Nutritional status of community-dwelling demented elderly: Associations with individual and family caregiver's characteristics

Laetitia Rullier, doctoral student (1,2)*, Alexia Lagarde, PhD (4), Jean Bouisson, PhD (1,2), Valérie Bergua, PhD, (1, 2) Pascale Barberger-Gateau, MD, PhD (1, 3)

(1) Bordeaux Segalen University, 146, rue Leo Saignat, BORDEAUX, F-33076, France
(2) Clinical Psychological Research Laboratory EA4139, 3 ter, Place de la Victoire, BORDEAUX, F-33076, France
(3) Research Centre Inserm, U897, Department of Nutritional Epidemiology, 146, rue Leo Saignat, BORDEAUX, F-33076 France
(4) Gerontological Information and Coordination Centre, 15, Boulevard Jean Moulin, BERGERAC, F-24100, France

***Corresponding Author**:

Laetitia Rullier, Doctoral student
Clinical Psychological Research Laboratory EA4139
Bordeaux Segalen University
3 ter, Place de la Victoire
BORDEAUX, F-33076 France
Phone: +33(0)5.57.57.19.64.
Fax: +33(0)5.57.57.19.64.
Email: laetitiarullier@hotmail.com

Manuscript submitted to *International Psychogeriatrics*, June 2011

Running title: Caregiving dyad and nutritional status in dementia

Abstract

Background: In dementia, several complex factors may compromise nutritional status. These nutritional problems can be associated with caregiving difficulties. Taking a multi-factorial approach, this study aimed to explore the associations of both cognitive, functional and psychobehavioral status of demented elderly and the psychological and nutritional status of family caregivers with the nutritional status of demented elderly.

Method(s): This cross-sectional study comprising 56 community-dwelling demented elderly and 56 family caregivers was performed in a French gerontological institution. The Nutritional status was evaluated using the Mini Nutritional Assessment (MNA). Demented elderly were assessed with Mini Mental State Examination (MMSE), Activities of Daily Living (ADL) and NeuroPsychiatric Inventory (NPI) and family caregivers with the Burden Interview (Zarit scale), the State-Trait Anxiety Inventory (STAI Y-B) and the Center for Epidemiologic Studies Depression Scale (CES-D).

Results: 58.9% of demented elderly were at risk of malnutrition and 23.2% presented a poor nutritional status. 32.1% of family caregivers were at risk of malnutrition and 5.4% presented a poor nutritional status. The MNA score of demented elderly was strongly and inversely associated with the ADL score and was strongly and positively associated with the MNA score of family caregiver. These two factors significantly explained 39 % of variation of MNA score of demented elderly and better than each factor taken separately.

Conclusion(s): These findings confirm the value of investigating nutritional deficiencies in dementia within the caregiving dyad and suggest that the functional status of demented elderly and the nutritional status of family caregivers should be carefully assessed.

Key-words: family caregiver, risk factors, malnutrition, psychosocial factors, community, dementia

Nutritional status of community-dwelling demented elderly: Associations with individual and family caregiver's characteristics

Introduction

Dementia is a complex chronic disease which frequently co-occurs with malnutrition (Vellas *et al*., 2005). The nutritional problems of demented elderly begin mostly by weight loss and lead to complications, including accelerated sarcopenia, falls, infections and loss of autonomy (Gillette-Guyonnet *et al*., 2000; Guerin *et al*., 2005a) which generate specific care needs.

In dementia, several complex factors may compromise nutritional status. These are mainly studied through different physiopathological mechanisms. Most studies suggest that nutritional status is associated with the evolution and severity of dementia (Berlinger and Potter, 1991; Guerin *et al*., 2005a). According to the DSM-IV criteria (DSM-IV; American Psychiatric Association, 1994), the evolution of dementia is characterized by a cognitive decline associated with a progressive loss of functional skills in daily living activities. Thus, demented elderly living at home may find it difficult to manage their budget (Barberger-Gateau *et al*., 1999), to go shopping, to prepare adequate meals and to recognize their need to eat (Gauthier *et al*., 1997). Over the long term, the primary need to feed can also be affected. In order to assess the nutritional status, lot of studies used the Mini Nutritional Assessment (MNA; Vellas *et al*., 2006) permitting a global nutritional evaluation. Some of these studies have demonstrated that the nutritional status of demented elderly is associated with cognitive deficit and with functional impairment (Guerin *et al*., 2005b; Spaccavento *et al*., 2009).

In addition to these impairments, behavioural and psychological symptoms commonly observed in dementia are associated with nutritional status (Broker *et al*., 2003; Guerin *et al*., 2005b; Spaccavento *et al*., 2009). After a one-year follow-up, Guerin *et al*. (2005b) showed a relationship between the worsening of nutritional status and the worsening of Behavioural and Psychological Symptoms in Dementia (BPSD) which have been evaluated using the NeuroPsychiatric Inventory (NPI; Cummings *et al*., 1994). Hence, some of these studies suggest that this link should be further explored to discriminate the impact of each BPSD on nutritional status.

Owing to its consequences on the health of demented elderly, these nutritional problems can be associated with caregiving difficulties. Some results demonstrated an association with the high burden on family caregivers (Brocker *et al*., 2003), which could even predict a compromised nutritional status in demented elderly (Gillette-Guyonnet *et al*., 2000). Moreover, research on the distress of family caregivers found that a high burden is often associated with depression, anxiety, the emotional impact of the demented elderly's BPSD and physical morbidity, including weight change (Schulz *et al*., 1995). However, to our knowledge, no study has examined the direct impact of these factors associated with distress among family caregivers on the nutritional status of demented elderly. Indeed, eating does not only serve a biological role; it also constitutes a social and emotional activity conducive to a balance in life corresponding to a biopsychosocial approach to health. Dementia might disrupt this stability within the caregiving dyad. However, the association between the physical and psychological health of both demented elderly and family caregivers is not well known in the specific context of nutritional problems in dementia.

In brief, studies to date have established that both cognitive and functional status and BPSD in demented elderly are associated with their nutritional status, and that the psychological and physical status of family caregivers are also related to this phenomenon. However, few studies have examined simultaneously both factors related to the demented elderly and those related to the family caregiver with regard to the nutritional status of demented elderly. Taking a cross-sectional multi-factorial approach, this study aimed to explore the associations of both cognitive and functional status and BPSD of demented elderly and the psychological and nutritional status of family caregivers with the nutritional status of demented elderly.

Method

Participants and procedure

This study was performed within the frame of a gerontological medico-social institution providing psychosocial interventions with demented elderly and family caregivers in rural areas of south west France. In these interventions, a psychologist specialized in gerontology proposed a follow-up of the caregiving dyad for one year. The intervention included three evaluation times (at baseline, 6 months

and 12 months later) during which the psychogerontologist proceeded to repeated measures with the demented elderly and their family caregivers. All assessments were conducted by psychogerontologists in a hetero-evaluation procedure. Most of them took place in the demented elderly's home. The data collected included basic sociodemographic information and measures of physical and mental health of demented elderly and family caregivers and was used for the present study. This psychosocial intervention, which took place from April 2007 to November 2009, was approved by the Committee for the Protection of Persons (CPP): 'Sud-Ouest & Outre Mer III'.

The sample consisted in 56 community-dwelling demented elderly and 56 family caregivers who participated in the psychosocial intervention. With the agreement of their general practitioner, elderly were included when they: (1) met the criteria for dementia as evaluated with a neuropsychological assessment according to the DSM-IV criteria (DSM-IV; American Psychiatric Association, 1994), (2) lived at home, (3) had a responsible caregiver who lived with them or visited them several times a week and was available to inform us about their activities. Written informed consent was obtained from participants or their legal representatives and from their caregiver.

Measures

Characteristics of the demented elderly

Sociodemographic variables

Sociodemographic data included: age (years), gender (0=male; 1=female), education level. Education level was encoded as follows: (0) low which corresponds to participants without schooling or having only obtained the French 'Certificat d'Etudes Primaires', equivalent to seven years of schooling; and (1) medium / high which corresponds to participants with a higher educational level.

Cognitive and functional assessment

Global cognitive functioning was examined using the Mini Mental State Examination (MMSE; Folstein *et al*., 1975), with scores ranging from 0 to 30.

Functional status was assessed using Katz's scale for five Activities of Daily Living (ADL; Katz *et al*., 1963). They include items related to bathing, dressing, using the toilet, changing places and eating.

Continence was not considered in this paper because difficulties in bladder or bowel control reflect an abnormality in a particular physical system, and should therefore be considered as an impairment rather than a disability (Spector, 1990). The five ADL total score ranged from 0 to 10.

Specific BPSD

BPSD were evaluated using the NeuroPsychiatric Inventory (NPI; Cummings *et al*., 1994). Twelve symptoms are assessed: delusions, hallucinations, agitation / aggression, dysphoria / depression, anxiety, euphoria, apathy, disinhibition, irritability / lability, aberrant motor activity, night-time disturbance and appetite / eating disturbance. The NPI is based on screening questions used to ask the family caregiver whether the patient's behavior has changed since the onset of dementia and, if so, whether the altered behavior was present during the last month. Thus, each symptom was coded as categorical variable: (0) absence of the symptom; (1) presence of the symptom. In the affirmative, the specific features of the behavioral and psychological disturbances related to the symptom are then explored. Both the frequency (F) and severity (S) of each symptom are rated on a four (1-4) and a three-point (1-3) Likert scale, respectively. A separate score was calculated for each symptom by multiplying the frequency and severity scores (FxS score), resulting in values ranging from 0 to 12 for each symptom. To specify what types of BPSD were specifically associated with nutritional status of demented elderly, the NPI FxS score for each symptom was considered rather than the total score.

Nutritional status

Nutritional status was measured with the Mini Nutritional Assessment (MNA; Vellas *et al*., 2006). With a range score from 0 to 30, this scale identifies people at risk of malnutrition and consists in 18 items including anthropometric measurements (Body Mass Index, mid-arm and calf circumference, weight loss), dietary information (number of meals consumed, food and fluid intake and feeding autonomy), a health and life style assessment (life style, medication, mobility, presence of acute stress and presence of dementia or depression) and a self-perception measure (self perception of health and nutrition). An MNA score < 17 indicates malnutrition, a score between 17 and 23.5 indicates a risk of malnutrition and a score ≥ 24 reflects a good nutritional status. In clinical practice and research, the MNA is usually used to grade nutritional state and to screen for the risk for malnutrition. In this

research, we used the MNA score as a continuous variable, as a global indicator of nutritional status, rather than as a screening tool for malnutrition.

Characteristics of family caregiver

Socio-demographic variables

Sociodemographic data included: age, gender, education level, caregiver relationship with demented elderly (0 = spouse; 1 = children; 2 = other relatives) and cohabitation (0 = living separately; 1 = living together).

Psychological status

Trait anxiety was assessed by the State-Trait Anxiety Inventory form Y/Trait Scale (STAI Y-B; Spielberger *et al*., 1983). Twenty different anxiety-related items ask caregivers how they 'generally feel' on a four-point Likert scale. Total score ranges for 0 to 80.

Caregiver's depressive symptoms were evaluated using the Center for Epidemiologic Studies Depression Scale (CES-D; Radloff, 1977). This scale assesses the frequency of 20 depressive symptoms during the previous week on a four-point Likert scale. Total score ranges for 0 to 60.

The Zarit Burden Interview evaluates caregiver burden (Zarit scale; Zarit and Zarit, 1983). For each of the 22 items of this questionnaire, caregivers indicate the frequency of occurrence of a feeling on a five-point Likert scale. Total score ranges for 0 to 88.

Emotional impact related to demented elderly's BPSD on family caregivers was evaluated using the NPI. For each of the 12 symptoms when present, caregivers evaluate the level of its emotional impact on a scale from 0 to 5.The presence of an emotional impact was also considered as a categorical variable: (0) absence of emotional impact corresponding to score = 0; (1) presence of emotional impact corresponding to score > 0.

Nutritional status

Nutritional status of the caregiver was also assessed with the MNA (Vellas *et al*., 2006).

Statistical analyses

Cross-sectional analysis of data collected at 6 months in the psychosocial intervention was performed since nutritional status was not assessed at baseline. The normal distribution for the continuous variables was checked using the Kolmogorov-Smirnov test. For the linear regression analyses, homoscedasticity and normality of the distribution of residuals were verified. The significance level of $p < 0.05$ was considered for all statistical analyses.

Demographics and clinical characteristics of demented elderly and family caregivers are presented as frequencies and percentages for categorical variables and as mean and standard deviation (SD) for continuous variables.

The MNA total score of the demented elderly as continuous variable (range 0 - 30) was considered as the dependent variable. To define the main explanatory variables of the nutritional status of the demented elderly, we conducted the following analyses:

(1) A set of univariate linear regressions with the diverse demographic and clinical variables of the demented elderly (sociodemographic variables, cognitive and functional status and specific BPSD) and those of family caregivers (sociodemographic variables, psychological and nutritional status) as separate independent variables. For the next step of the multivariate analyses, the selection criterion for the independent variables was a p-value ≤ 0.05 in these univariate linear regression analyses.

(2) Two separate multiple linear regressions to test the relationship between the MNA score and selected independent variables of the demented elderly on the one hand, and selected independent variables of family caregivers on the other hand, based on the previous set of univariate analyses, with a backward stepwise procedure.

(3) A single multiple linear regression with a backward stepwise procedure to test the relationship between the MNA score and the characteristics of both the demented elderly and family caregivers selected from the first univariate linear regressions, introduced simultaneously as explanatory variables.

Considering the inclusion of five predictors in the statistical model, a power analysis ensured that the current sample provided a statistical power above 0.95. All statistical analyses were performed with the Statistical Package for the Social Sciences (SPSS) for Windows version 18.0 (SPSS Inc., 2009).

Results

Description of the sample

This study was composed of 112 participants including 56 demented elderly and 56 family caregivers. The demographic and clinical characteristics of the demented elderly are presented in Table 1. Their average age was 80.7 years (SD = 6.5), and 57% were male. Their nutritional status was often deteriorated because only 17.9% of them presented a good nutritional status, 58.9% were at risk of malnutrition and 23.2% presented a poor nutritional status. The majority of demented elderly had moderate to severe dementia with MMSE mean score of 16.5 (SD = 7.7) and presented functional limitations with ADL mean score of 4.2 (SD = 3.2). The NPI assessing BPSD showed high frequency of apathy (91.1%), dysphoria / depression (58.9%), anxiety (57.1%), aberrant motor behavior (46.4%) and agitation / aggression (44.6%). The highest mean score of severity (FxS score) was apathy, followed by aberrant motor behavior, dysphoria/depression, agitation / aggression and anxiety.

The demographic and clinical characteristics of family caregivers are presented in Table 2. Their mean age was 70.9 (SD = 13.0) and most of them were female (73%). In this sample, 82% of family caregivers lived with the demented elderly, 69.6% of them were spouses, and 37.5% of them presented a compromised nutritional status, including 32.1% at risk of malnutrition and 5.4% with a poor nutritional status. The majority of family caregivers did not present elevated depressive symptomatology with CES-D mean score of 17.2 (SD = 12.5) or elevated anxiety with STAI Y-B mean score of 45.4 (SD = 3.4). Family caregivers had felt emotional impact for almost all BPSD when they were present. The highest emotional impact mean score was apathy, followed by dysphoria / depression, anxiety, agitation / aggression and irritability / lability.

Association between nutritional status of demented elderly and demographic and clinical characteristics of demented elderly and family caregivers

The results of univariate linear regressions analyses are presented for each independent variable of the demented elderly in Table 1 and for each independent variable of family caregivers in Table 2. Regarding the characteristics of the demented elderly (see Table 1), their nutritional status was strongly and positively associated with cognitive status. The total MNA score was inversely associated with level of dependence (ADL total score) and the score (FxS) of apathy.

Concerning the family caregiver's variables (see Table 2), the nutritional status of the demented elderly was strongly and positively associated with the nutritional status of caregivers. Significant associations were also observed with a low MNA total score of the demented elderly and a high level of depressive symptoms (CES-D score) for family caregivers. The inverse association between nutritional status of the demented elderly and perceived burden of the caregiver assessed on the Zarit scale was close to significance ($p = 0.08$). There was no significant association with any of the components of the NPI assessed in the caregiver.

Among the independent variables of the demented elderly, selected variables were: ADL total score, MMSE score, and apathy FxS score. Among the independent variables of family caregivers, selected variables were MNA total score and CES-D score.

The first multiple linear regression analysis with selected independent variables of demented elderly (including ADL total score, MMSE score, and apathy FxS score) showed that only ADL total score (Beta = -0.574, $p < 0.001$, 95% CI = -1.364 ~ -0.594) was a significant independent predictor of the variation of MNA total score of the demented elderly (Adjusted $R^2 = 0.317$, $F = 26.034$, $df = 1$, $p < 0.001$). For the second multiple linear regression analysis using selected independent variables of family caregivers (including MNA total score and CES-D score), only MNA total score of family caregiver (Beta = 0.383, $p = 0.004$, 95% CI = 0.163 ~ 0.825) was a significant predictive factor of the variation of MNA total score of the demented elderly (Adjusted $R^2 = 0.131$, $F = 8.965$, $df = 1$, $p = 0.004$).

In the final multiple linear regression analysis, all selected independent variables of both demented elderly (ADL total score, MMSE score, and apathy FxS score) and family caregivers (MNA total score and CES-D score) were simultaneously introduced as explanatory variables. In the final model, ADL total score of demented elderly and MNA total score of family caregivers significantly explained 39 % of variation of MNA total score of the demented elderly (see Table 3). A post hoc power analysis confirmed that this final statistical model provided a power of 0.99.

Discussion

In our sample of community dwellers included in a psychosocial intervention, the prevalence of poor nutritional status was very high in both the demented elderly and their family caregiver. There was a strong positive association between the nutritional status of the demented elderly and that of the caregiver. This underlines the importance of assessing nutritional status in the context of dementia because nutritional deficiencies co-occur with other morbidity and care difficulties and may compromise the quality of life of demented elderly and their family caregivers (Brocker *et al*., 2003).

Concerning factors related to demented elderly, our results showed a strong association between the level of dependence and nutritional status, confirming the literature results (Guerin *et al*., 2005b; Spaccavento *et al*., 2009). Unlike other investigators (Broker *et al*., 2003; Guerin *et al*., 2005b), we did not identify cognitive decline and behavioral disorders as factors associated with nutritional status in dementia in our sample. However, it could be hypothesized that the consequence of these symptoms of dementia is associated with the nutritional status of demented elderly, and the resulting dependency in daily life activities is food-related (shopping, meal preparation, eating). Future research could investigate the role of each activity of daily living on nutritional status in dementia. It seems that difficulties related to feeding activities and the need for help are detrimental to demented elderly and suggest the primary role of care in this phenomenon.

Concerning factors related to family caregivers, our results show that their own nutritional status is strongly associated with the nutritional status of the demented elderly. Unexpectedly, we did not find that the psychological status of family caregivers was associated with the nutritional status of

demented elderly in our sample. We can hypothesize that the compromised nutritional status of family caregivers could be due to stress and exhaustion, and that this would affect care including all eating-related activities, although the association with the overall burden score on the Zarit scale did not reach significance. This suggests that the nutritional status of family caregivers should be assessed, especially since it seems to be a vulnerability factor for home care. To our knowledge, no study to date has examined the association between the nutritional status of demented elderly and that of their family caregiver, both assessed on the MNA. However, weight change in caregivers has been investigated in the context of dementia as a health consequence of caregiving difficulties (Fredman, 1997). Moreover, a recent study showed that caregivers presented a risk of malnutrition, although the majority were overweight or obese (Torres *et al*., 2010). The family caregivers in our sample also reported that mealtime was no longer a moment of pleasure or exchange with their relative. Some helped the demented elderly to eat first and then ate alone. Therefore, this association between the nutritional status of demented elderly and that of their caregivers raises questions about interpersonal links and the sharing of emotions through the act of eating, and about the possible sharing of eating disorders.

Taking into account simultaneously factors related both to demented elderly patients and caregivers better explained the severity of nutritional deficiencies in the demented elderly than each of these factors independently. This finding means that the most highly dependent demented elderly and those whose family caregiver also presents nutritional deficiencies are the most at risk of poor nutritional status. Caregiving dyad interactions during the act of eating, including the mealtime, are considered as central by some authors (Keller *et al*., 2007; Aselage and Amella, 2010). Mealtime problems could cause distress for both persons in the caregiving dyad. While the demented elderly have problems in expressing and understanding their own needs, their caregivers often know little about the symptoms of dementia or how to interpret behaviors (Mamhidir *et al*., 2007). Moreover, feeding and being fed have psychoaffective implications. The gradual loss of ability in eating-related activities may affect the identity and integrity of the demented elderly. As already stated by Katz *et al*. (1963), feed is the first exchange with the environment and the last activity of daily living for which the individual needs

help. For the caregiver, the difficulties they experience can lead to worry or feel guilty because they think they are providing inadequate or inappropriate care (Wolf-Klein and Silverstone, 1994). Thus, this caregiving distress could affect the nutritional status of both demented elderly and family caregivers. This confirms that interventions in the context of dementia should concern the community-dwelling caregiving dyad in order to improve their quality of life.

Several educational programs for nursing staff have shown that the quality of interactions and a positive atmosphere during mealtimes require better understanding by caregivers of the symptoms of dementia (Mahmidir *et al*., 2007). Nutritional educational programs for caregivers can reduce the weight loss of persons with dementia and improve thier cognitive status (Rivière *et al*., 2001). More recently, the NutriAlz study proposed a socio-educative and nutritional intervention program to prevent weight and functional deterioration in family caregivers and demented (Salva *et al*., 2009).

However, there are some potential limitations to our findings. Our sample was not representative of demented elderly community dwellers. In particular, the sociodemographic and clinical characteristics of our demented elderly and their family caregivers are not similar to those of other French cohort studies such as PAQUID (Dartigues *et al*., 1991) or REAL.FR (Gillette-Guyonnet *et al*., 2003). Firstly, the specificity of our recruitment could explain the size and clinical characteristics of our sample. The demented elderly and family caregivers were not recruited in care centers but at home as a result of an alert or request from a general practitioner or from the home care staff. The most frequent situations we encountered were related to the absence or refusal of care staff to intervene at home from the demented elderly or from the family caregiver or suspicion of an exhaustion of the family caregiver. Furthermore, these caregiving dyads already present some vulnerability due to the course of the disease, which justifies psychosocial intervention corresponding to their needs. Since 2010 and the most recent Alzheimer program in France, community-dwelling caregiving dyads may receive an intervention provided by a *Disease Manager* from a gerontological medico-social institution. Secondly, the other specificity of our sample is the fact that the dyads were from rural areas and did not live near care centers. Therefore, their medical care may have been inadequate because some of the demented elderly did not receive a regular follow-up after the diagnosis of

dementia. Furthermore, living in a rural area could be a risk factor for nutritional deficiencies because of limited accessibility to food shops and lack of public transportation. Thus, in order to better describe risk factors for malnutrition in the context of dementia, it seems important to consider the dwelling environment (Aselage and Amella, 2010). In particular, future studies should compare the nutritional status of demented elderly living in urban areas with those living in rural areas to verify this hypothesis.

Conclusion

Our results show that the factors associated with the nutritional status of demented elderly are not only due to individual characteristics, their functional status, but also to the family caregivers characteristics, their nutritional status. These findings confirm the importance of investigating nutritional deficiencies in dementia within the caregiving dyad, and suggest that the functional status of demented elderly and the nutritional status of family caregivers should be carefully assessed. More research is also needed to understand the psychosocial factors associated with the nutritional status of family caregivers in the context of dementia. Gaining insight into these caregiving difficulties would help in providing better targeted support and care.

Conflict of interest

None.

Description of author's role

Laetitia Rullier designed the study, participated in data collection, analyzed and interpreted the data and wrote the paper. Alexia Lagarde supervised the medico-social staff, participated in the design of the study and in data collection. Valérie Bergua participated in the data analysis and contributed to drafting and revising the manuscript. Jean Bouisson provided psychological expertise. Pascale Barberger-Gateau provided nutritional and statistical expertise. Jean Bouisson and Pascale Barberger-Gateau participated in the design and supervised the study, participated in analyzing and interpreting the results and in drafting and revising the manuscript.

Acknowledgements

Our doctoral work was supported by the Mederic Alzheimer Foundation, the Federative Research Structure in Public Health (University Bordeaux Segalen) and the Oreade Foundation.

We are grateful to the demented elderly and their family caregivers. We would like to thank the medico-social staff for their cooperation and Thierry Atzeni and Fanny Matharan for assistance with the analysis.

We are grateful to Ray Cooke for revising the English.

References

American Psychiatric Association (1994). *Diagnostic and Statistical Manual of Disorders*, 4th edn. Washington, DC: American Psychiatric Association.

Aselage, M.B. and Amella, E.J. (2010). An evolutionary analysis of mealtimes difficulties in older adults with dementia. *Journal of Clinical Nursing,* 19 (1-2), 33-41.

Barberger-Gateau, P., Fabrigoulle, C., Helmer, C., Rouch, I. and Dartigues, J.F. (1999). Functional impairment in instrumental activities of daily living: an early clinical sign of dementia ? *Journal of the American Geriatrics Society,* 47, 456-462.

Berlinger, WG. and Potter, JF. (1991). Low body mass index in demented outpatients. *Journal of the American Geriatrics Society, 39*, 973-978.

Brocker, P., Benhardinat, T., Benoit, M., Staccini, P., Bertogliani, C., Guérin, O., Lechowski, L., Robert, P.H. and the group REAL.FR. (2003). Etat Nutritionnel et maladie d'Alzheimer: résultats préliminaires de l'étude REAL.fr. [Nutritional status and Alzheimer's disease : preliminary results of the REAL.fr study]. *La revue de médecine interne*, 24 (3), 314-318.

Cummings, J.L., Mega, M., Gray, K., Rosenberg-Thompson, S., Carusi, DA. and Gornbein, J. (1994). The NeuroPsychiatric Inventory: comprehensive assessment of psychopathology in dementia. *Neurology*, 44 (12), 2308-2314.

Dartigues, J.F., Gagnon, M., Michel, P., Letenneur, L., Commenges, D., Barberger-Gateau, P., Auriacombe, S., Rigal, B., Bédry, R., Alperovitch, A., Orgogozzo, J.M., Henry, P., Loiseau, P. and Salamon R. (1991). Le programme de recherche PAQUID sur l'épidémiologie de la démence: méthodologie et résultats initiaux [The PAQUID research program on the epidemiology of dementia: methods and first results]. *Revue de Neurologie,* 147, 225-230.

Folstein, M.F., Folstein, S.E. and McHugh, P.R. (1975). Mini-Mental State: A practical method for grading the cognitive state of patients for the clinician. *Journal of Psychiatric Research*, 12, 189-198.

Fredman, L. (1998). Weight change in informal caregivers. In Vellas B, Rivière S, Fitten J (eds). *Weight Loss and Eating disorders in Alzheimer's Patients*: *Research and Practice in Alzheimer's Disease* (pp 79-83). Paris: SERDI Editions.

Gauthier, S., Gelinas, I. and Gauthier, L. (1999). Functional disability in Alzheimer's disease. *International Psychogeriatrics*, 9 (1), 163-165.

Gillette-Guyonnet, S., Nourashemi, F., Andrieu, S., de Glisezinski, I., Ousset, P.J., Rivière, D., Albarède, J.L., and Vellas, B. (2000). Weight loss in Alzheimer disease. *The American Journal of Clinical Nutrition,* 71, 637s-642s.

Gillette-Guyonnet, S., Andrieu, S., Nourashemi, F., Balardy, L., Micas, M., Ousset, P.J., Vellas, B. and the REAL.fr group. (2003). The French multicenter prospective study: hospitalisation predictive factors and management of Alzheimer's disease patients (REAL.fr). *La revue de médecine interne*, 24, 278s-282s.

Guerin, O., Andrieu, S., Schneider, M., Milano, M., Boulahssass, R., Brocker, P. and Vellas, B. (2005a). Different modes of weight loss in Alzheimer disease: a prospective study of 395 patients. *The American Journal of Clinical Nutrition*, 82, 435-441.

Guerin, O., Soto, ME., Brocker, P., Robert, P.H., Benoit, M., Vellas, B. and the group REAL.Fr. (2005b). Nutritional Assessment during Alzheimer's Disease: Results after one year (the Real french Study group). *The Journal of Nutrition*, *Health and Aging,* 9, 81-84.

Katz, S., Ford, A.B., Moskowitz, R.W., Jackson, B.A. and Jaffe, M.A. (1963). The index of ADL: a standardized measure of biological and psychosocial function. *The journal of the American Medical Association*, 185, 914-919.

Keller, H., Edwards, G. and Cook, C. (2007). Mealtimes experiences of families with dementia. *American Journal of Alzheimer's disease and Other Dementias,* 21, 431-438.

Mamhidir, A.G., Karlsson, I., Norberg, A. and Kihlgren, M. (2007). Weight increase in patients with dementia, and alteration in meal routines and meal environment after integrity promoting care. *Journal of Clinical nursing*, 16, 987-996.

Radloff, L.S. (1977). The CES-D Scale: a self-report depression scale for research in the general population. *Applied Psychological Measurement*, 3, 385-401.

Rivière, S., Gillette-Guyonnet, S., Voisin, T. *et al.* (2001). A Nutritional Education Program Could Prevent Weight Loss and Slow Cognitive Decline in Alzheimer's Disease. *The Journal of Nutrition*, *Health and Aging,* 5 (4), 295-299.

Salva, A., Andrieu, S., Fernandez, E., Schiffrin, E.J., Moulin, J., Decarli, B., Guigoz, Y., Vellas, B. and the NutriAlz group. (2009). Health and nutritional promotion program for patients with dementia (NutriAlzh Study): Design and baseline data. *The Journal of Nutrition*, *Health and Aging,* 13, 529-537.

Schulz, R., O'Brien, A.T., Bookwala, J. and Fleissner, K. (1995). Psychiatric and Physical Morbidity Effects of Dementia Caregiving / Prevalence, Correlates, and causes. *The Gerontologist*, 35 (6), 771-791.

Spaccavento, S., Del Prete, M., Craca, A. and Fiore, P. (2009). Influence of nutritional status on cognitive, functional and neuropsychiatric deficits in Alzheimer's disease. *Archives of Gerontology and Geriatrics,* 48 (3), 356-360.

Spector, W.D. (1990). Functional disability scales. In Spilker B (ed.), *Quality of Life Assessments in Clinical Trials* (pp. 115-129). New-York: Raven Press Ltd.

Spielberger, C.D., Gorsuch, R.R. and Luschene, R.E. (1983). Manual for the State-Trait Anxiety Inventory (STAI). Palo Alto, CA: Consulting Psychologist Press.

SPSS Inc. (2009). *SPSS for Windows Release 18.0.0.* Chicago, IL, USA: SPSS Inc.

Torres, S.J, McCabe, M. and Nowson, C.A. (2010). Depression, nutritional risk and eating behavior in older caregivers. *The Journal of Nutrition*, *Health and Aging,* 14 (6), 442-448.

Vellas, B., Lauque, S., Gilette-Guyonnet, S. *et al.* (2005). Impact of nutritional status on the evolution of Alzheimer's disease and on response to acetylcholinesterase inhibitor treatment. *Journal of Nutrition Health and Aging,* 9, 75-80.

Vellas, B., Villards, H., Abellan, G. *et al.* (2006). Overview of the MNA® Its history and challenge. *Journal of Nutrition Health and Aging*, 10, 456-460.

Wolf-Klein, G.P. and Silverstone, F.A. (1994). Weight loss in Alzheimer's disease : an international review of the literature. *International Psychogeriatrics*, 6, 135-142.

Zarit, S. and Zarit, J. (1983). *The memory and behavior problems checklist and the burden interview*. Department of Individual and Family Studies. The Pennsylvania State University, University Park, PA 16802, USA : Copyrighted and published by the author, 1983.

Table legends

Table 1. Associations between each demographic and clinical characteristic of demented elderly (Independent variables) and nutritional status of demented elderly (MNA total score as dependent variable) Univariate linear regression analyses, N = 56.

Table 2. Associations between each demographic and clinical characteristic of family caregivers (Independent variables) and nutritional status of demented elderly (MNA total score as dependent variable) Univariate linear regression analyses, N = 56.

Table 3. Final multiple regression model of nutritional status of demented elderly by backward stepwise procedure, N = 56.

Table 1. Associations between each demographic and clinical characteristic of demented elderly (Independent variables) and nutritional status of demented elderly (MNA total score as dependent variable) Univariate linear regression analyses, N = 56

VARIABLES OF DEMENTED ELDERLY N= 56	MEAN, SD or n (%)	UNIVARIATE LINEAR REGRESSION ANALYSES		
		Adjusted R^2	BETA	p-VALUE
Age, mean (SD)	80.7 (6.5)	0.040	-0.200	0.139
Gender, n (%)				
Male (ref) [a]	32 (57)	0.012	-0.172	0.204
Female	24 (43)			
Education level, n (%)				
Low (ref)[a]	46 (82)	-0.012	-0.081	0.555
Medium, high	10 (18)			
MNA score, mean (SD)	19.8 (5.4)	NA[b]	NA[b]	NA[b]
Good nutritional Status (MNA ≥ 24)	10 (17.9)			
Status at risk of malnutrition (MNA17 - 23.5)	33 (58.9)			
Poor nutritional status (MNA < 17)	13 (23.2)			
MMSE score mean, (SD)	16.5 (7.7)	0.182	0.444	**0.001**
5 ADL score, mean (SD)	4.2 (3.2)	0.317	-0.574	**0.001**
NPI Subscales (FxS scores)				
Delusions, mean (SD)	2.3 (3.9)	-0.003	-0.125	0.358
n (%) presence of symptom	19 (33.9)			
Hallucinations, mean (SD)	1.2 (2.6)	-0.013	-0.070	0.606
n (%) presence of symptom	13 (23.2)			
Agitation / Aggression, mean (SD)	2.6 (3.6)	-0.018	-0.025	0.853
n (%) presence of symptom	25 (44.6)			
Dysphoria / Depression, mean (SD)	2.6 (3.4)	0.002	-0.127	0.350
n (%) presence of symptom	33 (58.9)			
Anxiety, mean (SD)	2.5 (3.6)	-0.005	-0.115	0.400
n (%) presence of symptom	32 (57.1)			
Euphoria, mean (SD)	0.2 (1.1)	-0.009	0.098	0.474
n (%) presence of symptom	3 (5.4)			
Apathy, mean (SD)	6.6 (3.8)	0.114	-0.361	**0.006**
n (%) presence of symptom	51 (91.1)			
Disinhibition, mean (SD)	0.5 (1.5)	-0.017	0.037	0.787
n (%) presence of symptom	11 (19.6)			
Irritability / Lability, mean (SD)	1.9 (3.1)	-0.016	-0.047	0.729
n (%) presence of symptom	20 (35.7)			
Aberrant motor behavior, mean (SD)	2.9 (3.9)	-0.013	-0.071	0.602
n (%) presence of symptom	26 (46.4)			
Night-time disturbance, mean (SD)	1.3 (2.8)	-0.016	-0.045	0.742
n (%) presence of symptom	15 (26.8)			
Appetite / eating disturbance, mean (SD)	2.4 (3.7)	0.015	-0.183	0.178
n (%) presence of symptom	22 (39.3)			

[a] Reference group for the analysis

[b] Not Appropriate

MNA = Mini Nutritional Assessment; MMSE = Mini Mental State Examination; ADL = Activities of Daily Living; NPI = NeuroPsychiatric Inventory.

Table 2. Associations between each demographic and clinical characteristic of family caregivers (Independent variables) and nutritional status of demented elderly (MNA total score as dependent variable) Univariate linear regression analyses, N = 56

VARIABLES OF FAMILY CAREGIVERS N=56	MEAN, SD or n (%)	SIMPLE LINEAR REGRESSION ANALYSES		
		Adjusted R^2	BETA	p-VALUE
Age, mean (SD)	70.9 (13.0)	-0.018	0.012	0.931
Gender, n (%)				
Male (ref) [a]	15 (27)	-0.018	-0.016	0.904
Female	41 (73)			
Education level, n (%)				
Low (ref) [a]	34 (60.7)	-0.006	0.113	0.407
medium / high	22 (39.3)			
Relationship with patient, n (%)				
Spouse (ref) [a]	39 (69.6)	-0.012	-0.081	0.555
Children	12 (21.4)			
Others relatives	5 (9.0)			
Living with patient (yes), n (%)	46 (82)	-0.016	0.046	0.736
MNA total score, mean (SD)	24.4 (4.2)	0.131	0.383	**0.004**
Good nutritional status (MNA ≥ 24)	35 (62.5)			
Status at risk of malnutrition (MNA17 - 23.5)	18 (32.1)			
Poor nutritional status (MNA < 17)	3 (5.4)			
Stai Y-B, mean (SD)	45.4 (3.4)	-0.002	-0.126	0.353
CES-D, mean (SD)	17.2 (12.5)	0.067	-0.290	**0.033**
Zarit scale, mean (SD)	34.1 (15.4)	0.038	-0.236	0.080
NPI subscales (Emotional impact scores)				
Delusions, mean (SD)	1.1 (1.6)	-0.018	-0.014	0.919
n (%) presence of impact [b]	19 (100)			
Hallucinations, mean (SD)	0.6 (1.3)	-0.008	-0.100	0.464
n (%) presence of impact [b]	12 (92.3)			
Agitation / Aggression, mean (SD)	1.6 (1.9)	-0.014	0.068	0.620
n (%) presence of impact [b]	25 (100)			
Dysphoria / Depression, mean (SD)	1.9 (1.8)	-0.004	-0.120	0.377
n (%) presence of impact [b]	32 (97.0)			
Anxiety, mean (SD)	1.8 (1.8)	-0.010	0.092	0.500
n (%) presence of impact [b]	30 (93.7)			
Euphoria, mean (SD)	0.2 (0.7)	-0.006	0.110	0.419
n (%) presence of impact [b]	3 (100)			
Apathy, mean (SD)	2.9 (1.4)	0.004	-0.150	0.270
n (%) presence of impact [b]	51 (100)			
Disinhibition, mean (SD)	0.6 (1.4)	-0.018	-0.016	0.905
n (%) presence of impact [b]	11 (100)			
Irritability / Lability, mean (SD)	1.3 (1.9)	-0.014	0.063	0.645
n (%) presence of impact [b]	20 (100)			
Aberrant motor behavior, mean (SD)	1.3 (1.6)	-0.013	-0.077	0.574
n (%) presence of impact [b]	26 (100)			
Night-time disturbance, mean (SD)	1.0 (1.7)	-0.015	-0.062	0.649
n (%) presence of impact [b]	15 (100)			
Appetite/eating disturbance, mean (SD)	1.0 (1.6)	0.038	-0.235	0.081
n (%) presence of impact [b]	19 (89.4)			

[a] Reference group for analysis

[b] If presence of symptom

MNA = Mini Nutritional Assessment; STAI Y-B = State-Trait Anxiety Inventory form Y / Trait Scale; CES-D = Center for Epidemiologic Studies Depression Scale; Zarit scale = Zarit Burden Interview; NPI = NeuroPsychiatric Inventory.

Table 3. Final multiple regression model of nutritional status of demented elderly by backward stepwise procedure, N = 56

VARIABLES	Adjusted R^2	F VALUE	df	p - VALUE	BETA	p - VALUE	95% CI
Model	0.389	15.932	2	0.000			
ADL total score					-0.509	0.000	-1.260 ~ -0.477
Caregiver's MNA total score					0.253	0.030	0.030 ~ 0.622

Dependent variable = MNA total score of demented elderly

ADL = Activities of Daily Living; MNA = Mini Nutritional Assessment

95% CI = 95% Confidence Interval