decayed results in 69.6% of the residents with decay and a mean number of 3.0 (SD 4.0; range 0-27) decayed teeth in the dentate group. Filled teeth (excluding crowned teeth) were found in 225 individuals (31.9%), with a mean number of 1.0 (SD 1.9; range 0-13). Fixed crowns and bridges were found in 135 individuals (19.0%), with a mean number of 4.9 (SD 4.0) replaced teeth, including pillar teeth. This resulted in a mean D_3MFt of 24.50 (SD 7.0; range 0-32).

Table 2 Sociodemographic data and (oral) health profile of the participants (total n = 1226)

Variable	*n*	*Mean (median) or Number*	*SD or %*
Age (years)			
Total sample	1226	83.9 (85.3)	8.5%
< 65		41	3.3%
65 - 79		222	18.1%
80 - 89		601	49.0%
> 89		362	29.5%
Gender	1226		
Male		368	30%
Female		858	70%
Increased allowance for health costs (preferential tariff)	1226	835	68.1%
Care dependency	1221		
Low (KATZ O and A)		218	17.9%
Medium (KATZ B)		328	26.9%
High (KATZ C and Cd)		675	55.3%
Natural teeth present	1226	712	58.1%
Number of natural teeth			
Total Sample	1226	7.1 (3.0)	8.6
0 teeth		514	41.9
1 - 9 teeth		310	25.3
10 - 20 teeth		270	22.0
> 20 teeth		132	10.8
Number of residual roots	1223	1.1 (0.0)	2.7
Decayed teeth	1217	1.8 (0.0)	3.4
Missing teeth	1226	24.9 (29.0)	8.6
Filled teeth	1220	1.0 (0.0)	2.3
DMFt	1216	27.7 (32.0)	6.5
Implants	1226	12	1.0%
Full denture upper and lower jaw	1226	415	33.8%
Overdenture in the upper or lower jaw	1226	27	2.2%
Full denture in upper jaw in combination with natural teeth (and partial denture) in lower jaw	1226	173	14.1%
Full denture in lower jaw in combination with natural teeth (and partial denture) in upper jaw	1226	38	3.1%
Natural teeth in combination with partial denture	1226	279	22.8%

Bivariate analysis in the dentate group (Table 3) showed that male residents had more natural teeth ($p = 0.003$) and a higher proportions of decayed teeth ($p = 0.001$) and residual roots ($p = 0.001$) than female. However, female residents had a significantly higher proportion of fillings ($p = 0.007$). Residents younger than the mean age had more natural teeth ($p < 0.001$), a lower proportion with decay ($p = 0.002$) and lower D_3MFt values ($p < 0.001$) than residents above the mean age. Residents with the highest care dependency had a higher proportion of residual roots ($p = 0.024$) than less dependent residents. Participants with a preferential tariff had a significantly lower proportion of fillings ($p < 0.001$) than those without a preferential tariff.

In the dentate group, 222 residents (31.4%) needed dental fillings, with a mean number of 0.76 (SD 1.5; range 0-8) per person, and 480 residents (67.7%) needed extractions, with a mean number of 3.0 per person (SD 4.3), range 0-32). In total, 548 participants (77%) needed dental treatment for their natural teeth. The total treatment need at tooth level was 3.74 (SD4.5; range 0-32). The mean restorative index and treatment index were 32.90% (SD 38.9) and 84.34% (SD 16.61) respectively.

The bivariate analysis (Table 4) did not detect associations between the explanatory variables and the proportion needing fillings. Men showed a higher assessed need for extractions ($p = 0.001$), a higher total treatment need ($p < 0.001$), and a lower treatment ($p < 0.001$) and restorative index ($p < 0.001$) than woman. Residents younger than the mean age needed less extractions ($p = 0.019$), had a lower proportion of total treatment need ($p < 0.001$) and a higher restorative index ($p = 0.024$) than residents above the mean age. Participants with a preferential tariff had a lower restorative index ($p = 0.002$) than those without a preferential tariff. Participants with the highest care dependency had the lowest treatment index ($p = 0.035$).

Table 3 The distribution of oral health indicators by sociodemographic groups and care dependency in the dentate group (n = 712).

Variables	*Number of natural teeth*			*Decayed* [3]			*Filled* [3]			*D_3MFt*			*Residual roots* [3]		
	n	*%*	Mean (SD)	*n*	*%*	Mean (SD)	*n*	*%*	Mean (SD)	*n*	*%*	Mean (SD)	*n*	*%*	Mean (SD)
Gender	712			703			706			702			709		
Male	232	32.6	13.64 (8.40)	228	32.4	34.24 (33.65)	228	32.3	9.63 (18.46)	228	32.5	23.67 (7.79)	232	32.7	24.30 (32.30)
Female	480	67.4	11.63 (7.81)	475	67.6	26.91 (32.18)	478	67.7	13.95 (22.01)	474	67.5	24.89 (6.53)	477	67.3	16.67 (27.41)
p [1]		**0.003**			**0.001**			**0.007**			0.173			**0.001**	
Age	712			703			706			702			709		
< Mean age	355	49.9	14.12 (8.34)	351	49.9	24.76 (30.19)	353	50.0	12.54 (19.89)	351	50.0	22.95 (7.42)	353	49.8	15.91 (25.93)
> Mean age	357	50.1	10.47 (7.32)	352	50.1	33.79 (34.70)	353	50.0	12.58 (22.12)	351	50.0	26.04 (6.14)	356	50.2	22.39 (32.00)
p [1]		**< 0.001**			**0.002**			0.231			**< 0.001**			0.067	
Care dependency	710			701			704			700			707		
Low	123	17.3	11.49 (7.96)	121	17.3	26.22 (29.94)	122	17.3	13.01 (20.92)	121	17.3	24.76 (6.74)	122	17.3	15.72 (25.89)
Medium	181	25.5	11.35 (7.82)	180	25.7	26.21 (30.71)	180	25.6	12.88 (21.26)	180	25.7	25.06 (6.25)	181	25.6	15.23 (25.93)
High	406	57.2	12.91 (8.14)	400	57.1	31.68 (34.46)	402	57.1	12.29 (21.02)	399	57.0	24.20 (7.35)	404	57.1	22.02 (31.41)
p [2]		0.051			0.222			0.909			0.880			**0.037**	
Preferential tariff	712			703			706			702			709		
No	270	37.9	12.79 (8.06)	266	37.8	29.04 (32.80)	267	37.8	16.90 (25.00)	266	37.9	24.58 (7.19)	269	37.9	18.58 (28.65)
Yes	442	62.1	11.98 (8.04)	437	62.2	29.43 (32.86)	439	62.2	9.92 (17.70)	436	62.1	24.45 (6.86)	440	62.1	19.52 (29.71)
p [1]		0.159			0.839			**< 0.001**			0.472			0.897	

[1] Man-Whitney U test ; [2] Kruskal Wallis test; [3] The outcome of this variable needs to be interpreted as part in its relation to the total number of remaining natural teeth.

Table 4 The distribution of treatment need assessment by sociodemographic groups and care dependency in the dentate group (n = 712).

Variables	*Fillings needed* [3]			*Extractions needed* [3]			*Total treatment need natural teeth* [3]			*Treatment Index*			*Restorative index*		
	n	*%*	Mean (SD)	*n*	*%*	Mean (SD)	*n*	*%*	Mean (SD)	*n*	*%*	Mean (SD)	*n*	*%*	Mean (SD)
Gender	707			709			707			702			574		
Male	229	32.4	6.65 (13.80)	231	32.6	38.85 (39.09)	229	32.4	45.79 (38.02)	227	32.3	83.39 (18.29)	198	34.5	24.02 (35.13)
Female	478	67.6	6.82 (14.70)	478	67.4	29.74 (37.84)	478	67.6	36.57 (37.95)	475	67.7	89.05 (14.75)	376	65.5	37.58 (39.96)
p [1]		0.661			**0.001**			**< 0.001**			**< 0.001**			**< 0.001**	
Age	707			709			707			702			574		
< Mean age	353	49.9	5.17 (10.76)	353	49.8	28.56 (36.17)	353	49.9	33.74 (36.23)	351	50.0	86.59 (17.32)	289	50.4	36.61 (40.24)
> Mean age	354	50.1	8.36 (17.17)	356	50.2	36.82 (40.24)	354	50.1	45.35 (39.25)	351	50.0	87.83 (14.96)	285	49.7	29.12 (37.11)
p [1]		0.113			**0.019**			**< 0.001**			0.558			**0.024**	
Care dependency	705			707			705			700			572		
Low	122	15.9	6.83 (14.19)	123	17.4	30.12 (38.03)	122	15.9	37.12 (37.66)	121	17.2	89.67 (15.30)	100	17.5	35.99 (40.98)
Medium	180	25.5	8.07 (16.79)	181	25.6	27.25 (35.20)	180	25.5	35.45 (35.65)	180	25.6	88.45 (15.19)	140	24.5	33.99 (38.80)
High	403	57.2	6.20 (13.31)	403	57.0	36.06 (39.79)	403	57.2	42.26 (39.35)	399	56.8	85.91 (16.81)	332	58.0	31.35 (38.27)
p [2]		0.694			0.071			0.197			**0.035**			0.692	
Preferential tariff	707			709			707			702			574		
No	267	37.8	6.89 (12.97)	269	37.9	29.33 (36.88)	267	37.8	36.39 (37.30)	266	37.9	87.30 (15.43)	224	39.0	38.43 (39.60)
Yes	440	62.2	6.69 (15.23)	440	62.1	34.78 (39.30)	440	62.2	41.47 (38.64)	436	62.1	87.16 (16.64)	350	61.0	29.35 (38.03)
p [1]		0.292			0.055			0.067			0.872			**0.002**	

[1] Man-Whitney U test; [2] Kruskal Wallis test; [3] The outcome of this variable needs to be interpreted as part in its relation to the total number of remaining natural teeth.

The general linear logistic mixed model (Table 5), revealed that the most predicting explanatory variables for the oral health status and treatment need(s) assessment of the dentate group were the residents' age and gender. With each year a resident gets older, the outcomes get worse and men have worse oral health and higher needs than women. For the outcome variable "filled teeth" and "restorative index", the preferential tariff also had a significant predicting value as residents with a preferential tariff have a lower proportion of fillings (p = 0.003) and a lower restorative index (p = 0.005). Care dependency had a significant impact on the proportion of extractions needed and the treatment index: the group with the highest care dependency needing more extractions than the group with medium care dependency (p = 0.013) and having a lower treatment index than the group with the lowest care dependency (p = 0.011). The power on the level of the effects for odds ratios 2 and higher or 0.5 and lower ranged from 88.3% to 100%.

Among the edentulous (n=514), 390 participants (75.9%) had full upper and lower dentures, 71 (13.8%) were wearing only an upper denture, 2 (0.4%) only a lower denture and 44 (8.6%) were not wearing any denture at all. Of all individuals wearing removable dentures (n = 745), 47 (6.3%) were suffering from pressure ulcers and in 275 (36.9%) cases repair, rebasing or renewal of the denture was strongly recommended. Residents older than the mean age (p = 0.007) and those with a preferential tariff (p < 0.002) had more full dentures. Significant differences in treatment need were found for the explanatory variables gender and age: men (p = 0.013) and residents younger than the mean age (p < 0.001) needed more denture renewals.

A general linear logistic mixed model of the total sample showed that medium care dependency (p = 0.012), increasing age (p < 0.001) and the possession of a preferential tariff (p = 0.026) resulted in a higher risk of wearing a full denture.

Table 5 General linear mixed-model analysis[1] for different dependent variables in the dentate group (n = 712)

Variables (reference)		*Est* β	*SE* β	*95% CI* β		*OR*	*95% CI OR*		*p-value*
				Lower	*Upper*		*Lower*	*Upper*	
Decayed teeth									
Intercept		- 2.686	0.76	- 4.18	-1.19	0,00	0,02	0,30	< 0.001
Gender (Female)	Male	0.485	0.17	0.15	0.82	1,62	1,16	2,27	0.004
Age		0.031	0.01	0.01	0.05	1,03	1,01	1,05	0.001
Filled teeth									
Intercept		1.161	0.77	- 0.34	2.66	3,19	0,71	14,30	0.129
Gender (Female)	Male	- 0.57	0.18	- 0.91	- 0.22	0,57	0,40	0,80	0.002
Age		-0.02	0.01	-0.04	-0.00	0,98	0,96	1,00	0.034
Preferential tariff (yes)	No	0.50	0.17	0.17	0.83	1,65	1,19	2,29	0.003
Residual roots									
Intercept		- 2.56	0.75	- 4.03	- 1.09	0,08	0,02	0,34	0.001
Gender (Female)	Male	0.55	0.17	0.22	0.88	1,73	1,25	2,41	0.001
Age		0.03	0.01	0.01	0.05	1,03	1,01	1,05	0.001
Extractions needed									
Intercept		- 2.57	0.77	- 4.07	- 1.06	0,08	0,02	0,35	0.001
Gender (Female)	Male	0.61	0.17	0.27	0.94	1,84	1,31	2,56	< 0.001
Age		0.03	0.01	0.01	0.05	1,03	1,01	1,05	< 0.001
Care dependency (High)	Medium	-0.46	0.19	- 0.83	- 0.10	0,63	0,44	0,90	0.013
	Low	-0.38	0.22	- 0.81	0.05	0,68	0,44	1,05	0.080
Total treatment need natural teeth									
Intercept		- 4.69	0.84	- 6.33	3.05	0,01	0,00	21,12	< 0.001
Gender (Female)	Male	0.64	0.18	0.30	0.99	1,90	1,35	2,69	< 0.001
Age		0.06	0.01	0.04	0.08	1,06	1,04	1,08	< 0.001
Restorative Index									
Intercept		1.87	0.86	0.18	3.57	6,49	1,20	35,52	0.030
Gender (Female)	Male	-0.80	0.19	-1.18	-0.43	0,45	0,31	0,65	< 0.001
Age		-0.02	0.01	-0.04	0.00	0,98	0,96	1,00	0.023
Preferential tariff (yes)	No	0.52	0.18	0.16	0.88	1,68	1,17	2,41	0.005
Treatment index									
Intercept		-0.11	0.75	-1.58	1.36	0,90	0,21	3,90	0.882
Gender (Female)	Male	-0.64	0.17	-0.98	-0.31	0,53	0,38	0,73	< 0.001
Care dependency (High)	Medium	0.27	0.18	-0.09	0.63	1,31	0,91	1,88	0.138
	Low	0.55	0.22	0.12	0.97	1,73	1,13	2,64	0.011

[1] The nursing home was introduced as random effect and age, gender, care dependency and preferential tariff as explanatory variables. Only the explanatory variables presenting significant results were included in this table.

Discussion

This study aimed to evaluate the oral health status and treatment needs of nursing home residents with limited access to regular dental care due to frailty and care dependency. Compared to the general nursing home population in Flanders, the present study sample has a lower proportion of residents with low care dependency (17.9% compared to 29.0% in general), and higher proportions of residents with high care dependency (55.3% compared to 42.92% in general; The Flemish Care Inspectorate, 2012). This indicates that the oral healthcare project (Gerodent) reached the predetermined goal of providing oral care to the most vulnerable residents.

In the investigation of the oral health status of the total group, a very high mean D_3MFt level of 27.7 (reference 32 teeth) was observed, dominated by a high number of missing teeth (M=24.9). These results are comparable to other studies with a D_3MFt ranging from 23 to 27 (Gaszynska *et al*., 2014; Gluhak *et al*., 2010; Samson *et al.*, 2008). Few residents with implants were observed and the prosthetic treatments were mainly focused on removable dentures. There were few filled teeth as compared to missing ones, which reflects the dental treatment options in the past. In the present study, 42% was observed to be edentulous compared to 36% in another Belgian study also representing data from 2010 (De Visschere *et* al., 2016).

In the dentate group, a very high proportion (69.6%) of the residents had carious teeth, many of which were residual roots. As a result, there was a high need for restorative treatment and extraction therapy. These results are comparable to other studies showing carious proportions around 70% (Samson *et al.*, 2008; Sweeny *et al*., 2007; The Flemish Care Inspectorate, 2012). The treatment needs in the present sample show a higher need for extraction therapy (67.7% compared to 45-54% in the international literature;Cohen *et al.*, 2006; Ferro *et al*., 2008; Montal *et* al., 2006) and a lower restorative treatment need (31.4% compared to 30-47%; Cohen *et al.*, 2006; Ferro *et al*., 2008; Gluhak *et al*., 2010; Jäger *et al.*, 2009; Montal *et* al., 2006). The present sample showed a lower mean restorative index than a random sample of frail dependent elderly in Belgium during the same period (32.90% compared to 45.1%; De Visschere *et* al., 2016). Summarizing, the proportion of caries is comparable to other national and international studies but within our sample the caries lesions are more severe resulting in a higher need for extractions compared to restorative treatment.

The need for repair, rebasing or renewal of a denture was strongly indicated in 36.9% of the residents, which is lower than reported in the international literature (Cohen *et al.*, 2006; Ferro *et al*., 2008; Gluhak *et al*., 2010; Montal *et* al., 2006). Comparability is hampered due to the variety of factors considered to define the need for prosthetic treatment.

Residents with a preferential tariff have a lower proportion of filled teeth and a lower restorative index. This was confirmed after the general linear mixed model analysis. The residents with a preferential tariff probably received more extraction therapy, and thus full dentures, whereas those without a preferential tariff received more restorative treatments.

The bivariate analysis showed that older residents had significantly fewer teeth and consequently a higher D_3MFt. They also had mire decay, higher treatment need and a lower restorative index. The general linear mixed model leads to the conclusion that for each year a resident gets older, the risk of having a worse outcome for all oral health variables increases. Previous research (NIHDI, 2011) revealed that half of the residents (48.5%) of a random sample in Belgian nursing homes had not received a dental visit during the preceding five years and that the time since the last visit increases with age. Hence, the presence of dental disease possibly increases as the time since the last dental visit increases.

Gender seemed to play an important role in all outcome variables introduced in the mixed model. Male residents had a higher risk of a high proportion of decay and residual roots, a higher treatment need, a low proportion of filled teeth and thus a higher risk of having a lower restorative index and treatment index. Previous studies did not show differences in the amount of dental or denture plaque between male and female residents (De Visschere *et al.*, 2006; 2016). More research is needed to understand and confirm the observed differences.

It could be considered a limitation that this study does not include periodontal data. However, the high care dependency level including a high proportion of subjects with dementia and a vast amount of calculus and/or plaque hampered obtaining a reliable CPITN index. However, the dental team did not need a detailed periodontal status to establish the periodontal treatment need because of the limited treatment options (supra gingival scaling or extraction) and the severe stage of periodontal disease. Future research should nevertheless consider measuring tooth mobility. Due to the lack of periodontal data, it was also impossible to distinguish between extractions needed because of caries and/or periodontitis. Furthermore, the three dentists performing the oral examinations were trained well but not calibrated. They did, however, discuss possible treatment options in case of doubts about the treatment plan.

The study's main strength is the large study sample. Consequently, the authors were able to exceed a descriptive analysis and could perform a bivariate and general linear mixed model analysis to find possible explanations for the observed results. Future quantitative and qualitative research on the explanatory variables for poor oral health will help to establish preventive oral health care programs for frail older people. In a future study, the authors will focus on the influence of medication intake and morbidity on the oral health status of nursing home residents.

Previous research (De Visschere et al., 2006; 2011; 2016; NIHDI, 2011) together with the present study resulted in the development of a global plan for lasting oral care for persons with special needs, including frail elders, ordered by the National Institute for Health and Disability Insurance (NIHDI) (NIHDI, 2012). This global plan was tested in a pilot study (NIHDI, 2014). The global plan suggested clear and specific action points to organise oral care for all persons with special needs.

Conclusion

The nursing home residents with limited access to oral health care presented a poor overall oral health status and high dental and prosthetic treatment needs. Gender and age were the most important predicting variables for most oral health outcomes. In Addition, the level of care dependency and income play a less extensive role in predicting the oral health outcomes of frail nursing home residents.

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