

Discrimination of functional capacity for oral hygiene in elderly Spanish people by the Barthel General Index

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Abstract - Objectives: To explore, among the institutionalized elderly in Spain, the association between functional dependence in manipulating aids used in oral self-care (oral hygiene dependence) and general functional capacities, as measured by the Index of Activities of Daily Oral Hygiene (ADOH) and the Barthel Index (BI), respectively. Methods: A cross-sectional study was performed in 2002 on 390 Spanish residents of a residential home for the elderly aged, 65-101 years. All study subjects underwent a oral examination and their ADOH and BI scores assessed. The association between the index scores was studied and the discriminant capacity of BI for oral hygiene dependence was calculated. Results: The mean number of decayed, missing, or filled permanent teeth (±SD) was 26.6 ± 7.3. The mean BI score was 68.31 (95% CI 64.35-72.27), and 172 individuals (44.1%; 95% CI 39.2-49.0%) were independent in all BImeasured functions. The mean ADOH score was 2.43 (95% CI 2.11-2.75), and 238 individuals (61.0%; 95% CI 56.2-65.9%) were independent for oral hygiene, 39 (10.0%; 95% CI 7.2–13.4%) required assistance (assistive devices), and 113 (29.0%; 95% CI 24.5-33.5%) were completely dependent. The BI scores were significantly correlated with the ADOH scores (r = -0.80, P < 0.001). The BI showed a high discriminant capacity to identify the individuals who were dependent for oral hygiene in this population (area under the ROC curve \pm SE = 0.929 \pm 0.013). Using the optimal cut-off point according to the Youden Index (<61), the sensitivity was 0.87 ± 0.03 and specificity 0.87 ± 0.02 . Conclusion: There is a close association between BI and ADOH in this population, which could be useful to identify elderly individuals who are dependent for oral hygiene.

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The oral health status of the Spanish elderly is far from ideal. According to the last Oral Health Survey of the elderly, whether institutionalized or not (data from 1999), the mean number of decayed, missing or filled permanent teeth (DMFT) was 20.8 (1.6 decayed, 18.9 missing and 0.2 filled), 31% of the population studied were edentulous and many individuals needed treatment (1).

With respect to oral hygiene, the last General Oral Health Survey in Spain (data from year 2000) found that 91.3% of the elderly (65–74 years)

required hygiene instruction (2). The importance of oral hygiene has been widely demonstrated, not only for its influence on well being and self-esteem (3) but also because of its role in systemic infections, atherosclerosis, and diabetes, among others, which are of special importance among the elderly (4–8). Improved oral hygiene can reduce the risk of bacterial pneumonia in the institutionalized elderly (9, 10). In general, oral hygiene should be considered as an investment that will reduce the rate of complications that require more costly hospital care (11). However, oral care in general, and oral hygiene in particular, are still given little priority in the care provided to the elderly in Spain.

To ensure a correct oral hygiene practice among the elderly, the first step is to identify the functional capacity of the individual to handle oral hygiene aids (toothbrush, mouthwash dispenser, etc.) (12). Instruments are available for objectively measuring the degree of disability for oral hygiene practice, such as the Index of Activities of Daily Oral Hygiene (ADOH) (12), the Toothbrushing Ability Test (TAT) (13), and the Oral Hygiene Performance Test (OHPT) (14). These instruments facilitate the assessment of special oral care needs and the planning of staffing requirements for assisting dependent individuals (3, 12, 15). Knowledge of the functional capacity of the elderly to maintain their oral hygiene should be a standard feature of comprehensive geriatric assessments but this is not the case. Geriatricians often make a clear distinction between oral health and other diseases or disabilities and pay considerably more attention to the latter.

However, the general functional dependence of the elderly is assessed by geriatricians, and assessments are routinely carried out at residential homes for the elderly in Spain. Around a quarter of elderly individuals are dependent for some of their daily activities (1). Multiple instruments have been developed to assess the degree of this dependence (16), and the Barthel Index (BI) (16) is one of the most widely used in Spanish residential homes. Although the implication of the loss of general functional capacity on oral health has been explored (17), the degree to which the oral hygiene of the elderly is affected by difficulties with other activities of daily life has yet to be elucidated (12).

The objective of this study was to explore, among the institutionalized elderly in Spain, the association between functional dependence in manipulating aids used in oral self-care (oral hygiene dependence) and the general functional capacities, as measured by the ADOH and BI, respectively.

Methods

This cross-sectional study was conducted between July and December 2002 at the Linares Residential Home for the Elderly in Jaen province (southern Spain), a public institution under the Social Affairs Department of the Andalusian Regional Government. The admission criteria for this residential impossibility of family members to take care of their elders, rather than severity of conditions or dependence compared with noninstitutionalized elders). It has 250 rooms and a capacity for 450 individuals. At the time of the study, there were 437 residents from different parts of Jaen province. As in most residential homes for the elderly in Spain, Linares Residence has a medical team but dental care is the responsibility of the local health care centre, which offers only emergency care and extractions. Residents must contact private dentists for other dental treatments. To ensure maximum compliance with the study, it was preceded by talks on oral health given to the residents and staff at the home. Forty-seven residents were excluded from the study: seven were under 65 years of age; nine died; five refused to participate; 10 were hospitalized in acute or terminal phase of their disease, preventing their oral examination; and 16 missed their appointments for the oral examination. The final study sample comprised 390 elderly residents (137 males and 253 females) aged between 65 and 101 years. This sample size is larger than that required (n = 384) to estimate the proportion of subjects with oral hygiene dependence with a precision of 5% and a confidence interval of 95%, considering a priori the worst of possibilities (P = 0.5). The study was approved by the Ethics Committee of the Department of Dentistry (University of Granada), and informed written consent was obtained from the Residential Home management and the residents studied. The age, sex and education level of all study subjects were recorded, and they were administered a brief questionnaire on oral hygiene habits (frequency of tooth/denture brushing and use of oral mouthwashes). All subjects received an oral examination following the WHO protocol (18), and their ADOH score (see below) was assessed by a single dentist (with 11 years of clinical experience, and specifically trained for this project) in their own rooms with the aid of a frontal illumination medical lamp. The criteria for the indication of normative dental treatment needs were those used in the last Spanish General Oral Health Survey (2).

home were reasonably similar to those used for

admission throughout Spain (mainly the lack or

The calibration of the examiner was performed by the re-examination of 18 subjects at one week by the same examiner and separately by another experienced examiner. The intra-examiner kappa values were 0.85 for dental status (considering the tooth as the unit of analysis, with the categories sound, decayed, missing and filled), 0.79 for dental treatment (with the categories none, restoration and extraction) and 0.61 for periodontal diagnosis [considering the sextant as the unit of analysis, with Community Periodontal Index (CPI) categories (18)]. The corresponding inter-examiner kappa values were 0.88, 0.76 and 0.70, respectively. The intraclass correlation coefficient (ICC) was 0.80 for ADOH-brushing and 1.00 for ADOH-mouthwash. All of the above values indicate an adequate reliability according to the Landis and Koch scale (19).

The functional (neurological and locomotive) capacity to manipulate oral hygiene aids was assessed by means of the ADOH Index. The original index assesses four activities: brushing, oral mouthwash, flossing and topical fluoride applications, evaluating only brushing and oral mouthwash in patients with a complete denture. In the present study, only these first two activities were assessed because of the small number of natural teeth expected in the study population. The examining dentist asked the resident to follow a series of instructions (open toothpaste tube, place some toothpaste on toothbrush, raise toothbrush to mouth, rinse out mouth, and clean toothbrush; and open mouthwash bottle, place some mouthwash in a glass, keep it in the mouth for a time, and spit it out). The brushing activities differed between individuals with (toothbrushing) and without (denture brushing) teeth. Each activity received scores of 0 (independent for oral hygiene), 1-2 (requires assistive devices), or 3-4 (requires a helper). The sum of the scores yields the total score, which ranged from 0 to 8 points.

All individuals were assessed by the psychologist on the Home staff using the 10-item version of the BI (16), based on observations immediately after the oral examination or during the previous week (urination and defaecation). The index measured the capacity for activities of daily living (eating, washing, dressing, personal hygiene, defaecation, urination, using the toilet, mobility from bed to chair, walking and going up and down stairs) and the score ranges from 0 (completely dependent) to 100 (completely independent). It was developed to monitor performance in chronic patients before and after treatment and to indicate the amount of nursing care needed (16).

Statistical analysis was performed by using SPSS-Windows v. 12.0 (SPSS Inc., Chicago, IL, USA). Descriptive and bivariate analyses were performed by using the tests expressed in Results and tables, considering the ADOH-total score as a quantitative variable. A forward stepwise linear regression model was constructed (P < 0.05 to enter and P > 0.10 to exclude a variable) with the ADOH-total score as the dependent variable. The potential predictors were age, sex, and BI score. The final model only included the BI score (results not shown).

Further analyses investigated the discriminant ability of BI in identifying patients dependent both for brushing and for mouthwash, considering the clinically relevant cut-off point described for the ADOH instrument. A receiver operating characteristic curve (ROC) was built for each ADOH cut-off point in each hygiene activity (brushing or mouthwash) and for both activities together, calculating the areas and standard error (SE) by means of the Wilcoxon statistic (20). The association between dependence for ADOH and the BI score was evaluated by means of the Mantel-Haenszel test for linear association, based on a chi-square distribution with one degree of freedom. Sensitivity (Se) and specificity (Sp) were calculated at clinically relevant BI cut-off points (21) and at the cut-off point giving the optimal (highest) Youden Index, i.e. Se + Sp – 1 (22).

Results

The mean age of the 390 residents was 81.8 years (SD 7.2). Their mean DMFT was 26.59 (SD 7.34), 155 (39.7%) were edentulous, and 156 (40.0%) wore a removable denture (partial or complete). There was a high level of treatment needs, particularly for instruction in oral hygiene (Table 1). According to self-reports of their tooth or denture brushing, 44.1% never performed this activity, 13.6% brushed one to two times a week, 20.0% once a day, and 22.3% more than once a day. Mouthwashes were never used by 72.1%, were sometimes used by 14.4% and were used daily by 13.6%.

The mean BI score was 68.31 (95% CI 64.35–72.27), and 172 residents (44.1%; 95% CI 39.2–49.0%) were independent in all functions, while the remaining 55.9% showed some degree of functional dependence (Table 2). Table 3 lists the results for functional capacity for oral hygiene. Other data not shown in Table 3 are reported below. There was a good concordance between brushing and mouthwash abilities, with an ICC of 0.973 (95% CI 0.967–0.978) between ADOH-brushing and ADOH-mouthwash. Combining both activities,

Ruiz-Medina et al.

Table 1. Description of sociodemographic variables and normative oral health status in patients (n = 390)

Variable	Distribution
Sex [n (%)]	
Male	137 (35.1)
Female	253 (64.9)
Age [years; n (%)]	
65–69	25 (6.4)
70–74	39 (10.0)
75–79	64 (16.4)
80-84	118 (30.3)
85–89	87 (22.3)
90–94	47 (12.1)
95–101	10 (2.6)
Mean ± sd	81.8 ± 7.2
Educational level $[n (\%)]$	
Illiterate	82 (21.0)
Primary school	263 (67.4)
Secondary school	37 (9.5)
Higher	8 (2.1)
Number of natural teeth $[n (\%)]$	
0 (edentulous)	155 (39.7)
1–5	44 (11.3)
6–10	45 (11.5)
11–15	38 (9.7)
16–20	45 (11.5)
21–25	46 (11.8)
26–32	17 (4.4)
Mean ± SD	8.45 ± 9.26
$DMFT (mean \pm SD)$	26.59 ± 7.34
Decayed (mean \pm SD)	2.94 ± 4.30
Missing (mean \pm SD)	23.55 ± 9.26
Filled (mean \pm SD)	0.09 ± 0.56
Presence of removable denture ^a (%)	
No	234 (60.0)
Yes	156 (40.0)
Normative treatment needs $[n (\%)]$	
Periodontal treatment ^b	
Instruction in oral hygiene	191 (99.5)
Prophylactic scaling	190 (99.0)
Complex periodontal treatment	17 (8.9)
Restorative dentistry ^c	145 (37.2)
Dental extraction	168 (43.1)

^aPartial or complete removable denture in one or both jaws.

^bAfter excluding the 198 patients with the 6 sextants excluded from periodontal diagnosis (18).

^cFilling (one or more surfaces) or endodontic treatment.

the mean ADOH-total score was 2.43 (95% CI 2.11–2.75), 238 residents (61.0%; 95% CI 56.2–65.9%) were independent for oral hygiene, 39 (10.0%; 95% CI 7.2–13.4%) required assistive devices, and 113 (29.0%; 95% CI 24.5–33.5%) were completely dependent on a helper.

A statistically significant association was observed, using the Pearson's linear coefficient, between the age and the BI (r = -0.26, P < 0.001) and ADOH-total (r = 0.17, P < 0.001) scores. Using the Student's *t*-test for independent samples, a

Concept	Distribution (%)		
BI distribution ^a			
0–20 (completely dependent) ^b	85 (21.8)		
21–60 (severely dependent)	49 (12.6)		
61–90 (moderately dependent)	53 (13.6)		
91–99 (slightly dependent)	31 (7.9)		
100 (independent)	172 (44.1)		
Mean ± SD	68.31 ± 39.80		

^aIntervals with clinical significance according to Shah et al. (21).

^bOf the 85 completely dependent patients, 65 had a score of 0 (i.e. completely dependent in all functions).

Table 3. Description of distribution of Index of Activities of Daily Oral Hygiene results (n = 390)

Activity	Category	Distribution (%)
ADOH-brushing	0 (Independence)	242 (62.1)
	1 (Assistance)	0 (0.0)
	2 (Assistance)	36 (9.2)
	3 (Dependence)	35 (9.0)
	4 (Dependence)	77 (19.7)
ADOH-	0 (Independence)	241 (61.8)
mouthwash	1 (Assistance)	0 (0.0)
	2 (Assistance)	47 (12.1)
	3 (Dependence)	39 (10.0)
	4 (Dependence)	63 (16.2)
ADOH-total ^a ,	0	238 (61.0)
distribution	1	0 (0.0)
	2	7 (1.8)
	3	0 (0.0)
	4	32 (8.2)
	5	10 (2.6)
	6	28 (7.2)
	7	12 (3.1)
	8	63 (16.2
ADOH-total		2.43 ± 3.25
$(mean \pm SD)$		
ADOH-Total,	Independent	238 (61.0)
qualitative	Needing asistance	39 (10.0)
distribution ^b	Dependent	113 (29.0)

^aBrushing + Mouthwash.

^bCombination of ADOH-brushing and ADOH-mouthwash. Independent: in both activities (total score of 0). Needing assistance: in at least one activity but not dependent in any activity (total score of 1–4 in our series); Dependent: dependent in at least one activity (total score of 5 or more in our series).

significant association was also observed between sex and BI (higher score in males, $t_{exp} = 3.60$, P < 0.001) and ADOH-total (higher score in females, $t_{exp} = 2.56$, P < 0.05) scores. No significant association was found between the oral status variables and the BI or ADOH-total scores.

The association between the BI and ADOH (ADOH-brushing, ADOH-mouthwash, and ADOH-total) scores is shown in Table 4. With

	Barthel Index ^c						
Activity ^b	0-20 (<i>n</i> = 85)	21–60 (<i>n</i> = 49)	61-90 (<i>n</i> = 53)	91–99 (<i>n</i> = 31)	100 (<i>n</i> = 172)	Association ^d	
ADOH-brushing							
Independent	4.7	32.7	64.2	54.8	99.4	$r = -0.79 \ (P < 0.001),$	
Need assistance	10.6	18.4	22.6	19.4	0.0	$R_{\rm adi}^2 = 0.63$	
Dependent	84.7	49.0	13.2	25.8	0.6	uuj	
ADOH-mouthwash							
Independent	3.5	32.7	64.2	54.8	99.4	$r = -0.80 \ (P < 0.001),$	
Need assistance	14.1	26.5	26.4	22.6	0.6	$R_{\rm adi}^2 = 0.65$	
Dependent	82.4	40.8	9.4	22.6	0.0	uuj	
ADOH-total							
Independent	3.5	30.6	60.4	54.8	99.4	$r = -0.80 \ (P < 0.001),$	
Need assistance	10.6	20.4	26.4	19.4	0.0	$R_{\rm adi}^2 = 0.65$	
Dependent	85.9	49.0	13.2	25.8	0.6	uuj	
Mean ± SD	6.84 ± 1.95	3.94 ± 2.98	1.70 ± 2.33	2.52 ± 3.02	0.03 ± 0.46		

Table 4. Asociation between Barthel Index and ADOH Index $(n = 390)^{a}$

^aThe table shows the percentage distribution of ADOH score for each category of the Barthel Index.

^bSee Table 3 for further description of activities.

^cSee Table 2 for description of clinical significance of intervals.

^dThe associations were calculated with the original variables (ADOH-brushing, ADOH-mouthwash, ADOH-total, and Barthel Index) without collapsing categories. The Pearson's linear correlation (r) and adjusted coefficient of determination (R_{adj}^2) values are given.

an increase in the BI score (greater general functional independence) there was a reduction in the percentage of patients who were functionally dependent for oral health. The adjusted coefficient of determination for the ADOH-total score was 0.65 (Table 4), indicating that 65% of the variability of the BI score was explained by the ADOH-total score.

The discriminant ability of the BI to identify dependent patients for oral health, i.e. those needing a helper, is shown in Table 5. The results are similar for the ADOH-brushing, ADOH-mouthwash and

Table 5. Discriminant capacity of the Barthel Index (BI) to identify elderly who were dependent^a for oral hygiene (n = 390)

Activity	Area (±SE) ^d under the ROC curve	$\chi^2_{\rm MH}$ (1 df) ^e	Sensitivity (±SE)	Specificity (±SE)
ADOH-brushi	ing cut-off point of BI ^b			
<21	0.928 ± 0.014	$\gamma^2 = 204.5; P < 0.001$	0.66 ± 0.04	0.95 ± 0.01
<61 ^c			0.87 ± 0.03	0.86 ± 0.02
<91			0.93 ± 0.02	0.70 ± 0.03
<100			0.99 ± 0.01	0.62 ± 0.03
ADOH-mouth	wash cut-off point of BI			
<21	0.936 ± 0.012	$\gamma^2 = 208.5; P < 0.001$	0.71 ± 0.04	0.95 ± 0.01
<61 ^c			0.89 ± 0.03	0.85 ± 0.02
<91			0.94 ± 0.02	0.68 ± 0.03
<100			1.00 ± 0.00	0.60 ± 0.03
ADOH-total c	ut-off point of BI			
<21	0.929 ± 0.013	$\gamma^2 = 208.6; P < 0.001$	0.67 ± 0.04	0.96 ± 0.01
<61 ^c			0.87 ± 0.03	0.87 ± 0.02
<91			0.93 ± 0.02	0.70 ± 0.03
<100			0.99 ± 0.01	0.62 ± 0.03

^aScores of 3–4 in ADOH-brushing and ADOH-mouthwash and dependent in at least one of these two activities for the ADOH-total.

^bThe cut-off points correspond to those with clinical relevance in this index (21). As BI and ADOH scales are built in opposite directions, the sensitivity in identifying patients dependent for oral hygiene refers to a score below the cut-off point of BI.

^cCut-off point given the optimal (highest) Youden Index (22) (see Methods).

^dArea under the ROC curve ± SE, according to Hanley and McNeil (20).

^eMantel–Haenszel test of linear trend (χ^2 with 1 degree of freedom).

ADOH-total scores. The area under the ROC curve for the ADOH-total score was very large (0.929; SE 0.013). Using the optimal cut-off point according to the Youden Index (<61), the Se was 0.87 (SE 0.03) and the Sp was 0.87 (SE 0.02).

Discussion

Aspects related to validity will first be addressed. The study population can be considered representative of the institutionalized elderly in Spain, an EU country where at present only 3% of people aged ≥ 65 years live in institutions (1). The age, sex, education level and oral status were similar to those recently reported in a survey of the institutionalized elderly in Spain (1), which found a mean of 23.8 DMFT (versus 26.6 in present study) and 21.6 missing teeth (versus 23.6 in present study). With regard to the external validity of this study, it seems reasonable to speculate that the strong association between BI and ADOH could be extrapolated to noninstitutionalized elders and elders in other countries. This is because the Residence studied did not apply admission criteria (e.g. specific disease or condition) that could in our view modify the association between general and specific (oral hygiene) functional limitations.

The ADOH Index was selected to assess the functional capacity for oral hygiene largely because it is designed for older individuals, and it is short and readily reproduced. One limitation, however, is that it only measures the functional capacity for brushing but not its efficacy, which is included in the TAT scale (13), for example. The hierarchical structure of the ADOH Index was contemplated within the conceptual framework of its development: mouthwash and topical fluoride application score the lowest in terms of physical ability, flossing the highest, and brushing has an intermediate score (12). Our data, based only on brushing and mouthwashes, cannot confirm this hypothesis because of the high concordance (ICC = 0.973) in the ability to perform these two activities.

The level of oral hygiene was very poor, as has been reported in other institutionalized elderly populations (see Ref. 12). The normative need for instruction in oral hygiene was found in 99.5% of our sample (Table 1), despite the fact that 22.3% of them reportedly brushed their teeth or denture more than once a day, suggesting the inadequate efficacy of their hygiene practice. A considerable percentage (39.0%) of our series were not independent for oral hygiene, with 29.0% needing a helper. These percentages were higher with greater age of the subjects, probably due to a reduction in manual dexterity (23).

The main finding of this study is the close association between BI and ADOH scores (r = -0.80). This could also be interpreted as a further validation of the BI. Thus, it is similar to the association (correlations of 0.73–0.77) obtained between BI and a motor ability index used in stroke patients (24). Moreover, the optimal cut-off point on the BI scale to separate dependence from independence for competence in oral hygiene was 60/61 according to the Youden Index (Table 5), which is also the most widely used BI cut-off point to differentiate between the elderly who are dependent or independent, in general (16).

The widespread use of the BI in Spanish homes for the elderly (not the case of the ADOH) and the high discrimination values (area under the ROC curve, Se, and Sp) of the BI to identify elderly dependent for oral hygiene mean that staffing requirements for oral hygiene care can be reliably estimated. Using the cut-off point for the optimal Youden Index (which assumes false positives and negatives are equally undesirable), the Se and Sp obtained are 0.87. It would be possible to consider a BI cut-off point of <100, which would produce an Se of 0.99, assigning staff for the oral care of these patients, although the Sp would fall to 0.62. However, the ideal would be to include an oral hygiene assessment, as previously suggested (25), but including the ADOH or some other measure of capacity for oral hygiene. If the true deficits are not assessed, oral hygiene performance cannot be optimized (12).

Some individuals considered independent according to the ADOH Index are probably incapable of effective oral hygiene practice since the ADOH only measures function, not the capacity of an individual to be educated or trained, and it does not measure their compliance. Effective oral hygiene does not solely rely on the basic functional capacity of the individual but also requires the acquisition of knowledge and habits to effectively remove plaque. A commitment to a daily oral care regimen must be made and maintained. Further studies are required that consider plaque and gingivitis levels in the assessment of the capacity for oral hygiene, in order to detect the efficacy of brushing as a function of the degree of general disability.

Finally, the strong association found between the BI and ADOH, together with the generally poor levels of oral hygiene in institutionalized elders, indicates that operators of nursing homes should include oral hygiene in their care protocols for dependent elders. Health policy makers need to be aware that assistance to dependent elders in their oral hygiene is essential if recommendations on the importance of oral health in general health and quality of life of institutionalized elders are to be implemented (25).

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