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What nursing home environment can maximise eating independence best among residents with cognitive impairment? Findings of a secondary analysis

Running title

Nursing Home Environment and Eating Indipendence

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What nursing home environment can maximise eating independence among residents with cognitive impairment? Findings from a secondary analysis

Abstract

To explore the influence of the Nursing Home (NH) environment on eating independence while taking into account individual and nursing care factors, was the aim of the study. A secondary analysis was performed based on data collected in a multicentre prospective observational study involving 13 NHs. Residents aged >65 were included (n=1,027). Dependence in eating was measured using the Edinburgh Feeding Evaluation in Dementia scale (EdFED, range 0-20). In addition to individual and nursing care variables, the NHs environments were assessed with the Therapeutic Environment Screening Survey for Nursing Homes (TESS-NH, range 0-149). The mean EdFED score was 2.48 (95% Confidence Interval [CI]=2.22-2.73) and the TESS-NH score was 122.19 (95% CI=115.89−128.49). A linear regression analysis explained 30.8% of the total variance in eating dependence. Alongside individual and nursing care factors, in poor NH unit environments, residents with severe cognitive impairment showed increased eating dependence; in contrast, in better environments, similar residents showed maximal eating performance.

Keywords: Cognitive impairment, Dementia, Eating difficulties, Eating performance, Environment, Nursing home, Therapeutic principles, Policy

Introduction

Nursing Homes (NHs) are places in which residents may live for long periods, approximately two and a half years or more,[1,2] largely due to functional and cognitive impairments.[3] In an attempt to ensure appropriate support for both residents' Activities of Daily Living (ADL) and cognitive functions,[4] NHs have been encouraged to transform their settings by considering the ecological model of aging[5,6] and incorporating certain "therapeutic principles" in their environments. Providing adequate lighting, visual/tactile stimulation, sounds, and familiar/homelike settings are some examples of these principles. These therapeutic principles have been conceptualised as elements that reflect more favourable attributes of the physical environment[7] and decrease excessively demanding or inappropriate stimuli with the aim of maximising the residents' well-being and functional independence.

Functional independence is the result of several biological, psychological, and social resources, as well as of environmental characteristics, and the "fit" between the individual and the environment in which the person lives.[5] The environment can generate pressure and promote adaptive behaviour when both support and stimulation are appropriate.[8] On the other hand, increased functional dependence has been documented in NH settings in which there is no congruence between the residents' capacity and the environment's demands.[4]

Among individuals with cognitive impairment, eating independence has been established as the last ADL to be lost along the functional decline trajectory.[9-11] Eating is a complex process that requires physical, intellectual, and organisational skills that individuals with cognitive impairment lose progressively.[12,13] As a consequence, hydration and nutritional issues have been reported in approximately 40% of NH residents with moderate dementia,[14] and approximately 85% of those with advanced dementia[15] have been documented to require partial or complete support in eating. According to the available evidence, the trajectories of functional and cognitive decline are interrelated to each other.[12,13]

Several factors have been documented to exacerbate or prevent eating dependence at the individual, nursing care, and environmental levels.[16-18] At the individual level, in addition to underlying functional and cognitive decline, behavioural (e.g., agitation/aggression), physical (e.g., comorbidities), and psychological factors (e.g., depression) all have been reported to increase eating dependence.[4,14,17] On the other hand, at the nursing levels, individualised strategies aimed at facilitating independent eating (e.g., offering finger food), or at re-learning how to eat independently (e.g., implementing the Montessori Method) as well as reinforcing the quality of the caregiver-resident relationship or providing adequate support (e.g., assistive devices) have all been documented to improve eating independence.[17,19] Moreover, at the environmental level, alterations in the dining room (e.g., providing a peaceful environment) have also been reported to increase eating independence.[20,21]

However, while individual and nursing care factors have been well investigated, [17-19] the NH environment's role in minimizing eating dependence has been explored only to a limited extent.[4,14,22] According to available data, the effects of altering the NH's environment have been studied primarily in the dining room setting where residents spend only a few hours per day.[23] In contrast, very little consideration has been devoted to the environment of the NH unit where residents spend their whole day, as well as to its interactions with individual[4] and nursing care factors.[17,24] Additionally, the environment has been evaluated largely according to each therapeutic principle (e.g., visual and tactile stimuli, noises)[23] rather than its global

features, which encompass several therapeutic principles interacting with each other, and allowing a NH to fully support its residents' residual capacities.

Because of the limitations in the available literature, no conclusive evidence-based design intervention(s) have been established to date to support both managers and healthcare providers in their daily challenge to promote functional independence, in general, and eating independence specifically.[19] As a consequence, recommendations available have been documented at the individual, at the nursing care, and at the dining room levels,[25,26] while actions to implement at the entire NH environment level, have not been established yet.[19] Improving the knowledge in this field was the main purpose of this study.

Methods

Aims

The aim of this study was to explore the influence of the NH environment on eating independence while taking into account individual and nursing care factors. We hypothesised that, overall, alongside individual and nursing care factors, the NH unit environment's therapeutic principles influence residents' eating dependence in various stages of their cognitive decline.

Study design

A secondary analysis of data collected in a multicentre prospective observational study design conducted in 2017 was performed. The methods and the findings have been reported here according to the STrengthening the Reporting of OBservational studies in Epidemiology (STROBE) guidelines.[27]

Setting

In the primary study, a network of 13 NHs regulated by the Regional Health Service and located in a rural area of the North-East of Italy was approached and all agreed to participate. The NHs were organised in 31 units (from one to four in each NH) and equipped with a mean of 86 beds (range=33-200, n=1,161). During the study period, there were, on average, 83 residents/NH (range=30-167, n=1,180) who received approximately 75 minutes/day of nursing care from nursing aides (NAs) and registered nurses (RNs). According to regional rules, residents were admitted to the NH with various health conditions, primarily dementia, and moderate to severe functional dependence that required assistance in eating.[28]

Participants

Participants included in the primary study were residents who (a) were aged >65 years, (b) lived in the same NH unit in the previous six months and during the entire study period, and whose (c) care needs had been assessed by RNs.[29] Therefore, among the 1,080 residents eligible, 53 were excluded because they: (a) were hospitalised during the previous six months or the study period (n=12) or had died (n=10); (b) received parenteral and/or enteral nutrition (via nasogastric tube or percutaneous tube) (n=29), or (c) their care needs had not been assessed (e.g., n=2). Thus, a total of 1,027 residents was included in the primary study.

Dependent variable

The dependent variable of the primary study was eating dependence as measured with the Italian-validated version[30] of the Edinburgh Feeding Evaluation in Dementia scale (EdFED).[31] The tool has been validated in the Italian context by an accurate process of back and forward translation and by assessing its scalability, as its capability to measure the hierarchy order in which each item measuring a manifested behaviour from independence to completely dependency in eating is measured with the tool (scalability=0.42, reliability Rho=0.83, invariant item ordering=0.41).[31] The EdFED consists of 10 items scored on a 3-point Likert scale (0 never, 1 sometimes, 2 often), in which eating dependence increases as the total score increases (from 0 to 20).

Explanatory variables

In the primary study, the explanatory variables were measured at the (a) individual, (b) nursing care, and (c) NH unit environment levels (Table 1):

(a) individual level: data on age, gender, functional dependence in ADL, cognitive status, depressive disorders, pain intensity, relationships with family relatives when present during lunch was all measured with the Val.Graf tool. The tool was validated for face, content, structural validity (13 factors; variance explained 53%), concurrent validity (Pearson [*r*] >0.73) and acceptability and reported good properties in all dimensions;[29,36,37]

(b) nursing care level: data regarding the number of interventions performed on a daily basis in the dining room (e.g., starting the mealtime ritual by stimulating hearing memory by ringing a bell) and at the resident-level (e.g., escalating feeding care by adopting verbal, behavioural, and motivational prompts) was collected through direct observation by using a checklist which has been validated both for face and content validity;[23]

(c) NH unit level: the environment's therapeutic principles were measured using the Therapeutic Environment Screening Survey for Nursing Homes (TESS-NH).[7] The tool was developed originally based on the social ecological model,[32] which conceptualized the environment as interactions between a physical space and the persons within it.[33] Thus, the therapeutic principles of the NH environment were measured with the tool including 84 items organised in 13 domains (unit autonomy; outdoor access; provision of privacy; exit control; maintenance; cleanliness; safety; lighting; visual/tactile stimulation; sound;

space/setting; personalization/familiarity, and orientation/cueing).[7] The absolute values obtained for each item were added to provide a global evaluation of each NH unit's therapeutic properties that ranged from 0 to 149. Firstly, the author, Prof. Sloane, authorised the use of the tool (correspondence available from authors); the tool was then validated in Italian by assessing, among others, (i) the inter-rater reliability (r >0.917 for continuous variables and weighted kappa (K) statistics of >0.779 for non-continuous variables; (ii) the test−retest reliability (r >0.848 and K of >0.778, respectively); and (iii) the internal consistency (Cronbach alpha >0.600 for all dimensions).[34]

Data collection

In the primary study, the therapeutic principles of the NH unit environment were evaluated using the Italian-validated version[34] of the TESS-NH.[7] Two trained researchers with a nursing background visited each NH unit and spent approximately two hours collecting the data. Data was collected independently and then agreed upon; any disagreements were discussed with a third researcher.

Then, after 3-4 weeks, on a day the principal investigator selected randomly, the dependent variable was measured by observing each resident during lunch time, either in the dining room or at the bedside, based on his/her routine. Four researchers with a nursing background who had been trained to use the Italian-validated version of the EdFED in a 4-hour course, were involved.[31] On the same day, four researchers observed and recorded with a checklist the staff's interventions implemented both at the resident and at the environment levels to maintain eating independence. For the larger NHs, data collection was performed over the course of several days.

Thereafter, the latest complete comprehensive assessment of residents included in the study that the RN responsible for each resident's care performed using the Val.Graf tool[29] was extracted from the regional database.

Strategies used to prevent and control sources of bias are detailed in Supplementary Table 1.

Data analyses

Databases related to the primary study were assessed for their completeness and then analysed by computing frequencies, percentages, and averages (with median, standard deviations [SD], ranges, or 95% confidence intervals [CI]). Moreover, the intra-class correlation (ICC) was computed (random and fixed effects; 95% CI bootstrap method) to identify clustered effects at the NH and unit levels on the dependent variable (e.g., residents with increased dependence in eating attributable to unit features).[35]

Then, according to the study hypothesis, correlations between the dependent and the explanatory variables, namely individual, nursing care and NH unit factors were explored on a preliminary basis (available from Authors) and most were statistically significant. Thus, a

linear regression model was designed including those variables that emerged as being significantly correlated.

The model considered the linear component by including all above-mentioned variables, and the TESS-NH[7,34] and the Cognitive Performance Score (CPS)[38] variables to account for the possible interaction between individual cognitive performance and the therapeutic principles of the unit where each resident was living. Then, the TESS-NH's effect was introduced as a smooth component. A natural cubic spline[39] was identified that considered 4 knots within the variable definition set. The number of breakpoints was selected by comparing the results of the regression analysis with 1, 2, 3, 4, and 5 knots. The breakpoints' position was determined by considering the empirical quantiles of the TESS-NH score values. Because of the interaction with the individual CPS score, the form of the curve obtained was allowed to vary with the level of the cognitive performance scale.

The entire model was estimated according to the total variance of the outcome (R^2). All analyses were performed using SPSS v. 24 and R Core Team. The *p* value was set at <0.05.

Ethical issues

For the primary study, the healthcare trust responsible for the NHs provided approval to access NHs to measure the dependent and explanatory variables (N. 66935, 2017); in the same context, the Regional Ethical Committee (Friuli Venezia Giulia) approved the study protocol and allowed access to residents' assessment records (N. 29747, 2018). With regards to the secondary analysis, the research protocol was approved by the Internal Review Board of the University of Udine (Italy) (N. 47, 2019). Residents' data was anonymised and the NHs' anonymity was also ensured.

Results

Dependent variable

In total, 1,027 residents were included and they had an average EdFED score of 2.48 points of 20 (95% CI=2.22-2.73, Table 2). The ICC of the EdFED scores at the NH level was 0.10 (95% CI=0.03-0.19) and 0.06 (95% CI=0.02-0.15) under random and fixed effects, respectively; at the NH unit level, the ICC was 0.13 (95% CI=0.06-0.20) and 0.10 (95% CI=0.07-0.20) under random and fixed effects, respectively.

Explanatory variables

At the individual level, three-quarters of the residents were female, and were, on average, 85 years old (Table 3). The mean Barthel and Pain Intensity Index scores were 25.2 out of 100 (95% CI=23.50-27.00) and 0.70 out of 3 (95% CI=0.70-0.80), respectively. Nearly half of the residents had moderate or severe cognitive impairment (n=471; 45.9%) as demonstrated by their Cognitive Performance Score ≥4. Similarly, approximately half of the residents appeared to suffer from depressive disorders according to the Depression Rating Score ≥3 (n=459; 44.7%). The majority of residents still maintained close relationships with their relatives (n=710; 69.1%) and ate in the dining room surrounded by other residents on a daily basis (n=558; 54.3%).

At the nursing care levels, an average of 3.76 out of 6 (95% CI=2.98-4.55) environmental interventions was performed on a daily basis; at the residents' level, an average of 8.46 out of 10 (95% CI=7.39-9.52) interventions was performed.

At the NH unit level, the average TESS-NH score was 122.19 (95% CI=115.89−128.49; range 84−149; SD 17.17), with a median value of 123 and a mode of 121. Overall, 25% of the NH units (=7) reported a total score ≤113 and another 25% (=7) reported scores ≥133. The scores were homogeneous in NHs with more than one unit.

A total of 16.4% residents (=168) were living in facilities with a total TESS-NH score ≤113, while 20.0% (=236) were living in NHs with a total TESS-NH score ≥133.

Predictors

The linear regression analysis explained 30.8% of the total variance in eating dependence (Table 4). At the resident level, the following variables reduced the likelihood of eating dependence: a higher Barthel Index score (β=−2.513, p=<0.001); eating in the dining room surrounded by other residents (β=−1.968, p=<0.006) or near two residents (left plus right [β=−1.615, p=<0.001]; left/right plus in front [β=−1.333, p=0.002]) compared with eating alone in the bedroom, and having a close relationship with family (β=−0.850, p=0.006). However, female residents (β=0.777, p=0.006) had an increased risk of eating dependence.

At the nursing care level, the number of environmental interventions (β=0.579, p=<0.001) increased the risk of eating dependence, while the number of interventions the nursing staff performed daily at the resident level was negatively associated with eating dependence (β=−0.338, p=<0.001).

At the NH unit environment level, an interaction emerged between the TESS-NH score overall and the CPS score. The interaction showed that the non-linear effect of the TESS-NH score varied significantly with the CPS score. The higher the CPS score, the more prominent the TESS-NH score's effect (Table 4, Figure 1). This effect was similar to a quadratic function of the values of the TESS-NH scores, with an additional positive peak between 130 and 140. In those facilities where the TESS-NH score was low (<110), the NH environmental status worsened the eating dependence score, while on the other hand, a higher TESS-NH score had a protective effect on eating dependence, especially for residents with a CPS ≥4.

Discussion

Maintaining the eating performance of individuals with cognitive impairment living in long-term care facilities has become a care priority for NH managers and staff:[9,40] accordingly, several studies have been performed to date in this field. However, to the best of our knowledge, this is the first study that has explored the contribution of the NH unit environment's therapeutic principles on its residents' eating dependence in various stages of their cognitive decline and taking into account other individual and nursing care variables.

Consistently with previous studies,[14,41] approximately 40% of the residents required physical help in eating occasionally or often, which confirms that eating dependence is an increasing concern in NHs. As the ICCs suggested, the variability in the dependent variable attributable to the NH was limited, but was higher at the unit level: this suggest that some characteristics

of the unit where residents live most of the day can play a role in eating dependence. In fact, according to our regression model, which explained approximately 30% of the variance in eating dependence, most of the underlying factors emerged at the resident and at the unit levels in the interaction between (a) the residents' cognitive status as measured with the Cognitive Performance Scale tool,[38] and (b) the NH environment's therapeutic principles as measured with the TESS-NH tool.[7]

At the resident level, all of the significant variables that emerged in the analysis were modifiable, with the exception of gender. No previous studies have identified gender as a factor that affects eating dependence, and further research is needed to identify the underlying mechanisms. However, fully adjusted models have found that female gender is a predictor of dementia's severity at death[42] and cognitive impairment has been demonstrated largely to be associated with poor eating performance, as both cognitive and physical function decrease as dementia progresses.[4,14,17,43,44]

Moreover, higher scores on the Barthel Index—indicating better functional independence—were associated with a decreased likelihood of eating dependence. The research available has recognised the functional performance's role in eating independence,[17,43,44] suggesting the importance of individualised care plans—such as muscle strengthening and range of motion of the extremities—designed to optimise functional performance[45] that, in turn, can promote eating independence. As eating independence is considered one of the ADLs that are lost late, promoting middle or late loss ADLs can prevent a decline in eating independence.[11]

The decreased eating dependence among residents who have meals in the dining room regularly compared to those who eat alone in their bedrooms confirmed the relational and social implications of mealtimes.[4,14,18,44] This finding can be interpreted in different ways: eating with others can ensure the consistency of the mealtime cultural pattern in which eating has a social meaning.[46] Moreover, eating with others can also increase the residents' abilities through imitation, which can be maximised when the resident is surrounded by peers. In contrast, eating alone in bed can be necessary due to greater functional decline, as well as due to the higher occurrence of disturbing behaviours (e.g., aggressiveness, agitation). Residents who have close relationships with their family were also reported to have better eating performance as already documented.[16,18] Families can promote the retention of independent eating through different strategies based on an in-depth knowledge of their loved one's preferences, as well as through their individualised care and strong relationships.[19,46-48]

At the nursing care level, a statistically significant relation emerged between eating dependence and both environment and resident-centred interventions. Previous research has found that residents who eat in a supportive dining environment with adequate levels of light, sound volume,[41] and stimulation,[4,14] are at decreased risk of developing eating dependence,[19,49] although a recent review of the literature[23] reported no definitive evidence. Unexpectedly, we found that such interventions at the dining room level increased the risk of eating dependence: on the one hand, interventions performed routinely can promote mealtime rituals and their repetitiveness can lead the stimuli to be perceived as progressively less intense. On the other hand, these interventions are likely to be more intense among residents with poor eating performances, thus suggesting a retro-causality mechanism,[23] in which the increased dependence increases the intensity of the environmental interventions the staff perform. In contrast, patient-centred interventions prevented eating dependence, thus

highlighting the importance of investigating personal preferences, and adapting tools and the consistency of food.[18,50]

Finally, eating dependence emerged also as a result of the interaction between NH unit environmental therapeutic principles measured by the total TESS-NH score[7]—and the severity of the residents' cognitive impairment. The NH unit's environmental quality overall did not influence eating performance for intact to moderately cognitively impaired residents. However, among those with moderate to very severe cognitive impairment, the NH unit's therapeutic principles demonstrated a protective role by preventing eating dependence when the TESS-NH scores were >110. Moreover, the extent of the protective role increased with the severity of cognitive impairment, thus confirming that the environment can generate appropriate support and stimulation promoting adaptive behaviour.[8] Specifically, when both individual and nursing care variables were considered as well, the effect of the NH unit environment's therapeutic principles on eating dependence was significant among residents with moderate/severe dementia (CPS ≥4). In units with poor TESS-NH scores (<110), residents' eating dependence scores were approximately 7 out of 20 as measured with the EdFED;[31] differently, resident eating dependence scores were approximately 4 or 4.5 at maximum in units with better TESS-NH scores (>124).

However, a non-linear relation did emerge between the unit environment's therapeutic principles and the eating performance: according to the findings, eating dependence may also decline slightly in high-quality environments. Individual trajectory of dementia may vary: as a consequence, its signs and symptoms—including eating performance—may differ during the course of the disease also on a daily basis.[51] Therefore, in addition to ensuring that NH unit environments are of good quality by embodying therapeutic principles, proactive approaches at the resident's level (e.g., Montessori methods) are needed to maintain eating performance for as long as possible.[52]

Limitations

This study has several limitations. First, it included residents who lived in the same NH for six months and they were consistently exposed to the same practices during the study period: therefore, findings cannot be generalized to residents changing NH units or with multiple hospitalizations. Second, data in the primary study was collected to answer different research questions and this has limited the completeness of the analysis: for example, eating dependence was measured only once during lunch time, while eating performance may change during the day and time;[53] moreover, data on other potential factors associated with eating dependency (e.g., sensory impairments, clinical conditions) was not collected.

Third, the checklist[23] used to observe the interventions that the nursing staff performed at the resident and environment levels was filled-in only once in a randomly selected day: variations over time may have affected the findings. Moreover, further studies should assess all validity properties of this check list.

Fourth, we used the TESS-NH total scores as suggested for checklist use[54] with the aim of transforming the evaluation with appreciable and concrete measures. In this manner, the total TESS-NH scores[7] were interpreted by comparing them and identifying NH unit environments with different therapeutic properties. Further multicentre studies on larger samples are required to confirm these preliminary results that may have been affected by the limited

proportion of residents living in NHs with poor environments. The availability of further evidence on larger scale can help to establish a minimum value on the TESS-NH tool to support NH managers and policymakers in their decisions regarding facility environment design and improvements.

Conclusions

As already established, individual and nursing care variables influence eating dependence among NH residents. Promoting a close family relationship and communal meal consumption, as well as educating staff to perform resident-centred interventions can prevent eating dependence. However, NH managers should consider also the therapeutic properties of the NH environment at the unit level where residents spend a large part of their day in addition to strategies at the individual and dining room levels. In poor NH unit environments, residents with severe cognitive impairments showed increased eating dependence; in contrast, in better environments, similar residents showed maximised eating performance with a difference of approximately 3 points out of 20 in the performance measured with the EdFED tool.

Policymakers and NH managers should consider the value of 110 on the TESS-NH tool as the minimum NH unit environment therapeutic properties able to maximise residents' eating performance. Moreover, in their efforts to design and implement intervention studies, researchers should evaluate environmental therapeutic principles as well, as settings characterised by poor quality may erode actual eating performance and influence the effectiveness of interventions investigated. Furthermore, alongside its influence on eating performance, we found that approximately 16.4% of residents were living in facilities with a poor environment at the time of the study, which raises relevant ethical concerns.

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Table 1

Explanatory variables measured and metrics.

Individual level	**Measure metrics**
Age, Gender	-
Comprehensive assessment, including	Val.Graf tool[29]
Functional dependence in ADL	Barthel Index, composed of 10 items from 0 totally dependent, to 100 totally independent[55]
Cognitive impairment/decline	CPS composed of 6 items from 0 intact, to 6 severe impairment; scores ≥4 indicate moderate/severe cognitive impairment[38]
Degree of mood disorders/depression	DRS composed of 14 the from 0 to 14; scores ≥3 indicate minor or major depressive disorders[36]
Pain	Pain Intensity composed by one item, from 0 no pain, to 3 severe pain[56]
Close/intimate relationships with family relatives, single item	Val.Graf tool, dichotomous variable, yes/no[29]
Where the resident habitually eats (breakfast, lunch and dinner): (a) in his/her bedroom, alone; or (b) in the dining room, (i) near one resident (on left or right side); (ii) near two residents (on left and right); (iii) near two residents (on left/right and in front); (iv) surrounded by other residents (on left, right and in front)	As reported in the nursing records From 0 eating alone, to 4 surrounded by other residents
Nursing care level	
Daily interventions performed to maintain eating performance: (a) at the dining rooms' level:[23] starting the mealtime ritual by stimulating hearing and sight memory (1. ringing a bell, 2. opening the dining room), promoting the desire to eat by stimulating smell and visual memory (3. setting the tables in advance as in a restaurant, 4. entering the dining room with a meal trolley); creating and maintaining a peaceful environment allowing residents' concentration (5. lowering distracting stimuli; 6. balancing the presence of the family) (b) at the resident levels[23]: knowing the resident (1. collecting and sharing their stories and habits; 2. understanding their daily variances and adapting routines; 3. establishing residual self-feeding abilities), escalating feeding care (4. verbal, 5. behavioural, 6. motivational prompts; 7. respecting refusals and waiting; 8. balancing insistence and resistance; 9. deciding the best position), de-escalating difficulties due to meals/utensils (10. by adapting the consistency of food, and utensils)	As measured with a check list,[23] including (a) from 0 none, to 6 all interventions are daily performed in the NH (b) from 0 none, to 10 all interventions are daily performed in the NH
NH unit level	

Environment's therapeutic principles, regarding the following dimensions: 'Unit autonomy'; 'Outdoor access'; 'Privacy'; 'Exit control'; 'Maintenance'; 'Cleanliness'; 'Safety'; 'Lighting'; 'Visual/tactile stimulation'; 'Noise'; 'Space/seating'; 'Familiarity/home likeness' and 'Orientation/cueing'	TESS-NH composed of 84 items categorised in 13 domains: a higher score in each domain reflects a more favourable environmental attribute:[7,57] therefore, the total scores range from 0 to 149[7]

ADL=Activity of Daily Living; CPS=Cognitive Performance Scale; DRS=Depression Rating Scale; NH=nursing home; RN=registered nurse; TESS-NH=Therapeutic Environment Screening Survey for Nursing Home.

Table 2

Degree of dependence in eating according to the EdFED scores.[7,31]

Items	**Average (CI 95%)**	**Never, *n* (%)**	**Sometimes, *n* (%)**	**Often, *n* (%)**
The resident requires close supervision while feeding (0-2)	0.69 (0.64-0.75)	616 (60.0)	112 (10.9)	299 (29.1)
The resident requires physical help with feeding (0-2)	0.66 (0.61-0.72)	630 (61.3)	114 (11.1)	283 (27.6)
There is spillage while feeding (0-2)	0.25 (0.22-0.30)	853 (83.0)	88 (8.6)	86 (8.4)
The resident tends to leave food on the plate at the meal end (0-2)	0.26 (0.23-0.30)	834 (81.2)	116 (11.3)	77 (7.5)
The resident ever refuses to eat (0-2)	0.16 (0.13-0.19)	916 (89.2)	54 (5.3)	57 (5.5)
The resident turns his/her head away while being fed (0-2)	0.10 (0.07-0.12)	967 (94.2)	21 (2.0)	39 (3.8)
The resident refuses to open his/her mouth (0-2)	0.12 (0.09-0.14)	951 (92.6)	32 (3.1)	44 (4.3)
The resident spits out his/her food (0-2)	0.07 (0.05-0.09)	988 (96.2)	10 (1.0)	29 (2.8)
The resident leaves his/her mouth open, thus food to drop out (0-2)	0.08 (0.05-0.10)	980 (95.3)	15 (1.5)	33 (3.2)
The resident refuses to swallow (0-2)	0.08 (0.06-0.11)	978 (95.4)	15 (1.5)	32 (3.1)
Total score (0-20)	**2.48 (2.22-2.73)**	—	—	—

CI=confidence of interval; EdFED=Edinburgh Feeding Evaluation in Dementia scale; n=number.

Table 3

Explanatory variables.

Individual level	***n* (%), average (95% CI)**
Age, years	85.32 (84.75-85.89)
Gender, female	781 (76.0)
Barthel Index (0-100)	25.3 (23.5-27.0)
Cognitive Performance Scale (0-6)	3.4 (3.2-3.5)
Cognitive Performance Scale (≥ 4)	471 (45.9)
Depression Rating Scale (0-14)	2.9 (2.7-3.1)
Depression Rating Scale (≥ 3)	459 (44.7)
Pain Intensity (0-3)	0.7 (0.7-0.8)
Close/intimate relationships with family relatives, weekly (yes)	710 (69.1)
Used to have meals	
In his/her bedroom, alone	223 (21.7)
Dining room, near one resident (on left or right side)	57 (5.6)
Dining room, near two residents (on left and right)	92 (9.0)
Dining room, near two residents (on left/right and in front)	97 (9.4)
Dining room, surrounded by other residents	558 (54.3)
Nursing care level (possible scores)	
Interventions at the dining rooms' level (0-6)	3.76 (2.98-4.55)
Interventions at the residents' level (0-10)	8.46 (7.39-9.52)
NH unit level (possible scores)	
TESS-NH (0-149)	122.19 (115.89-128.49)

CI=confidence of interval; n=number; NH=nursing home; SD=standard deviation; TESS-NH=Therapeutic Environment Screening Survey for Nursing Home.

Table 4

Predictors of eating dependence as measured with the EdFED.[7,31]

Coefficients	***β***	**Std. Error**	***p*-value**
(Intercept)	3.804	1.687	0.024
Age	0.016	0.013	0.215
Gender female *vs* Male	0.777	0.285	0.006
Barthel Index (0-100)	−2.513	0.533	<0.001
DRS (0-14)	−0.373	0.501	0.456
Pain scale (0-3)	−0.114	0.161	0.478
Close relationship with family (yes)	−0.850	0.273	0.001
Used to have meals			
In his/her bedroom, alone *vs*			
Dining room, near one resident (on left or right side)	−0.993	0.547	0.069
Dining room, near two residents (left + right)	−1.615	0.448	<0.001
Dining room, near two residents (left/right + in front)	−1.333	0.441	0.002
Dining room, surrounded by other residents	−1.968	0.303	<0.001
Interventions at the residents' level (0-10)	−0.338	0.092	<0.001
Interventions at the dining room's level (0-6)	0.579	0.149	<0.001
First spline component	0.134	1.075	0.900
Second spline component	−1.970	1.331	0.139
Third spline component	−0.334	3.008	0.911
Fourth spline component	−1.718	1.073	0.109
CPS (0-6)	0.070	0.322	0.826
First spline component: CPS	0.305	0.300	0.309
Second spline component: CPS	0.629	0.373	0.091
Third spline component: CPS	1.683	0.837	0.044
Fourth spline component: CPS	−0.520	0.257	0.043
R^2	**0.308**		
R^2_adj	0.293		
res.st.err.	3.503		
Test F	**20.52**		**<0.001**

CPS=Cognitive Performance Scale; DRS=Depression Rating Scale; EdFED=Edinburgh Feeding Evaluation in Dementia scale; R^2=variance explained; R^2_adj=adjusted variance; res.st.err=residual standard error; TESS-NH=Therapeutic Environment Screening Survey for Nursing Home.

Supplementary Table 1.

Strategies used to control source of bias.

(a) To prevent selection bias all residents living in the NHs were included.
(b) To avoid misclassification, validated tools were used both for the end point[11] and the explanatory variables.[7,29]
(c) To prevent misclassification, data were collected by RNs certified in the use of the Val.Graf tool,[29] caring for the residents in the involved NH; the end-point variable and those variables collected at the nursing care and NH unit environment levels were collected by trained researchers not involved in the care of residents.
(d) To prevent observer bias, researchers responsible for the evaluation of the NH unit environment using the TESS-NH tool[7,34] were not involved in the evaluation of the end-point.
(e) To prevent performance bias, only residents living continuously in the NH for the last six months and from the unit environment assessment to the day of end-point evaluation were included. The NHs were subjected to the same policies regarding admission criteria and the amount of nursing care delivered; NH policies were stable during the study period.

NH=nursing home; RNs=registered nurses; TESS-NH=Therapeutic Environment Screening Survey for Nursing Home.