Nutrition and Health (including climate and ecological aspects)

Recent and current low food intake – prevalence and associated factors in hospital patients from different medical specialities

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BACKGROUND/OBJECTIVES: Poor food intake is a major etiological factor of malnutrition. This research aims to describe the prevalence of recent and current low food intake (LIRC) and to identify factors associated with LIRC in adult hospital patients from different medical specialities.

SUBJECT/METHODS: 1865 patients participating in the nutritionDay survey 2016–2020 in Germany were included. LIRC was defined by decreased eating both on nutritionDay and in the week before hospitalisation. Multivariate binary logistic regression was used to identify factors associated with LIRC overall and in different specialities.

RESULTS: LIRC was observed in 21.1% of all patients, with the highest prevalence in Gastroenterology (26.6%) and the lowest in Neurology (11.2%). Weight loss within three months before nutritionDay (OR 2.62 [95% CI 1.93–3.56]), (very) poor self-rated health (2.17 [1.62–2.91]), female sex (1.98 [1.50–2.61]), uncertain weight loss (1.90 [1.03–3.51]), digestive disease (1.90 [1.40–2.56]), inability to walk without assistance (1.55 [1.14–2.12]) and emergency admission (1.38 [1.02–1.86]) were associated with increased risk, cardiac insufficiency (0.55 [0.37–0.83]) and being in a neurological ward (0.51 [0.28–0.92]) with decreased risk in the total sample. In Gastroenterology and Oncology, estimates were higher than in the entire sample; no significant associations were found in Neurology and Geriatrics, presumably due to the low prevalence of LIRC in Neurology and limited data quality in Geriatrics.

CONCLUSION: LIRC is common in German hospital patients and associated with female sex, poor health and decreased functional status. Interdisciplinary differences suggest a discipline-specific approach to dealing with malnutrition.

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INTRODUCTION

Malnutrition is known to impair many organ systems and physiological functions, resulting in poor clinical outcomes [1], increased complication rates, prolonged hospital stays and subsequent higher healthcare costs [2]. Low food intake is a major contributing factor to malnutrition [3] and has been identified as a risk factor for 30-day-mortality through the nutritionDay project [4], an annual worldwide study initiated to increase awareness of disease-related malnutrition in healthcare facilities. Causes of reduced eating are numerous and include disease-related factors (e.g. loss of appetite, feeling too sick or tired), hospital-related (e.g. unfamiliar serving times, meal interruptions) and individual factors (e.g. physical disabilities, need of assistance) [5, 6]. Low food intake during the week before the nutritionDay survey has been associated with reduced eating on nutritionDay [7]. Recent and current low food intake (LIRC) both on nutritionDay and prior to hospitalisation may be even more relevant for the development of malnutrition and poor outcome than reduced eating at one single point in time only. To the best of our knowledge, no information about LIRC has been published up to now.

Apart from that, varying malnutrition prevalence rates have been reported in different medical disciplines. According to the Malnutrition Screening Tool (MST), especially patients from oncological, long-term care and infectious disease units are at nutritional risk [8]. Another study using Subjective Global Assessment (SGA) found a significantly higher risk for malnutrition in oncological and gastroenterological patients than in patients from other specialities [9]. Henriksen et al. [10] focused on reduced food intake during the week prior to nutritionDay, and reported that surgical patients were more frequently affected than others. There is, however, no detailed comparison of medical specialities regarding low food intake and associated factors. Knowledge on discipline-related variations could be helpful in counteracting poor eating in a targeted, discipline-specific manner.

Moreover, to date little is known about malnutrition in German hospitals. In a multicentre study from 2006, 27% of the patients were malnourished according to SGA, with wide variation...
between medical specialities: prevalence ranged from below 10% in Gynaecology to >50% in geriatric patients [11]. Unfortunately, no further up-to-date information has been published despite strong political interest and available nutritionDay data from Germany. Thus, the German nutritionDay database was used with the aim of describing the prevalence of and factors associated with LIRC, i.e. both on nutritionDay and in the week before hospital admission, overall and in different medical disciplines.

MATERIAL & METHODS

The nutritionDay survey

nutritionDay is an annual one-day cross-sectional study in hospitals, intensive care units and nursing homes worldwide. The project was founded in 2006 with the support of the European Society for Clinical Nutrition and Metabolism (ESPEN) and the Medical University of Vienna in order to raise attention to malnutrition. Participation is open to any interested institution and free of charge, and registration is accomplished online (www.nutritionday.org). The data is collected and entered into the database by local unit staff by means of a standardised questionnaire, which can be downloaded in >30 languages from the nutritionDay website. The questionnaire consists of three parts: one hospital sheet, two unit sheets and four sheets concerning the patient – two filled out by unit staff and two completed by the patients themselves. Hospital patient outcome is collected 30 days after nutritionDay. The survey is approved yearly by the ethics committee of the Medical University of Vienna (number 407/2005) and was also approved by the ethics committee of the Friedrich-Alexander-Universität Erlangen-Nürnberg in Germany in 2018 (number 208_18 B).

Study participants

For this research project, adult patients (≥18 years) from German hospital units participating in the nutritionDay surveys from 2016 to 2019 and from three additional units participating in August 2020 were included. Patients who participated in the nutritionDay hospital express survey were excluded because of the reduced questionnaire. Patients who did not give oral or written consent, with missing information about specialty and sex, and in wards reporting outcome 30 days after nutritionDay from less than 75% of the participating patients.

Variables

Food intake. LIRC was defined by two variables from the questionnaire filled out by the patient: ‘Lunch eaten on nutrition-Day’, described in words and by a symbolic plate used to visualise the eaten meal, was categorised as follows: ‘About all’ was considered normal eating, while ‘1/2’, ‘1/4’ and ‘nothing’ were summarised as reduced intake. The amount of food eaten before hospital admission (‘eaten before admitted’) was defined adequate when patients answered ‘More than normal’ or ‘normal’, and reduced when ‘3/4 of normal’, ‘about half’ or ‘about a quarter to nearly nothing’ were indicated. If patients were unable to complete the questionnaire, data was collected by unit staff. Food intake was defined as recently and currently low (LIRC) if it was reduced on nutritionDay as well as in the week before hospital admission.

Potential factors associated with LIRC. Medical specialities, specified on the unit questionnaire, were categorised into the following groups: Internal Medicine (Cardiology, Nephrology, Infectious diseases and General Internal Medicine), Gastroenterology (including Hepatology), Geriatrics, Oncology (including Radiotherapy), Surgery (General, Cardiac/Vascular/Thoracic, Orthopaedic, Neurosurgery, Trauma) and Neurology. All other units (Interdisciplinary, Ear Nose Throat, Gynaecology/Obstetrics, Psychiatry, Paediatrics, Others) were summarised as ‘Others’.

From the patient’s questionnaire completed by unit staff, the following variables were considered: age (dichotomised as ‘70 years or older’ and ‘below 70 years’), sex (female – male), body mass index (BMI, calculated as weight/height2 and classified into <20, 20–30 and >30 kg/m²), admission type (emergency – planned – I do not know), length of hospital stay before nutritionDay (LOS, dichotomised as ‘up to 4 days’ – ‘more than 4 days’), number of medications on nutritionDay (oral and other, categorised into ‘up to 5’ – ‘more than 5’), previous surgery (Yes, planned – Yes, acute – No, categorised into ‘Yes’ – ‘No’), prior ICU admission (Yes – No) and terminal illness (Yes – No – I do not know). ‘Diseases and endocrine, nutritional and metabolic disease’ were rated as present if chosen by unit staff out of 21 admission diagnoses (multiple answer options), or if indicated as main diagnosis. The following comorbidities were included: cancer, dementia, cardiac insufficiency, infection, and chronic liver, lung and kidney disease (Yes – No, respectively).

From the questionnaire completed by the patients, the following variables were included: weight loss within the three months before nutritionDay (Yes, intentional – Yes, unintentional – No, gained weight – No, stayed the same – I do not know, categorised into ‘Yes’ – ‘No’ – ‘unknown’) and the ability to walk without assistance on nutritionDay (Yes – No, only with assistance’ and ‘No, I stay in bed’ merged into ‘No’). Self-rated general health was asked in five categories (very good – good – fair – poor – very poor) and divided into the two groups ‘fair or better’ and ‘poor or very poor’. Patients who were unable to complete their questionnaire received help from unit staff.

Statistical analysis

Statistical analysis was performed using IBM SPSS Statistics version 26.0. Absolute frequencies and percentage were calculated for categorical variables, and mean with standard deviation for continuous variables. Univariate binary logistic regression models with LIRC as dependent variable were calculated in the entire sample for each of the above-mentioned variables. Continuous independent variables were categorised for simplicity. The reference group of LIRC consisted of patients with normal food intake both before hospitalisation and on nutritionDay, as well as patients who reported reduced eating at either point in time but not both. Cases with missing information about LIRC were excluded. Participants with missing information on independent variables were also excluded if the percentage of missing values was below 10% in the whole sample. If the percentage was 10% or more, a separate category was created. All univariate models not per se containing either age or sex were adjusted for both variables. A p value below 0.1 was set as inclusion criterion for the multivariate binary logistic regression model, which was calculated in the total population. To check for peculiarities in medical specialities, the multivariate model was then calculated separately for every discipline. Odds ratios (OR) with 95% confidence intervals (CI) are reported. Regression models were tested for significance through omnibus chi² test, and effect size is presented according to Cohen’s f².

RESULTS

Study participants

The patient inclusion process is described in Fig. 1. 15.5% of patients had to be excluded; mainly to meet the quality criterion of more than 75% completed outcome sheets in the unit. In total, 1865 patients from 127 units in 44 hospitals were included, 23.2% of which from gastroenterological/hepatological units, 17.3% surgical (13.9% General and 3.4% Orthopaedic Surgery) and 15.0% oncological patients. 13.0% were treated in neurological, 11.4% in Internal Medicine (10.7% General Internal Medicine and 0.7% Infectious disease units) and 9.2% in geriatric wards. The group of ‘Others’ (11.0%) was composed of 4.5% interdisciplinary
Factors associated with LI\textsubscript{RC}

In the univariate analyses, the subsequent variables met the selection criterion and were thus included in the multivariate model: age; sex; BMI; weight loss within the three months before nutrition\texttextsubscript{Day}; admission type; cardiac insufficiency; infection; digestive disease; endocrine, nutritional or metabolic disease; self-rated general health; ability to walk without assistance on nutrition\texttextsubscript{Day}; and medical speciality (Table S1). According to the multivariate logistic regression in the entire sample, female sex, weight loss and unknown weight loss history, emergency admissions, digestive disease, poor or very poor self-rated general health, and not being able to walk without assistance on nutrition\texttextsubscript{Day} were positively associated with LI\textsubscript{RC}. Neurology admission and cardiac insufficiency were related to a reduced risk of LI\textsubscript{RC} (Table 3). Regarding medical specialities, most associations and consistency with the whole sample were found in Gastroenterology and Oncology patients (Table 4). Odds ratios of significant associations were generally higher in the subgroups than in the total population, and highest in Oncology, especially for poor or very poor self-rated general health, unknown admission type and female sex. In Gastroenterology, odds ratios for weight loss and unknown weight loss were about 4- and 3-times increased compared with no weight loss. In the Internal Medicine sample, patients unable to walk without assistance on nutrition\textsubscript{Day} had the highest risk of LI\textsubscript{RC}, whereas the odds ratio of cardiac insufficiency was reduced. Weight loss and digestive disease were relevant in Surgery and the group of other specialties. No significant associations were found in both Geriatrics and Neurology. All multivariate models except those of Neurology and Geriatrics were significant in the chi\textsuperscript{2} test for overall model fit, and effect size was strong for Internal Medicine, Gastroenterology and Oncology (Cohen’s \( f^2 \geq 0.35\)), medium for the overall sample, Geriatrics, Surgery and Others (\( f^2 > 0.15\)), and low for Neurology (\( f^2 > 0.02\)).

DISCUSSION

Low food intake

This analysis of recent data from German hospitals participating in the nutrition\textsubscript{Day} study focuses on reduced nutritional intake as an important etiological contributor to malnutrition [3], which is associated with poor outcomes [4]. Low food intake at a single meal on nutrition\textsubscript{Day} was examined earlier, and prevalence rates of 53% [7] and 52% [4] were reported in worldwide samples. In this analysis, also about half of the patients reported low food intake on nutrition\textsubscript{Day}, thereby confirming that this problem is found to a similar extent in German hospitals, despite the rather good health care system. When focusing only on one meal at the hospital, however, this potentially includes patients with good nutrition who did not like the hospital food and had visitors bring food from home, as well as patients who normally eat smaller portions, who missed the meal because of a medical procedure, or who did not eat up for some other external reason [12]. By contrast, this research aims to give a more comprehensive picture of low food intake by considering nutritional intake prior to hospitalisation in addition to the amount eaten on nutrition\textsubscript{Day}. It can be assumed that patients with LI\textsubscript{RC} already had their health problems some time prior to admission, whereas observation of low food intake only on nutrition\textsubscript{Day} might rather reflect an acute health problem and acute disease-related malnutrition. In any case, with a prevalence of 21%, LI\textsubscript{RC} was very common among German hospital patients. Since nearly half of the patients who ate little on nutrition\textsubscript{Day} had eaten poorly already before hospital admission, it appears reasonable to inquire about previous nutrition at admission to identify patients in need of further support. Moreover, according to an additional question (not yet described), most patients with LI\textsubscript{RC} reported an unfavourable development of nutritional intake during their hospital stay. 50.9%
| Characteristic                              | Total sample | Internal Medicine | Gastroenterology | Geriatrics | Oncology | Surgery | Neurology | Others |
|--------------------------------------------|--------------|-------------------|------------------|------------|----------|---------|-----------|--------|
|                                           | N = 1865     | n = 212           | n = 432          | n = 171    | n = 279  | n = 233 | n = 242   | n = 206 |
| Age [years]                               | %            | %                 | %                | %          | %        | %       | %         | %       |
| ≥70                                       | 49.3         | 58.5              | 44.0             | 97.1       | 38.7     | 41.8    | 41.7      | 46.1    |
| <70                                       | 50.7         | 41.5              | 56.0             | 2.9        | 61.3     | 58.2    | 58.3      | 53.9    |
| Sex                                        |              |                   |                  |            |          |         |           |         |
| Female                                    | 51.8         | 50.9              | 50.9             | 69.0       | 42.3     | 51.7    | 58.7      | 45.6    |
| Male                                       | 48.2         | 49.1              | 49.1             | 31.0       | 57.7     | 48.3    | 41.3      | 54.4    |
| BMI [kg/m²]                               | <20          | 10.9              | 12.3             | 12.3       | 10.4     | 5.6     | 73        | 46.1    |
| 20–30                                     | 62.5         | 62.7              | 61.8             | 49.7       | 71.0     | 62.2    | 64.9      | 60.7    |
| >30                                       | 19.5         | 17.5              | 20.1             | 19.9       | 15.4     | 21.4    | 24.8      | 16.5    |
| Weight loss within the three months before nDay |          |                   |                  |            |          |         |           |         |
| Yes                                       | 49.9         | 55.7              | 52.8             | 55.0       | 54.1     | 48.6    | 36.4      | 46.1    |
| No                                        | 39.8         | 37.3              | 36.1             | 28.1       | 38.7     | 38.7    | 56.6      | 43.7    |
| Unknown                                   | 5.7          | 4.2               | 6.5              | 8.8        | 4.3      | 5.6     | 4.1       | 7.3     |
| Missing                                   | 4.5          | 2.8               | 4.6              | 8.2        | 2.9      | 7.1     | 2.9       | 2.9     |
| LOS before nDay [days]                    | ≤4           | 45.3              | 42.5             | 52.8       | 16.4     | 47.7    | 44.9      | 53.3    |
|                                          | >4           | 52.2              | 53.8             | 44.9       | 81.3     | 50.9    | 51.7      | 45.5    |
| Missing                                   | 2.5          | 3.8               | 2.3              | 2.3        | 1.4      | 3.4     | 1.2       | 3.4     |
| Admission type                            | Emergency    | 46.1              | 64.6             | 50.0       | 59.6     | 30.1    | 39.0      | 42.6    |
|                                          | Planned      | 43.5              | 28.3             | 36.3       | 33.9     | 63.4    | 47.7      | 52.5    |
|                                          | I do not know/missing | 10.4            | 7.1              | 13.7       | 6.4      | 6.5     | 13.3      | 5.0     |
| Cancer                                    | Yes          | 27.6              | 21.2             | 23.6       | 14.6     | 70.6    | 25.4      | 6.6     |
|                                          | No           | 66.0              | 77.4             | 70.1       | 55.6     | 28.0    | 72.8      | 92.6    |
|                                          | Missing      | 6.5               | 1.4              | 6.3        | 29.8     | 1.4     | 1.9       | 0.8     |
| Dementia                                  | Yes          | 4.0               | 4.7              | 1.9        | 18.1     | 1.4     | 2.5       | 2.1     |
|                                          | No           | 88.3              | 95.3             | 91.9       | 45.6     | 95.3    | 93.5      | 96.3    |
|                                          | Missing      | 7.7               | 0.0              | 6.3        | 36.3     | 3.2     | 4.0       | 1.7     |
| Cardiac insufficiency                     | Yes          | 17.8              | 29.7             | 15.3       | 39.8     | 9.7     | 18.6      | 9.9     |
|                                          | No           | 76.5              | 68.9             | 79.4       | 38.6     | 88.9    | 78.3      | 88.8    |
|                                          | Missing      | 5.7               | 1.4              | 5.3        | 21.6     | 1.4     | 3.1       | 1.2     |
| Infection                                 | Yes          | 12.5              | 23.6             | 11.3       | 18.1     | 14.0    | 10.8      | 5.4     |
|                                          | No           | 79.8              | 76.4             | 81.7       | 46.2     | 83.2    | 85.1      | 93.4    |
|                                          | Missing      | 7.7               | 0.0              | 6.9        | 35.7     | 2.9     | 4.0       | 1.2     |
| Chronic liver disease                     | Yes          | 9.7               | 11.3             | 20.8       | 3.5      | 7.5     | 5.3       | 1.7     |
|                                          | No           | 82.9              | 86.3             | 73.6       | 59.6     | 91.0    | 91.0      | 96.3    |
|                                          | Missing      | 7.4               | 2.4              | 5.6        | 36.8     | 1.4     | 3.7       | 2.1     |
| Chronic lung disease                      | Yes          | 14.6              | 38.7             | 11.6       | 23.4     | 12.9    | 6.5       | 5.8     |
|                                          | No           | 78.4              | 57.5             | 82.2       | 49.1     | 85.7    | 89.5      | 93.0    |
|                                          | Missing      | 6.9               | 3.8              | 6.3        | 27.5     | 1.4     | 4.0       | 1.2     |
| Chronic kidney disease                    | Yes          | 14.6              | 13.2             | 16.7       | 32.2     | 12.2    | 11.1      | 6.6     |
|                                          | No           | 78.5              | 85.4             | 77.3       | 38.0     | 84.9    | 85.4      | 91.7    |
|                                          | Missing      | 6.9               | 1.4              | 6.0        | 29.8     | 2.9     | 3.4       | 1.7     |
| Digestive disease                         | Yes          | 38.5              | 34.4             | 68.8       | 17.5     | 24.4    | 51.4      | 4.1     |
|                                          | No           | 61.1              | 64.6             | 31.3       | 82.5     | 74.9    | 48.3      | 95.9    |
|                                          | Missing      | 0.4               | 0.9              | 0.0        | 0.0      | 0.7     | 0.3       | 0.0     |
| Endocrine, nutritional and metabolic disease | Yes          | 24.0              | 28.3             | 31.3       | 31.0     | 22.6    | 18.0      | 16.1    |
|                                          | No           | 75.6              | 70.8             | 68.8       | 69.0     | 76.7    | 81.7      | 78.3    |
|                                          | Missing      | 0.4               | 0.9              | 0.0        | 0.0      | 0.7     | 0.3       | 0.0     |
Table 1. continued

|                                | Total sample | Internal Medicine | Gastroenterology | Geriatrics | Oncology | Surgery | Neurology | Others |
|--------------------------------|--------------|-------------------|------------------|------------|----------|---------|-----------|--------|
|                                | N = 1865     | n = 212           | n = 432          | n = 171    | n = 279  | n = 323 | n = 242   | n = 206|
| Nr. of medications on nDay     |              |                   |                  |            |          |         |           |        |
| >5                             | 50.6         | 52.8              | 47.5             | 66.7       | 53.0     | 43.7    | 47.5      | 52.4   |
| ≤5                             | 23.1         | 22.2              | 27.8             | 8.8        | 20.1     | 26.3    | 21.9      | 26.7   |
| Missing                        | 26.3         | 25.0              | 24.8             | 24.6       | 26.9     | 30.0    | 30.6      | 20.9   |
| Previous surgery               |              |                   |                  |            |          |         |           |        |
| Yes                            | 20.2         | 5.2               | 8.1              | 7.6        | 12.5     | 65.3    | 3.7       | 30.6   |
| No                             | 77.2         | 92.5              | 89.6             | 91.2       | 82.4     | 31.0    | 95.9      | 67.0   |
| Missing                        | 2.6          | 2.4               | 2.3              | 1.2        | 5.0      | 3.7     | 0.4       | 2.4    |
| Prior ICU admission            |              |                   |                  |            |          |         |           |        |
| Yes                            | 10.9         | 8.0               | 8.1              | 5.3        | 4.7      | 25.1    | 9.5       | 12.6   |
| No                             | 86.1         | 91.5              | 88.4             | 94.7       | 91.8     | 69.7    | 90.1      | 81.6   |
| Missing                        | 3.0          | 0.5               | 3.5              | 0.0        | 3.6      | 5.3     | 0.4       | 5.8    |
| Terminally ill                 |              |                   |                  |            |          |         |           |        |
| Yes                            | 13.8         | 5.2               | 19.7             | 2.9        | 28.0     | 3.7     | 19.4      | 9.2    |
| No                             | 64.7         | 83.5              | 58.3             | 74.9       | 42.7     | 74.6    | 72.3      | 55.8   |
| I do not know                  | 21.5         | 11.3              | 22.0             | 22.2       | 29.4     | 21.7    | 8.3       | 35.0   |
| Self-rated general health      |              |                   |                  |            |          |         |           |        |
| Fair or better                 | 68.5         | 66.5              | 68.1             | 59.6       | 64.9     | 73.7    | 69.4      | 74.3   |
| Poor or very poor had health   | 27.5         | 31.1              | 28.0             | 34.5       | 30.1     | 19.8    | 30.2      | 21.8   |
| Missing                        | 4.1          | 2.4               | 3.9              | 5.8        | 5.0      | 6.5     | 0.4       | 3.9    |
| Ability to walk without        |              |                   |                  |            |          |         |           |        |
| assistance on nDay            |              |                   |                  |            |          |         |           |        |
| Yes                            | 62.4         | 63.7              | 67.4             | 34.5       | 72.8     | 60.4    | 54.1      | 72.3   |
| No                             | 30.5         | 29.7              | 24.1             | 54.4       | 22.2     | 29.7    | 43.4      | 21.8   |
| Missing                        | 7.2          | 6.6               | 8.6              | 11.1       | 5.0      | 9.9     | 2.5       | 5.8    |

ICU intensive care unit, LOS before nDay length of hospital stay before nutritionDay, nDay nutritionDay.

Fig. 2 Food intake of patients from the German nutritionDay survey 2016–2020 in different medical specialities. a In the week before hospital admission and (b) on nutritionDay.
underpin the assumption of a longer lasting problem that was also European Journal of Clinical Nutrition (2022) 76:1440 – 1448

reported a further decrease, and 22.9% constantly reduced intake in the total sample (OR and 95% confidence intervals (CI) for recent and current low food intake in the total sample (N = 1410).

Factors associated with LIRc overall
More than half of the variables (12 out of 22) examined in the univariate analyses of the total sample were included in the multivariate model, eight of which were still associated with LIRc in the multivariate model with similar odds ratios (Table 3). The choice of variables for this analysis was guided by previous research on malnutrition in general [3, 13–19] and food intake specifically [7]. Female sex is a known risk factor for low food intake on nutritionDay, which was explained by women generally eating smaller meal portions and having stronger weight concerns [7]. The connection to LIRc and thus to pre-hospital nutrition, however, supports only the latter. Surprisingly, being aged 70 years and above was not related to LIRc, and nor was a BMI of below 20 kg/m². Higher age is generally considered a risk factor [20] and low BMI is an important phenotypic criterion of malnutrition [3]. Nonetheless, categorisation of both variables differed from the previous analysis, where younger (18–29 years and 30–39 years) and older age (80–89 years and above), as well as a BMI below 18.5 kg/m² were significantly associated with low food intake on nutritionDay [7]. Our analysis confirms that weight loss is clearly associated with LIRc implying an even longer than one-week period of low intake before admission in many patients, as weight loss is usually a process which develops over weeks or even months. Yet, the high odds ratio for patients who were not sure about a weight loss should draw health care workers’ attention. In this subgroup, the proportion of patients with LIRc was higher (26.2%) than in the total sample (data not shown). Older and severely ill patients, having lost the sense of their body or not being able to rate their health status, might have lost weight unknowingly because of LIRc. Malnutrition in hospitals is often disease-related. Thus, it is not surprising that a poor or very poor self-rated general health is associated with LIRc. It also appears logical that patients with affection of the digestive system are more likely to eat little because of related symptoms such as nausea, vomiting or loss of appetite, and because their food intake at the hospital is often restricted by doctors. Interestingly, cancer was not included in the multivariate regression model by the selection criterion used, although it is commonly known to imply nutritional risk [15]. Acute cancer as admission diagnosis has previously been associated with current low intake and might be a plausible reason for LIRc too [7]. Comorbid cancer, however, rather includes patients with former or stable malign disease who did not show a higher risk of LIRc in this analysis. The negative correlation of cardiac insufficiency with LIRc is remarkable and probably partly explained by the finding that a BMI below 20 kg/m² was less frequent, and above 30 kg/m² was more frequent in patients with cardiac insufficiency (data not shown), suggesting a lower likelihood of LIRc. Unfortunately, the stage of this disease, a strong factor influencing the development of cardiac cachexia [21], is not known.

Role of the medical speciality
Pirlich et al. [11] compared the prevalence of malnutrition in German hospital patients from different medical specialities, finding the highest prevalence in Geriatrics, Oncology, Gastro-enterology and other medical patients. Interestingly, the most affected specialities were similar in the present analysis,

Table 2. Prevalence of recent and current low food intake in the total sample and in different medical specialities.

|                          | Total sample | Internal medicine | Gastro-enterology | Geriatrics | Oncology | Surgery | Neurology | Others |
|--------------------------|--------------|-------------------|-------------------|------------|----------|---------|-----------|--------|
| N                        | 1865         | 212               | 432               | 171        | 279      | 323     | 242       | 206    |
| Yes                      | 21.1         | 22.2              | 26.6              | 22.8       | 21.9     | 19.5    | 11.2      | 19.9   |
| No                       | 72.8         | 73.6              | 65.0              | 66.1       | 74.2     | 72.4    | 88.0      | 74.8   |
| Missing                  | 6.1          | 4.2               | 8.3               | 11.1       | 3.9      | 8.0     | 0.8       | 5.3    |

Table 3. Multivariate binary logistic regression model: Odds ratios (OR) and 95% confidence intervals (CI) for recent and current low food intake in the total sample (N = 1410).

|                          | OR  | [CI 95%]          |
|--------------------------|-----|-------------------|
| Age [years]              |     |                   |
| <70 (ref)                | 1.00|                   |
| ≥70                      | 1.17| [0.87–1.57]       |
| Sex                      |     |                   |
| Male (ref)               | 1.00|                   |
| Female                   | 1.98| [1.50–2.61]***    |
| BMI [kg/m²]              |     |                   |
| <20                      | 1.11| [0.74–1.68]       |
| 20–30 (ref)              | 1.00|                   |
| >30                      | 1.00| [0.70–1.42]       |
| Weight loss within the three months before nDay |     |                   |
| No (ref)                 | 1.00|                   |
| Yes                      | 2.62| [1.93–3.56]***    |
| Unknown                  | 1.90| [1.03–3.51]*      |
| Admission type           |     |                   |
| Planned (ref)            | 1.00|                   |
| Emergency                | 1.38| [1.02–1.86]*     |
| I do not know/ Missing   | 1.41| [0.87–2.29]       |
| Cardiac insufficiency    |     |                   |
| No (ref)                 | 1.00|                   |
| Yes                      | 0.55| [0.37–0.83]**     |
| Infection                |     |                   |
| No (ref)                 | 1.00|                   |
| Yes                      | 1.17| [0.80–1.71]       |
| Digestive disease        |     |                   |
| No (ref)                 | 1.00|                   |
| Yes                      | 1.90| [1.40–2.56]***    |
| Endocrine, nutritional and metabolic disease |     |                   |
| No (ref)                 | 1.00|                   |
| Yes                      | 0.81| [0.58–1.11]       |
| Self-rated general health |     |                   |
| Fair or better (ref)     | 1.00|                   |
| Poor or very poor        | 2.17| [1.62–2.91]***    |
| Ability to walk without assistance on nDay |     |                   |
| Yes (ref)                | 1.00|                   |
| No                      | 1.55| [1.14–2.12]**     |
| Medical speciality       |     |                   |
| Internal Med.(ref)       | 1.17| [0.73–1.89]       |
| Gastro-enterology        | 1.17| [0.73–1.89]       |
| Geriatrics               | 1.01| [0.51–2.01]       |
| Oncology                 | 1.16| [0.69–1.94]       |
| Surgery                  | 0.91| [0.55–1.51]       |
| Neurology                | 0.51| [0.28–0.92]*      |
| Others                   | 0.96| [0.53–1.72]       |
| Model significance       |     |                   |
| p value                  | 0.000|                   |
| Effect size              | Cohen's f²| 0.230 |
Table 4. Multivariate binary logistic regression models: Odds ratios (OR) and 95% confidence intervals (CI) for recent and current low food intake according to medical specialty.

|                          | Internal medicine | Gastroenterology | Geriatrics | Oncology | Surgery | Neurology | Others |
|--------------------------|-------------------|------------------|------------|----------|---------|-----------|--------|
|                          | n = 169           | n = 327          | n = 72     | n = 236  | n = 247 | n = 215   | n = 144 |
| Age (years)              |                   |                  |            |          |         |           |        |
| <70 (ref)                | 1.00              | 1.00             | 1.00       | 1.00     | 1.00    | 1.00      | 1.00   |
| ≥70                      | 1.25 [0.48–3.28]  | 1.20 [0.68–2.12] | 1.70 [0.05–58.9] | 1.41 [0.65–3.04] | 1.17 [0.55–2.49] | 1.56 [0.62–3.95] | 1.02 [0.39–2.71] |
| Sex                      |                   |                  |            |          |         |           |        |
| Male (ref)               | 1.00              | 1.00             | 1.00       | 1.00     | 1.00    | 1.00      | 1.00   |
| Female                   | 1.97 [0.83–4.68]  | 1.88 [1.08–3.29] | 1.38 [0.32–5.93] | 1.71 [1.71–8.30] | 1.47 [0.73–2.96] | 2.43 [0.92–6.40] | 1.75 [0.68–4.51] |
| BMI (kg/m²)              |                   |                  |            |          |         |           |        |
| <20                      | 1.30 [0.41–4.11]  | 2.00 [0.92–4.35] | 2.61 [0.39–17.6] | 0.70 [0.22–2.21] | 1.29 [0.42–3.99] | 0.98 [0.19–5.15] | 0.29 [0.07–1.21] |
| 20–30 (ref)              | 1.00              | 1.00             | 1.00       | 1.00     | 1.00    | 1.00      | 1.00   |
| >30                      | 0.70 [0.22–2.19]  | 0.82 [0.39–1.70] | 1.60 [0.29–8.98] | 0.61 [0.21–1.74] | 1.57 [0.68–3.61] | 1.46 [0.54–3.92] | 0.50 [0.13–1.90] |
| Weight loss in 3 months before nDay |           |                  |            |          |         |           |        |
| No (ref)                 | 1.00              | 1.00             | 1.00       | 1.00     | 1.00    | 1.00      | 1.00   |
| Yes                      | 1.84 [0.75–4.47]  | 4.41 [2.29–8.52] | 6.07 [0.15–2.96] | 3.35 [1.45–7.73] | 3.78 [1.68–8.51] | 1.65 [0.67–4.08] | 2.65 [0.89–7.90] |
| Unknown                  | 0.00              | 0.00             | 3.03 [1.03–8.90] | 2.11 [0.18–24.5] | 0.94 [0.14–6.34] | 1.08 [0.17–7.09] | 2.55 [0.38–16.9] |
| Admission type           |                   |                  |            |          |         |           |        |
| Planned (ref)            | 1.00              | 1.00             | 1.00       | 1.00     | 1.00    | 1.00      | 1.00   |
| Emergency                | 1.03 [0.38–2.80]  | 0.97 [0.54–1.76] | 3.39 [0.70–16.3] | 2.59 [1.20–5.62] | 2.02 [0.94–4.34] | 0.92 [0.36–2.37] | 1.90 [0.64–5.67] |
| I don’t know             | 1.81 [0.33–9.76]  | 1.26 [0.53–2.97] | 3.47 [0.13–90.3] | 5.76 [1.29–25.7] | 1.81 [0.53–6.16] | 0.00 [0.00] | 1.61 [0.42–6.16] |
| Cardiac insufficiency    |                   |                  |            |          |         |           |        |
| Yes                      | 0.16 [0.05–0.55]  | 0.82 [0.37–1.81] | 0.43 [0.10–1.85] | 0.49 [0.11–2.21] | 0.62 [0.24–1.62] | 1.04 [0.25–4.35] | 1.12 [0.25–5.01] |
| Infection                |                   |                  |            |          |         |           |        |
| Yes                      | 1.97 [0.74–5.27]  | 0.54 [0.22–1.33] | 1.43 [0.36–5.70] | 1.33 [0.52–3.41] | 1.26 [0.46–3.46] | 0.45 [0.05–4.20] | 1.78 [0.42–7.48] |
| Digestive disease        |                   |                  |            |          |         |           |        |
| Yes                      | 1.75 [0.75–4.12]  | 1.38 [0.76–2.48] | 0.81 [0.13–4.93] | 1.39 [0.62–3.11] | 3.43 [1.64–7.17] | 0.61 [0.06–6.14] | 3.85 [1.41–10.5] |
| Endocrine, nut., metab. diseases |           |                  |            |          |         |           |        |
| Yes                      | 0.87 [0.32–2.38]  | 0.65 [0.36–1.19] | 0.37 [0.09–1.54] | 0.52 [0.21–1.33] | 1.15 [0.47–2.76] | 1.12 [0.35–3.61] | 1.37 [0.46–4.11] |
| Self-rated general health|                   |                  |            |          |         |           |        |
| Fair or better (ref)     | 1.00              | 1.00             | 1.00       | 1.00     | 1.00    | 1.00      | 1.00   |
| Poor or very poor        | 2.07 [0.84–5.15]  | 2.23 [1.25–3.97] | 3.17 [0.78–12.9] | 6.76 [3.09–14.8] | 1.09 [0.44–2.69] | 1.88 [0.74–4.77] | 1.73 [0.59–5.12] |
| Ability to walk without assistance on nDay |             |                  |            |          |         |           |        |
| Yes (ref)                | 1.00              | 1.00             | 1.00       | 1.00     | 1.00    | 1.00      | 1.00   |
| No                       | 3.11 [1.23–7.87]  | 2.17 [1.16–4.05] | 0.43 [0.10–1.82] | 1.37 [0.59–3.18] | 2.33 [1.06–5.10] | 1.76 [0.66–4.65] | 0.47 [0.11–2.00] |
| Model significance       | p value           | 0.001            | 0.000      | 0.635    | 0.000   | 0.389     | 0.045  |
| Effect size              | Coherence^2       | 0.395            | 0.361      | 0.279    | 0.484   | 0.330     | 0.147  |

nDay, nutritionDay, ref reference. *p < 0.05; **p < 0.01; ***p < 0.001.
reaffirming the important role of malnutrition in these fields. Results of the specialty-specific multivariate regression models showed a high consistency for significant variables with the overall sample. Intriguingly, odds ratios of significant variables were considerably higher in the relevant subgroups than in the entire population (Table 4), suggesting a discipline-specific importance. In Gastroenterology and Oncology especially, many factors associated with \( L_{IRC} \) were confirmed, with the highest odds ratios in Oncology. In contrast, admission to Neurology was associated with reduced risk for \( L_{IRC} \) compared with Internal Medicine patients (Table 3). Additionally, \( L_{IRC} \) was the least frequent and without significant associations in Neurology, suggesting that low food intake is a rather minor and non-specific problem in this discipline. This analysis partly confirms results from Schindler et al. [7], where patients from Neurology and Geriatrics were at lower risk for reduced food intake on nutritionDay. At first glance, \( L_{IRC} \) does not seem to play an important role in Geriatrics either, as no significant associations were found in this subgroup. However, the prevalence of \( L_{IRC} \) in Geriatrics was twice as high as in Neurology, suggesting that the lack of significant associations can be explained by the limited data quality in this subgroup, which is mainly due to a high percentage of missing values for comorbidities, and subsequently leads to the small number of 72 patients in this subgroup after exclusion of missing values. The lacking significance of weight loss in Internal Medicine is surprising. Unfortunately, the reasons are unclear and should be addressed in future research.

**Strengths and limitations**

The biggest strength and uniqueness of this study was the close look at \( L_{IRC} \), reflecting reduced food intake for a longer period of time, which is very plausible to be more relevant for the development of malnutrition than only intake on nutritionDay. As food intake measurements were self-reported by the patients, data might reflect the patients’ individual perception and their estimating abilities. Thus, it might be less reliable than if it was collected by a designated researcher. Further, retrospective data elicitation holds the risk of bias. Patients might not remember their previous food intake correctly, and their perception of current intake at the hospital might influence the appraisal of their recent intake. There is, however, always a certain degree of uncertainty when recording food intake. An additional strength of the present analysis is the focus on one country with the same health care system in all participating hospitals. This analysis of a large and recent German dataset increases our knowledge on low food intake as a contributor to malnutrition in German hospitals, where little is currently known in this regard. Schindler et al. [7] reported wide variations in the prevalence of low intake on nutritionDay between different world regions. Therefore, a country-specific approach seems also reasonable for the assessment of \( L_{IRC} \). However, the country-specific focus led to a smaller sample, which is a limitation of this research. The sample was further reduced in the regression analysis due to missing values, caused, for example, by staff untrained in data collection. The identification of potential associations in small samples such as the geriatric group is difficult; hence, further analyses with larger patient groups are desirable. Moreover, length bias is a common limitation of cross-sectional studies, as patients are more likely to be included if they stay longer at the hospital [22]. Selection bias is another possible limitation. The sample may not be representative for the German hospital population, since patients aged 70 years or older were overrepresented (personal communication: German Federal Statistical Office, hospital statistics from 2019, obtained 2021), as well as patients with digestive disease and endocrine, nutritional or metabolic disease [23]. On the other hand, sex distribution was comparable to data reported by German hospital statistics from 2019 [24]. Besides, the participation of hospital units with special interest in nutrition medicine is probably higher, and patients who are severely ill and thus not able to answer questions might not be well represented in the survey.

**CONCLUSION**

In German hospital patients participating in the nutritionDay project from 2016 to 2020, recent and current low food intake (\( L_{IRC} \)) was observed in every fifth patient overall, in every fourth gastroenterological but only every ninth neurological patient. Female sex, weight loss history, poor subjective health and functional status were related to \( L_{IRC} \) in the whole sample, and in several medical disciplines. Medical staff from all specialties, but from oncological and gastroenterological wards in particular, should assess food intake before hospitalisation at hospital admission and subsequently monitor food intake during the course of the hospital stay to intervene in time with nutritional therapy and further assessment of malnutrition. On top of this, our findings might help healthcare professionals in certain disciplines to focus on specific patient subgroups that are at high risk for \( L_{IRC} \) and therefore require additional nutritional treatment. In a next step, it should be evaluated whether nutritional therapy improves clinical outcome in these patient subgroups. Moreover, additional analyses of \( L_{IRC} \) in international samples and inclusion of dynamic variables such as the development of food intake are of further interest. Analysis of outcome data in a \( L_{IRC} \) patient group is desirable to better understand its role in comparison to current low intake only.

**DATA AVAILABILITY**

The data here analysed was provided by nutritionDay worldwide (office@nutrition-day.org). Data is available upon approval of a scientific project proposal by the nutritionDay worldwide scientific board and completion of a data sharing agreement. Additional data collection was enabled by the staff of the Klinikum Fürth, Germany.

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AUTHOR CONTRIBUTIONS
SEJB designed the research project and was part of the data collection in 2020. She analysed and validated the data. She wrote the original draft and was responsible of editing. MH and IS contributed to conceptualisation, methodology and interpretation of research results, and reviewed the original draft. IS was also responsible of data curation and validation. ST was in charge of project management and contributed to interpretation of results and editing of the original manuscript. RW contributed to methodology, review and editing of the original draft. DV supervised the research. She was responsible of determining the objective and design of the project. She contributed to the writing of the original draft as well as review and editing.

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