To eat or not to eat? Indicators for reduced food intake in 91,245 patients hospitalized on nutritionDays 2006–2014 in 56 countries worldwide: a descriptive analysis[1,2]

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ABSTRACT

Background: Inadequate nutrition during hospitalization is strongly associated with poor patient outcome, but ensuring adequate food intake is not a priority in clinical routine worldwide. This lack of priority results in inadequate and unbalanced food intake in patients and huge amounts of wasted food.

Objectives: We evaluate the main factors that are associated with reduced meal intake in hospitalized patients and the differences between geographical regions.

Design: We conducted a descriptive analysis of data from 9 consecutive, annual, and cross-sectional nutritionDay samples (2006–2014) in a total of 91,245 adult patients in 6668 wards in 2584 hospitals in 56 countries. A general estimation equation methodology was used to develop a model for meal intake, and *P*-value thresholding was used for model selection.

Results: The proportion of patients who ate a full meal varied widely (24.7–61.5%) across world regions. The factors that were most strongly associated with reduced food intake on nutritionDay were reduced intake during the previous week (OR: 0.20; 95% CI: 0.17, 0.22), confinement to bed (OR: 0.49; 95% CI: 0.44, 0.55), female sex (OR: 0.53; 95% CI: 0.5, 0.56), younger age (OR: 0.74; 95% CI: 0.64, 0.85) and older age (OR: 0.80; 95% CI: 0.74; 0.88), and low body mass index (OR: 0.84; 95% CI: 0.79, 0.90). The pattern of associated factors was homogenous across world regions.

Conclusions: A set of factors that are associated with full meal intake was identified and is applicable to patients hospitalized in any region of the world. Thus, the likelihood for reduced food intake is easily estimated through access to patient characteristics, independent of world regions, and enables the easy personalization of food provision. This trial was registered at clinicaltrials.gov as NCT02820246. *Am J Clin Nutr* 2016;104:1393–402.

Keywords: disease-related malnutrition, food intake, hospital, mobility, patient sex, undernutrition

INTRODUCTION

Inadequate feeding and undernutrition are important political and public health issues that affect social and economic performances in both high- and low-income countries (1). Adequate feeding should be a priority when caring for hospitalized patients (2, 3). The clinical relevance has been highlighted by the prevalence of malnutrition in hospitals (up to 50% of patients) (4) and the association between inadequate feeding, increased mortality (up to 8 times), and prolonged length of stay (5, 6). Although proper diet, both qualitatively and quantitatively, is relevant for a patient's recovery (7, 8), the prevalence of reduced meal intake ranges between 50% and 60% (5, 8–10), and inadequate food intake is rarely followed by nutritional care interventions (10). Furthermore, hospitals produce enormous amounts of food waste, which is an ethical and economic issue.

The causes of inadequate feeding in hospitals are multifaceted; disease, per se, is often paralleled by a loss of appetite and functional impairment. The hospital organization of food provision can negatively affect food intake and nutritional status of patients. Such factors include patients' dissatisfaction with meals and

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[2] Supplemental Tables 1–3 are available from the "Online Supporting Material" link in the online posting of the article and from the same link in the online table of contents at http://ajcn.nutrition.org.

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mealtimes (11), the unavailability of staff for feeding assistance (12), missed screening routines and planning and monitoring of nutritional care (10), inadequate awareness, and insufficient training of health care personnel (13).

In 2004, the unchanged prevalence of malnutrition in hospitals over many years gave rise to the concept of the nutritionDay, which is a 1-d survey of patients' food intakes. The focus of nutritionDay data collection is on the assessment of easily accessible data that are typically included in patients' medical histories and on questions that are easily answered by patients themselves that do not require expert knowledge in nutrition medicine.

The first nutritionDay took place in 2006 in Europe and Israel and is now repeated annually worldwide. We have already used this approach to evaluate associations between food intake, nutritional structures and processes (10), mortality (5), and self-rated health (14) in real-world hospital settings worldwide.

Most studies in the field of clinical nutrition have focused on the screening and assessment of nutrition risk and on clinical interventions that have used nutrition substrates. In the current descriptive analysis, we address patient-related factors that are most likely associated with reduced food intake during hospitalization and whether there are differences between regions worldwide.

METHODS

The nutritionDay hospital survey is a worldwide, standardized, 1-d, multinational cross-sectional audit with a 1-mo follow-up. Questionnaires were designed to enable the participation of any interested ward and are available in 32 languages; no specialized knowledge or specific laboratory measurements are necessary (www.nutritionday.org). Participation is voluntary. After data entry in the nutritionDay multilingual online database, wards receive a report comparing their data with those from wards with the same specialty. A detailed description of the nutritionDay survey has been published previously (5). Data from the years 2006–2014 (with Intensive Care Unit data excluded) were used in the current study.

Ethical approval

The nutritionDay project was approved by the Ethical Committee of the Medical University, Vienna (EK407/2005) and has been amended annually. In accordance with national regulations, the project was also submitted to national or local ethical committees in each participating country. This trial was registered at clinicaltrials.gov as NCT02820246.

Data collection and data quality

The collection and quality of data comprised 3 sections as follows: *1*) a unit organization and policy on nutritional screening and nutrition therapy; *2*) caregivers' input regarding patients including data on age, height, weight, medical condition, comorbidities, and type of nutritional intake; and *3*) patients' self-reported weight and nutrition histories before hospitalization and self-reported actual food intakes on the nutritionDay.

Food intake was determined with the use of categories that were similar to those of Olin et al. (15). The main study objective was to determine the amount of food eaten by patients during hospitalization; therefore, only patients who had voluntary food intake were studied. Patients on enteral or parenteral nutrition, terminally ill patients, children, and patients with incomplete information on food intake were excluded (**Figure 1**).

Calculations and statistical analysis

Qualitative variables are described with the use of frequencies and percentages, and quantitative variables are described with the use of means ± SDs.

The chosen target variable for food intake was the quantity eaten on nutritionDay with 4 categories, as follows: full meal eaten, one-half meal eaten, one-quarter meal eaten, or nothing eaten. For convenience, this variable was reduced to 2 categories as follows: full meal eaten and less than full meal eaten. A multivariate logistic regression analysis with the use of general estimation equations (GEEs), with hospital wards as repeated factors, was used to estimate within-hospital ward correlations. The PROC GENMOD procedure (SAS Institute Inc.) was used, and default testing methods were used for calculating P values and CIs.

The following factors were available for the period 2006–2014 and were used in the analyses: food intake during the previous week, unintentional weight loss within the past 3 mo, receipt of supplements, eating snacks, age, sex, BMI (in kg/m^2), physical mobility status, length of hospital stay before nutritionDay, number of drugs prescribed, Intensive Care Unit stay before nutritionDay, organs affected (according to the top International Classification of Diseases-10 groups) (16), ward specialty, year of survey, and region and continent. Correlations between variables were calculated to check for collinearity between variables.

We divided metric variables such as age, length of hospital stay, and BMI into categories. Cutoffs were chosen according to the WHO classification of BMI (17), according to 10-y age groups, or for simplicity (e.g., duration of hospitalization ≥1 or <1 wk). Similarly, countries were summarized to regions (18–20). Missing values of variables were modeled as a separate category.

The univariate GEE for the full meal eaten on nutritionDay was used for prescreening. Only variables that were associated with the outcome ($P < 0.05$) were included in the multivariate modeling. On the basis of the crude preselection, a multivariate GEE approach was used for model building. A smaller-than-usual local significance level of 0.005 was used for selection of variables because model selection with the use of multiple P-value thresholding may serve as a consistent selection procedure if the threshold for individual P values is decreased for large sample sizes (21).

The last step in modeling was to add all possible 2-fold interactions in the selected factors. Interaction terms that showed an association with the outcome at $P < 0.005$ were also included in the final model. SAS software (version 9.4; SAS Institute Inc.) and R software (version 3.2.2; R Core Team) were used for the data analyses (22).

Sensitivity analysis

For the sensitivity analysis to assess the impact of missing outcome data (the quantity eaten on nutritionDay), we repeated the model-building process with the exclusion of all wards with <95% of the outcome reported. A second sensitivity

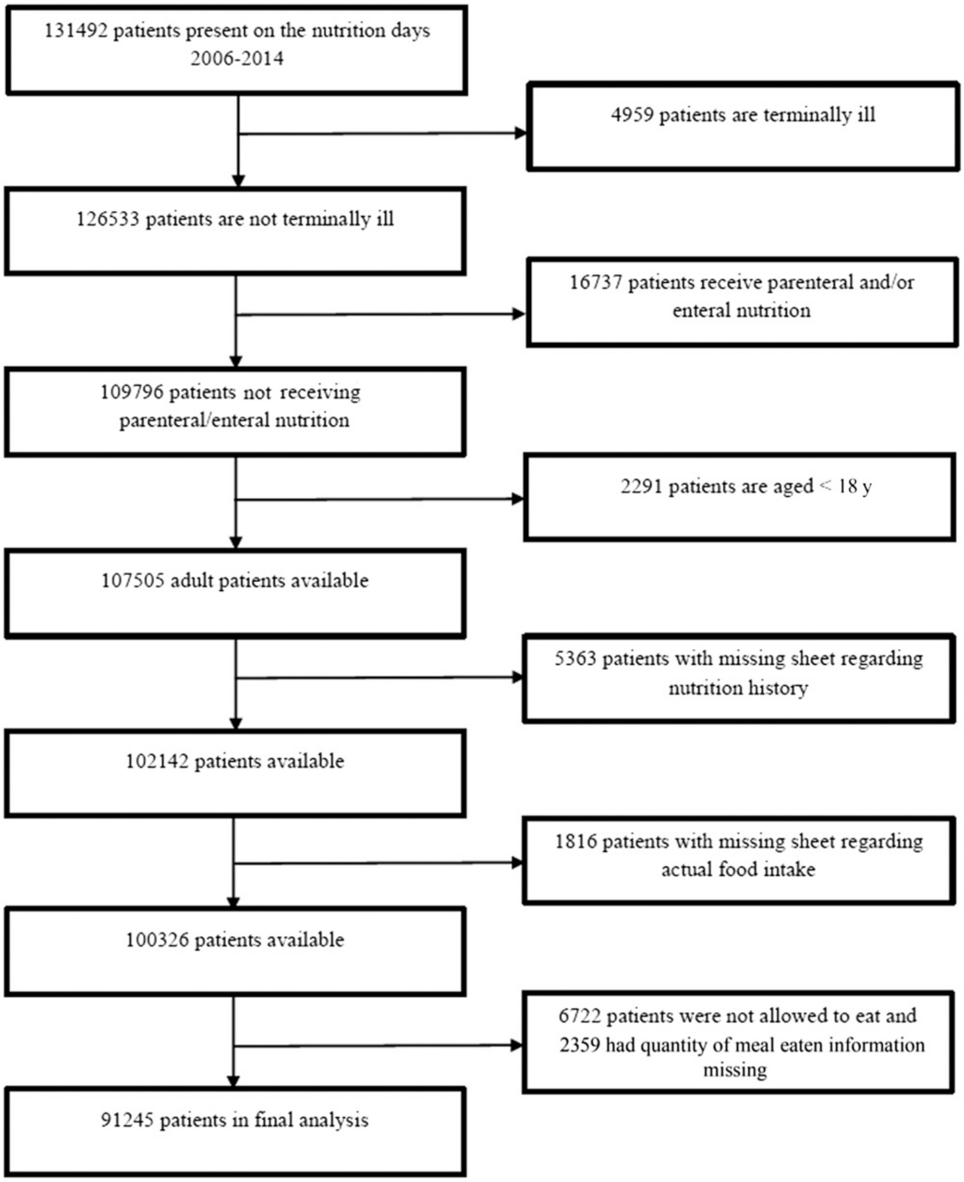

FIGURE 1 Flowchart of the study.

analysis included only cases without any missing values. In a third sensitivity analysis, the target variable quantity eaten on nutritionDay was dichotomized into the categories nothing eaten or more than nothing eaten. The model-building process was repeated again. We also used PROC LOGISTIC (SAS Institute Inc.) to calculate an ordinal logistic regression with the use of the original categories (full meal eaten, one-half meal eaten, one-quarter meal eaten, and nothing eaten) of the target variable quantity eaten on nutritionDay.

RESULTS

Information on 91,245 patients (women: 50.4%) in 6668 wards in 2584 hospitals in 56 countries was available (Figure 1). The mean ± SD age was 64.0 ± 18.2 y, and mean ± SD BMI was 26.0± 6.0). BMI was <18.5 in 6% of patients. Characteristics of the patients are shown in **Table 1**.

Food intake

The majority of patients (53.3%) ate one-half or less of the served main meal; 5.8% of patients ate nothing although they were allowed to eat (Table 1). The resulting multivariate model (**Table 2**) contained 11 main effects and 9 interaction effects. There were large differences between geographical regions (for the assignment of countries to regions, see **Supplemental Table 1**) with regard to eating the full meal (range: 24.7–61.5%; **Supplemental Table 2**). Compared with Western Europe, patients hospitalized in Northern Europe (OR: 1.71; 95% CI: 1.38, 2.11), the Western Pacific or Asia (OR: 1.71; 95% CI: 1.44, 2.05), and Central and Eastern Europe (OR: 1.24; 95% CI: 1.04, 1.47) were more likely to eat the full meal. In contrast, patients in the Eastern Mediterranean region (OR: 0.29; 95% CI: 0.17, 0.49) and Southern Europe (OR: 0.85; 95% CI: 0.74, 0.98) had a significantly greater chance of eating less.

TABLE 1
Demographic profile and characteristics of patients on nutritionDays 2006–2014[1]

Variable or group	*n* (%)
Total population[2]	91,245 (100.0)
Age, y	
18–29	4991 (5.5)
30–39	5911 (6.5)
40–49	8605 (9.4)
50–59	13,739 (15.1)
60–69	18,122 (19.9)
70–79	19,412 (21.3)
80–89	16,336 (17.9)
>90	4129 (4.5)
Sex	
F	46,032 (50.4)
M	44,674 (49.0)
No information	539 (0.6)
BMI, kg/m^2	
<18.5	5330 (5.8)
18.5–24.9	35,712 (39.1)
25–29.9	25,399 (27.8)
30–34.9	10,905 (12.0)
35–40	3637 (4.0)
>40	2148 (2.4)
No information	8114 (8.9)
Have you lost weight unintentionally within the past 3 mo?	
Yes	39,953 (43.8)
No	35,999 (39.5)
No, I have gained weight	8245 (9.0)
I do not know	6044 (6.6)
No information	1004 (1.1)
How well did you eat last week?	
Normal	46,636 (51.1)
A bit less than normal	21,301 (23.3)
Less than one-half of normal	13,344 (14.6)
Less than one-quarter of normal	8728 (9.6)
No information	1236 (1.4)
Receiving supplements, yes	8613 (9.4)
Eating snacks on nutritionDay	
No	53,749 (58.9)
Yes, 1 snack	21,120 (23.1)
>1 snack	16,376 (17.9)
What did you eat today?	
All of the meal	42,577 (46.7)
One-half of the meal	29,282 (32.1)
One-quarter of the meal	14,117 (15.4)
Nothing (allowed to eat)	5269 (5.8)
Dietetic personnel present	
Yes	40,734 (44.6)
No	31,907 (35.0)
No information	18,604 (20.4)
Can you walk unaided?	
Yes	58,576 (64.2)
No, only with assistance	22,541 (24.7)
No, I stay in bed	8610 (9.4)
No information	1518 (1.7)
Drugs prescribed, *n*	
0	5937 (6.5)
1–2	13,160 (14.4)
3–5	24,014 (26.3)
>5	34,581 (37.9)
No information	13,553 (14.9)

(Continued)

TABLE 1 (*Continued*)

Variable or group	*n* (%)
Duration since admission to hospital, d	
≤7	50,459 (55.3)
>7	39,313 (43.1)
No information	1473 (1.6)
ICU stay	
Yes	8710 (9.5)
No	77,942 (85.4)
No information	4593 (5.1)
Main admission group	
Internal	35,756 (39.2)
Surgery	36,813 (40.3)
Geriatrics	6888 (7.5)
Neurology	2745 (3.0)
Other	9043 (9.9)
Geographical region	
Central America	511 (0.6)
Central and Eastern Europe	8935 (9.8)
Eastern Mediterranean	1365 (1.5)
North America	7739 (8.5)
Northern Europe	5019 (5.5)
South America	7973 (8.7)
Southeastern Europe	2954 (3.2)
Southern Europe	18,177 (19.9)
Western Europe	29,303 (32.1)
Western Pacific and Asia	9269 (10.2)
Affected organs according to ICD-10 top group (multiple answers were possible)	
Brain, nerves	14,017 (15.4)
Eye, ear	2023 (2.2)
Nose, throat	2066 (2.3)
Heart, circulation	25,270 (27.7)
Lung	15,203 (16.7)
Liver	5402 (5.9)
Gastrointestinal tract	16,115 (17.7)
Kidney or urinary tract	11,407 (12.5)
Endocrine system	20,346 (22.3)
Skeleton, bone, or muscle	16,237 (17.8)
Blood or bone marrow	4203 (4.6)
Skin	3363 (3.7)
Ischemia	1205 (1.3)
Cancer	13,415 (14.7)
Infection	5766 (6.3)
Other	37,037 (40.6)

[1] All values are absolute and relative frequencies of variables. ICD-10, International Classification of Diseases-10; ICU, Intensive Care Unit.

[2] Patients who were not allowed to eat and those with missing data on food intake were excluded.

Moreover, the variable region was contained in 7 of 9 interaction effects; because of its strong association, we present the final model for the whole sample and have applied it separately to the different regions including the 2 interaction effects that did not include the regions. The regional distribution of the factors is shown in Supplemental Table 2. Correlations between factors were only low to moderate. The 2 highest correlation coefficients were between the age group and the affected organ heart (r-Kendall = 0.232) and between age group and mobility (r-Kendall = 0.228).

TABLE 2
Multivariate and univariate analyses showing factors associated with eating the full main meal on nutritionDay (all compared with less than all) (n = 91,245)[1]

	Univariate		Multivariate	
Factor and amount or level	OR (95% CI)	P	OR (95% CI)	P
Age, y				
18–29	0.78 (0.73, 0.83)	<0.001	0.74 (0.64, 0.85)	<0.001
30–39	0.93 (0.87, 0.98)	0.01	0.85 (0.75, 0.96)	0.01
40–49	1.00 (0.95, 1.06)	0.88	1.04 (0.94, 1.16)	0.46
50–59	1.04 (1.00, 1.09)	0.05	1.10 (1.00, 1.20)	0.05
60–69 (reference)	1.00		1.00	
70–79	0.87 (0.83, 0.90)	<0.001	0.97 (0.90, 1.05)	0.46
80–89	0.64 (0.61, 0.67)	<0.001	0.80 (0.74, 0.88)	<0.001
≥90	0.48 (0.44, 0.51)	<0.001	0.62 (0.55, 0.71)	<0.001
Sex				
M (reference)	1.00		1.00	
F	0.55 (0.53, 0.56)	<0.001	0.53 (0.50, 0.56)	<0.001
BMI, kg/m^2				
<18.5	0.69 (0.65, 0.73)	<0.001	0.84 (0.79, 0.90)	<0.001
18.5–24.9 (reference)	1.00		1.00	
25–29.9	1.16 (1.13, 1.20)	<0.001	1.06 (1.02, 1.10)	0.002
30–34.9	1.19 (1.14, 1.24)	<0.001	1.10 (1.05, 1.16)	<0.001
35–40	1.28 (1.19, 1.37)	<0.001	1.28 (1.19, 1.39)	<0.001
>40	1.18 (1.09, 1.29)	<0.001	1.26 (1.14, 1.39)	<0.001
No information	1.00 (0.94, 1.06)	0.99	1.04 (0.97, 1.11)	0.24
Unintended loss of weight				
No (reference)	1.00	—	1.00	—
Yes	0.63 (0.61, 0.65)	<0.001	0.90 (0.87, 0.93)	<0.001
No, I have gained weight	0.98 (0.94, 1.03)	0.53	0.97 (0.92, 1.02)	0.24
Not sure	0.62 (0.58, 0.65)	<0.001	0.83 (0.78, 0.89)	<0.001
No information	0.69 (0.61, 0.78)	<0.001	0.86 (0.74, 0.99)	0.04
Eaten last week				
Normal (reference)	1.00	—	1.00	—
A bit less than normal	0.37 (0.36, 0.38)	<0.001	0.47 (0.43, 0.50)	<0.001
Less than one-half of normal	0.20 (0.19, 0.20)	<0.001	0.26 (0.23, 0.28)	<0.001
Less than one-quarter of normal	0.15 (0.15, 0.16)	<0.001	0.20 (0.17, 0.22)	<0.001
No information	0.37 (0.33, 0.42)	<0.001	0.49 (0.42, 0.57)	<0.001
Receiving supplements				
No (reference)	1.00		1.00	
Yes	0.64 (0.61, 0.68)	<0.001	0.80 (0.73, 0.87)	<0.001
Walk unaided				
Yes (reference)	1.00		1.00	
No, only with assistance	0.58 (0.56, 0.60)	<0.001	0.67 (0.62, 0.72)	<0.001
No, I stay in bed	0.43 (0.41, 0.46)	<0.001	0.49 (0.44, 0.55)	<0.001
No information	0.73 (0.66, 0.82)	<0.001	0.90 (0.80, 1.01)	0.09
Duration since admission to hospital, d				
≤7 (reference)	1.00	—	1.00	—
>7	0.94 (0.91, 0.96)	<0.001	1.19 (1.11, 1.27)	<0.001
No information	1.06 (0.94, 1.19)	0.35	1.05 (0.92, 1.20)	0.47
Organs (reference: not affected)				
Liver	0.83 (0.79, 0.88)	<0.001	0.82 (0.77, 0.87)	<0.001
Gastrointestinal tract	0.79 (0.76, 0.82)	<0.001	0.91 (0.87, 0.95)	<0.001
Kidney, urinary tract, or female genital tract	0.84 (0.80, 0.87)	<0.001	0.88 (0.84, 0.92)	<0.001
Endocrine system	1.08 (1.05, 1.12)	<0.001	1.10 (1.06, 1.14)	0.002
Cancer	0.80 (0.77, 0.84)	<0.001	0.80 (0.76, 0.84)	<0.001
Admission group				
Internal (reference)	1.00	—	1.00	—
Surgery	1.05 (1.01, 1.09)	0.02	1.01 (0.94, 1.09)	0.82
Geriatrics	0.93 (0.86, 0.99)	0.04	1.23 (1.10, 1.38)	<0.001
Neurology	1.36 (1.22, 1.51)	<0.001	1.23 (1.04, 1.44)	0.01
Other	1.19 (1.11, 1.27)	<0.001	1.08 (0.97, 1.20)	0.14
Geographical region				
Western Europe (reference)	1.00	—	1.00	—
Central America	0.93 (0.76, 1.15)	0.53	1.14 (0.85, 1.53)	0.39

(Continued)

TABLE 2 (*Continued*)

	Univariate		Multivariate	
Factor and amount or level	OR (95% CI)	*P*	OR (95% CI)	*P*
Central and Eastern Europe	1.20 (1.12, 1.30)	<0.001	1.24 (1.04, 1.47)	0.02
Eastern Mediterranean	0.38 (0.31, 0.46)	<0.001	0.29 (0.17, 0.49)	<0.001
North America	0.90 (0.84, 0.95)	<0.001	1.22 (1.02, 1.45)	0.03
Northern Europe	1.41 (1.30, 1.52)	<0.001	1.71 (1.38, 2.11)	<0.001
South America	1.09 (1.01, 1.18)	0.02	1.11 (0.90, 1.36)	0.32
Southeastern Europe	0.98 (0.87, 1.11)	0.77	1.05 (0.79, 1.40)	0.72
Southern Europe	0.86 (0.81, 0.91)	<0.001	0.85 (0.74, 0.98)	0.03
Western Pacific and Asia	1.90 (1.77, 2.05)	<0.001	1.71 (1.44, 2.05)	<0.001
Eaten last week × duration of stay, d				
A bit less than normal; >7	—	—	0.82 (0.76, 0.88)	<0.001
Less than one-half of normal; >7	—	—	0.74 (0.68, 0.82)	<0.001
Less than one-quarter of normal; >7	—	—	0.75 (0.66, 0.84)	<0.001
Walk unaided × duration of stay, d	—	—		
No, only with assistance; >7	—	—	1.17 (1.10, 1.26)	<0.001
No, I stay in bed; >7	—	—	1.17 (1.05, 1.31)	0.005

[1] ORs >1 indicate that the probability of eating the full meal was increased. *P* values were determined with the use of chi-square test statistics.

The results of application of the model to the total sample (overall) and to separate regions are shown in **Figures 2** and **3**. The 3 regions with the smallest sample sizes [i.e., Southeastern Europe (*n* = 2954), Eastern Mediterranean (*n* = 1365), and Central America (*n* = 511)] are not shown in Figures 2 and 3 because the resulting estimates lacked precision.

We showed that eating less during the previous week was most strongly associated with not eating the full meal on nutritionDay in terms of the area under the receiver operating characteristic curve (aROC) in the univariate analysis. The OR for eating the full meal on nutritionDay was 0.20; (95% CI: 0.17, 0.22) when patients who were eating less than one-quarter were compared with patients who ate normally the previous week. The OR increased stepwise for eating more on nutritionDay with increased amounts of food consumed in the previous week. Compared with the ability to walk unaided, being bedridden showed the next strongest effect (OR: 0.49; 95% CI: 0.44, 0.55). This factor was closely followed by female sex compared with male sex (OR: 0.53; 95% CI: 0.50, 0.56). The association between food intake and age was U-shaped for younger patients compared with the reference category of 60–69-y-olds (OR for 18–29-y-olds: 0.74; 95% CI: 0.64, 0.85), and older patients ate less than patients aged 60–69 y (OR for 80–89-y-olds: 0.80; 95% CI: 0.74, 0.88).

Other less-influential factors were receiving a food supplement (OR: 0.80; 95% CI: 0.73, 0.87), unintended weight loss compared with no weight loss (OR: 0.90; 95% CI: 0.87, 0.93), and lower BMI (<18.5: OR, 0.84; 95% CI, 0.79, 0.90). Patients in geriatric wards (OR: 1.23; 95% CI: 1.10, 1.23) and neurologic wards (OR: 1.23; 95% CI: 1.04, 1.44) were more likely to eat a full meal than were patients who were in internal medical wards. Food intake was also associated with the length of hospitalization whereby the longer the hospital stay was, the more the patients ate. In contrast, the effect of mobility was less pronounced with increasing lengths of stay. However, the overall effect of the 2 interactions (excluding regions) was almost negligible in the model.

Despite differences between regions in eating the full meal, the patterns of associations between eating less and the factors were very similar across the regions (Figures 2 and 3). For example, the pattern for the 5 most important factors (amount eaten in the past week, mobility, sex, age, and BMI) was of similar shape in all regions.

The discriminatory capability of the resulting model (aROC) was 0.738. With the use of a more parsimonious model with the 5 important factors, the aROC decreased to 0.718. If the model was reduced even further by omitting BMI, the aROC was almost the same. When a model with only 3 factors was used (amount eaten during the past week, patient sex, and mobility), the aROC was 0.714.

Sensitivity analyses

In the sensitivity analysis with the exclusion of wards with <95% of outcome data, 78,710 patients were available. The approach previously described was used to build the model. The same 11 main effects and the same 9 interaction effects were selected. Estimates were very similar to those in the original model.

For the complete case-sensitivity analysis, 64,553 patients were available. The variable year was added to the model. The other variables remained in the model, and estimates were similar to those in the original model. Eleven significant interaction effects (6 effects included the variable region) were also added.

In the third sensitivity analysis, with the target variable eating more than nothing compared with nothing, a slightly different model resulted (**Supplemental Table 3**). The variable patient's sex was no longer included in the model. As regards the affected organs, the gastrointestinal tract and cancer were associated with decreased meal intake, whereas skeleton, bone, and muscle were associated with increased intake. Some other variables such as eating snacks, the number of drugs prescribed, and the year entered the model. Eating snacks was associated with eating at least something in the main meal. The resulting model contained

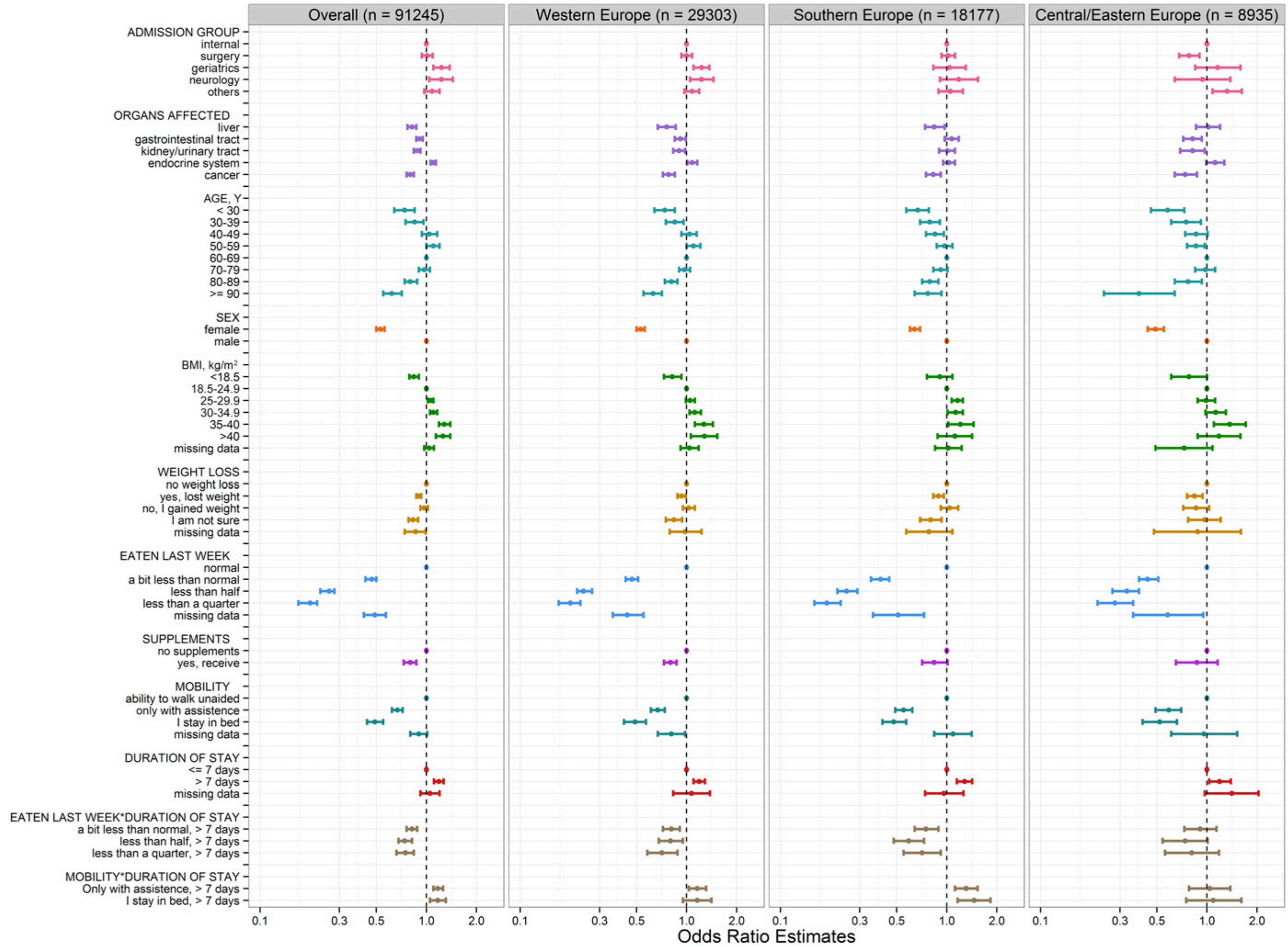

FIGURE 2 Multivariate analysis (ORs and 95% CIs) showing factors associated with eating the full meal on nutritionDay (full meal eaten compared with one-half meal eaten, one-quarter meal eaten, or nothing eaten) for the overall sample and for Western European, Southern European and Central and Eastern European regions. ORs >1 indicate that the probability of eating the full meal was increased.

only 3 significant interaction effects, and only 1 of these interaction effects included regions. The resulting aROC was 0.717.

In the last sensitivity analysis, with the use of ordinal logistic regression, more variables were selected in the final model (eating snacks, number of drugs prescribed, year, and variables regarding affected organs). However, in this model, the proportional odds assumption was not met ($P < 0.0001$).

DISCUSSION

Our study showed that 47% of hospitalized patients (n = 91,245) had inadequate food intake on nutritionDays. However, food intake varied substantially across the world. To explain why the OR for eating the full meal in the nutritionDay cohort varied by up to 71% across world regions compared with in Western Europe (the reference region) would have required data beyond the nutritionDay survey protocol.

The most-important factors associated with eating less than the full meal were eating less the week before, physical immobility, female sex, old or young age, and very low BMI. Note that the pattern of these factors appeared homogeneous worldwide (Figures 2 and 3). Strikingly, when only the 3 most important factors were used (i.e., the quantity eaten during the past week, immobility, and female sex), the quality of association was not noticeably reduced.

In other studies on patients' food intake in larger hospital populations (8, 9, 23), the proportions of patients with insufficient food intake were similar. Reduced previous food intake was the factor that was most-strongly associated with reduced intake on nutritionDay in all regions, thereby underpinning the importance of documenting patients' dietary histories when assessing the likelihood of decreased food intake. Such screening and monitoring of food intake during hospitalization is not implemented in every ward (10), and not every screening tool for nutrition risk includes questions on recent food intake (24).

Female sex and immobility were the factors that were the second and third most-strongly associated factors with impaired food intake, which pointed toward structural and organizational factors in hospitals, namely food provision (25), portion size (26), choice of portion size, ward activities around mealtimes, and availability of support in association with eating (11). The third sensitivity analysis with the target variable eating more than

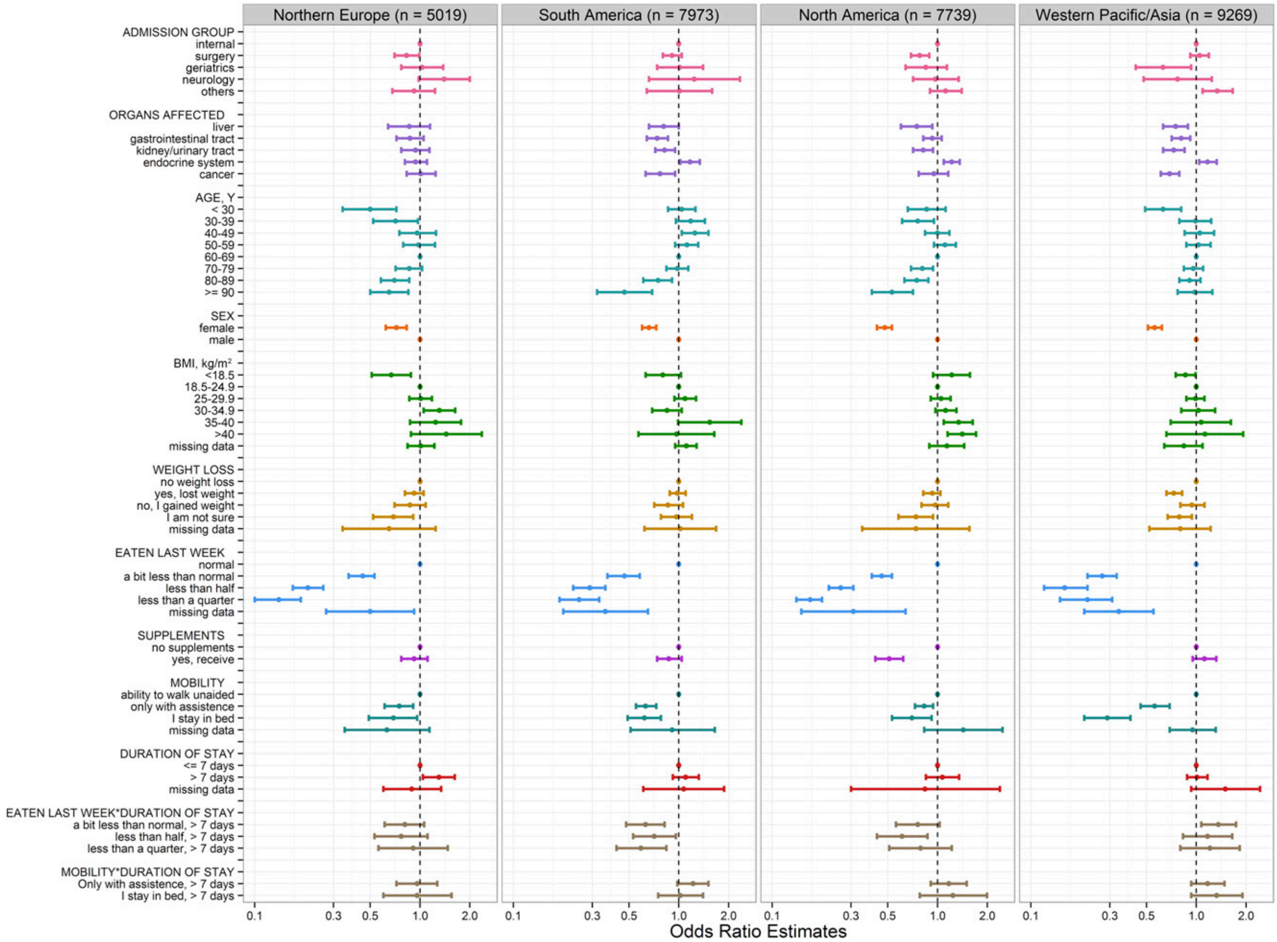

FIGURE 3 Multivariate analysis (ORs and 95% CIs) showing factors associated with eating the full meal on nutritionDay (full meal eaten compared with one-half meal eaten, one-quarter meal eaten, or nothing eaten) for Northern European, South American, North American, and Western Pacific and Asian regions. ORs >1 indicate that the probability of eating the full meal was increased.

nothing compared with nothing endorsed this finding: eating nothing did not depend on the sex of the patient. The full meal may have been too large for many women; more frequently, women indicated that they normally ate less than the quantity served. The serving of a smaller portion of a complete meal may increase the likelihood of balanced intake than would eating patient-selected parts of a larger meal. Moreover, the recommended dietary intake is lower for women than for men, and women might be more concerned about their weight as has been reflected by the underrepresentation of men in clinical weight-loss trials (27). We are aware that sex also stands as a proxy for other patient characteristics such as weight, height, and body composition.

Older age and age <40 y were also associated with reduced meal intake. The finding of a global U-shaped pattern has been supported by nation-specific malnutrition prevalence data from the Nutrition Screening Week 2007–2011 (28). Younger patients might suffer from more-serious diseases when admitted to the hospital and have a disease-related or younger age–related higher expenditure of energy (29, 30) Actual reduced meal intake might supply sufficient energy for women and older patients. Nevertheless, it is questionable whether micronutrient requirements are met when these patients, especially those who are hospitalized for longer, regularly eat unbalanced or only selected parts of the meal provided.

BMI <18.5 has a long history as an indicator of malnutrition in global health and in hospital and nursing-home settings. Globally, low BMI is associated with reduced food intake. The higher percentage of patients with BMI <18.5 in the Western Pacific and Asia is noteworthy; however, this factor might be ethnicity specific, thereby questioning the usefulness of BMI of 18.5 or even 20 (31) as an indicator for malnutrition in Asian hospital populations. The higher general prevalence of obesity in the North American population (32) is reflected in the higher obesity rate in hospitalized patients.

There are large differences in food intakes between world regions (e.g., 61.5% of Western Pacific and Asia patients eat the full meal compared with 42.7% of patients in North America. The Western Pacific and Asia population consists of >50% of Japanese patients (Supplemental Table 1). Since 1998, duties of the nutrition-support teams in hospitals have been expanded from the provision of artificial nutrition to taking care of food intake in general (T Higashiguchi, personal communication, 21 June 2016). We can only speculate that such structures have impacts on food selection, presentation, and intake. Moreover, the length of stay in Japan is, on average, >2 times as long as in Organisation for Economic Co-operation and Development countries (33). In our study, the proportion of patients who stayed >1 wk in the Western Pacific and Asia region was the highest of all regions (59.9% compared with, e.g., 22.8% in North America; Supplemental Table 2). It is known that daily food intake increases with the length of stay.

Because of the large sample size, we showed that there were several other significant associated variables (Table 2, Figures 2 and 3); however, these variables did not noticeably influence the likelihood of reduced food intake, and we have not provided a detailed discussion and interpretation.

The strengths of this study are the evaluation of factors associated with food intake *1*) with the use of the same standardized and simple data-collection tool, *2*) in local languages, *3*) at the same time, *4*) in a large number of patients hospitalized, 5) in different world regions, and *6*) not only in specialized academic settings but also in all kinds of hospitals.

Nevertheless, our study has several potential limitations. We are aware that the sample could not be considered as representative for every country worldwide. The wards that participated in the study represented a convenience sample, which could have caused sampling bias; however, the wards represented a wide range of specialties, which increased the likelihood of the participation of wards without a special interest in nutrition. The participation rate varied widely between countries within regions.

A second weakness of the study is the number of patients with incomplete data. However, the sensitivity analysis that included only wards providing 95% of the outcome data did not noticeably change the results. The catering characteristics of the hospitals (i.e., buffet, bulk trolley, or plate system) and the amount of food provided were not assessed and may have had some impact on the data reported (34). No information was collected on the macronutrient composition of served or consumed foods, which could have influenced both the satiety and outcomes in at-risk patients (5, 35, 36). Most caregivers do not have the ability to calculate the energy content and macronutrient composition of meals; therefore, asking for the meal composition in such a large cross-sectional survey would have excluded all wards without access to nutrition experts. Consequently, the mapping of meal intake in a large-scale, real-life environment would have been impossible.

The division of the meals into quarters allowed for the assessment of what was not eaten, thereby providing a semiquantitative estimate. To that end, we used a sensitivity analysis with a different dichotomization of meal intake of eating at least something compared with eating nothing. A similar pattern of factors was identified with the exception of patient sex (Supplemental Table 3) because this variable had an effect on eating the full meal or not but not on eating nothing. The most important factors for eating nothing were eating less the week before, physical immobility, old and young age, and very-low BMI.

In conclusion, this study identified a set of factors associated with full meal intake on nutritionDay in patients hospitalized worldwide. A very similar pattern of factors was found for patients who ate nothing. The results highlight the importance of questions on recent food intake, physical mobility, patient sex, age, and BMI for planning food provision and nutrition care in hospitals. The likelihood of reduced food intake can be estimated through easy access to patient characteristics, independent of world region, and allows for the easy personalization of food provision. These factors confirm a common-sense approach and are applicable universally, no matter in which region of the world a patient is hospitalized.

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