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Original article

Geriatric syndromes increased the nutritional risk in elderly cancer patients independently from tumoursite and metastatic status. The ELCAPA-05 cohort study

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SUMMARY

Background & aims: We assessed the prevalence and risk factors of malnutrition in elderly cancer patients.
Methods: We studied a prospective cohort of solid cancer patients aged ≥70 years at referral to two geriatric oncology clinics between 2007 and 2010. Nutrition was evaluated using the Mini-Nutritional Assessment (MNA) using validated cut-offs (<17: malnutrition, 17–23.5: at-risk for malnutrition). Patients with non-digestive tumours (breast, prostate, urinary tract) and with digestive (colorectal, upper digestive tract and liver) were analysed separately using multinomial logistic regression.
Results: Of 643 consecutive patients, 519 had available data (median age, 80; men, 48.2%; metastases, 46.3%; digestive cancer 47.8%). In non-digestive group, 13.3% had malnutrition versus 28.6% in digestive group. The link between metastasis and malnutrition was significantly higher in non-digestive group (adjusted odds ratio [OR_a], 25.25; 95%CI: 5.97–106.8) than in digestive group (OR_a, 2.59; 1.08–6.24; p for heterogeneity = 0.04). Other factors independently associated with malnutrition were cognitive impairment ($OR_{a\ MMMSE \leq 24\ versus\ > 24}$ in non-digestive group: 16.68; 4.89–56.90 and in digestive group: 3.93; 1.34–11.50), and depressed mood ($OR_{a\ MiniGDS \geq 1\ versus\ <1}$ in non-digestive group: 11.11; 3.32–37.17 and in digestive group: 3.25; 1.29–8.15) and fall risk ($OR_{a\ fall\ risk\ versus\ no\ fall\ risk}$ in non-digestive group: 4.68; 1.77–12.37; in digestive group: 100% of malnourished patients were faller's).
Conclusion: We highlighted, in elderly cancer patients, the high prevalence of malnutrition and that geriatrics syndromes (i.e. cognitive impairment, depressed mood and fall risk) were independent risk factors for malnutrition. Moreover, metastatic status was significantly much more strongly associated with malnutrition in non-digestive than digestive tumours.

1. Introduction

Malnutrition is a common complication of cancer and a major risk factor for adverse outcomes such as poor treatment response, short survival, chemotherapy-induced toxicity, infection, long hospital stays, and impaired quality of life. Malnutrition is particularly common after 70 years of age, when intakes of protein and other nutrients are often inadequate.[1,2] Several age-related conditions increase the risk of malnutrition, including dementia, oral and dental disorders, and eating dependency.[3] Malnutrition was

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recently identified as an independent predictor of early death in elderly cancer patients treated with first-line chemotherapy.[4] Consequently, malnutrition in elderly cancer patients should be prevented or detected as early as possible, and modifiable risk factors for malnutrition should be corrected.

Clinical practice guidelines for geriatric oncology recommend the routine use of at least one nutritional screening tool.[5,6] The Mini-Nutritional Assessment (MNA) is a validated tool that is often used in practice to assess the nutritional status of elderly cancer patients.[6,7] Several studies assessed the prevalence and risk factors of malnutrition in middle-aged cancer patients.[8–10] The main factors associated with malnutrition were location of the tumour in the gastrointestinal tract, advanced tumour stage, chemotherapy, poor performance status, depression, older age, and frequent admissions.

To our knowledge, no study has assessed the risk factors for malnutrition in elderly cancer patients. We hypothesised that specific geriatric factors were associated with malnutrition in elderly cancer patients independently from oncologic factors. To test this hypothesis, we assessed the prevalence of malnutrition, overall and according to tumour site and metastatic status, in elderly cancer patients and we looked for patient- and tumour-specific factors associated with malnutrition.

2. Patients and methods

2.1. Study design and population

The ELCAPA (ELderly CAncer PAtient) survey is a prospective open cohort survey of consecutive patients aged 70 years or older with histologically documented cancer who are referred by an oncologist, radiotherapist, surgeon, or other specialist to the geriatric oncology clinics of two teaching hospitals in the Paris urban area, France.

For the present cross-sectional analysis, we used all ELCAPA included patients with solid cancer who were included between January 2007 and December 2010, before the initiation of cancer treatment (chemotherapy, radiotherapy, surgery, and/or hormonal therapy), and for whom MNA data were available. Informed consent was obtained from all patients prior to inclusion. The protocol was approved by the appropriate ethics committee (CPP Ile-de-France I, Paris, France).

2.2. Data collection

Data were collected prospectively. At baseline, age, sex, tumour site (six groups: colorectal, upper gastrointestinal tract and liver, breast, prostate, urinary tract, and other), and metastatic status (M+ according to the TNM classification and/or distant node) were collected. All patients underwent a multidimensional comprehensive geriatric assessment (CGA), as previously detailed.[11] Briefly, the CGA uses validated tests and scores to assess nine domains, according to international recommendations[5,6]: Activities of Daily Living (ADL) and Eastern Cooperative Oncology Group Performance Status (ECOG PS) for functional status, timed get-up-and-go test (GUG) and/or one-leg standing balance test for fall risk, MNA, body mass index (BMI) and serum albumin level for nutritional status, Mini-Mental State Examination (MMSE) for cognitive status, Mini-Geriatric Depression Scale (mini-GDS) for mood, Cumulative Illness Rating Scale for Geriatrics (CIRS-G) for co-morbidities, number of medications per day for polypharmacy, social environment (living alone, marital status, and use of homemaker services), and urinary and/or faecal incontinence.

Co-morbidities were evaluated by recording the following conditions: coronary artery disease, chronic heart failure (New York Heart Association classes III and IV), cardiac arrhythmia, hypertension ($\geq$140/90 mmHg), diabetes mellitus, chronic obstructive pulmonary disease, severe renal insufficiency (creatinine clearance $<$30 mL/min estimated using the Cockroft and Gault formula), cirrhosis, and stroke-related residual neurologic impairments.

Patients were asked about cancer-related pain. Pain was classified as cancer-related if located in an organ or organ system involved by the primary tumour or tumour spread.

We recorded symptoms associated with impaired food intake such as anorexia, pain, dry mouth, dysgueusia, candidiasis, abnormal oral or dental status, diarrhoea, and constipation. Abnormal oral or dental health was defined as at least three missing teeth and/or dental plaque impinging on the gums and/or periodontal disease and/or improperly fitted dentures causing discomfort or pain when eating.

2.3. Assessment of nutritional status

Nutritional status was the primary evaluation criterion and was assessed at study inclusion using the MNA,[12] an 18-item questionnaire evaluating anthropometric variables (body mass index [BMI]; mid-arm and calf circumferences; weight loss in the last 3 months), dietary intake (number of meals, food and fluid intakes, self-sufficiency for eating), a global assessment (lifestyle, number of medications per day, mobility, acute disease or stress in the past 3 months, and neuropsychological problems), and a self-assessment of health and nutritional status. Based on the total score (maximum 30 points), patients can be classified into one of the three categories based on validated cut-offs: normal nutritional status, MNA $>$ 23.5; risk of malnutrition, 17 $\leq$ MNA $\leq$ 23.5; and malnutrition, MNA $<$ 17.[12]

BMI was handled in continuous variable and categorized using the validated cut-off of 21 kg/m^2 for elderly. Similarly, albuminaemia was handled in continuous variable and categorized using the cut-off of 35 g/L in accordance with French Authority Nutritional Guidelines.

Moreover, we recorded body mass index and weight loss since the diagnosis of cancer and/or onset of symptoms that led to the diagnosis of cancer.

2.4. Data analysis

The proportions of patients at risk for malnutrition (17 $\leq$ MNA $\leq$ 23.5) and having malnutrition (MNA $<$ 17) were calculated in the overall population and in subgroups defined by tumour site and metastatic status, with their 95% confidence intervals (95%CIs). Patient characteristics were described as numbers and percentages for qualitative variables and means with standard deviations (SD) or medians with 25th and 75th percentiles (quartile 1 to quartile 3), as appropriate, for quantitative variables. Linear quantitative variables were handled as continuous variables. Correlations between MNA score and potential explanatory variables assessing a domain included in the MNA questionnaire were tested. We used the Spearman correlation coefficient for quantitative variables and the intraclass correlation coefficient for qualitative variables. To avoid co-linearity, variables correlated with MNA (r or ICC $\geq$ 0.40) were not considered in the multivariate analysis.

The three MNA groups (normal, at risk for malnutrition, and malnutrition) were compared using the Pearson χ^2 test or Fisher's exact test for qualitative variables and ANOVA or nonparametric Kruskal–Wallis test for quantitative variables. Variables yielding p values lower than 0.20 by univariate analysis were considered for the multivariate analysis. Pairwise analyses were performed to assess potential interactions and confounding by fitting multiplicative models. A multivariate multinomial logistic model was built

using the factors associated with MNA category. Odds ratios (ORs) and their 95%CIs were estimated. All tests were two-tailed. Values of p were taken to indicate significant differences when lower than 0.05 and trends when lower than 0.10. We did not perform multiple imputations for missing data.

The statistical analysis was done using STATA statistical software (STATA 2005, release 11.0; College Station, TX, USA). This observational study is reported according to Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.

3. Results

Of the 643 patients included in the ELCAPA survey, 519 were included in the present study (Fig. 1). Patients were scheduled to receive chemotherapy (43%), radiotherapy (26%), surgery (16%) or hormone therapy (15%) at the time of the geriatric assessment. Compared to the study population, patients without available MNA data ($n = 67$) were more likely to have colorectal cancer (32.8% versus 27.7%; $p = 0.005$) and ECOG-PS $\geq$2 (71.6% versus 50.4%; $p = 0.001$), and they had a lower median ADL score (4 [IQR, 2–6] 6 versus 6,[5,6] $p < 0.001$). Table 1 reports the baseline characteristics of the study population. Most patients were outpatients ($N = 314$, 60.5%). The 248 patients with digestive tumours had colorectal cancer ($N = 144$, 27.8%) or upper gastrointestinal tract or liver cancer ($N = 104$, 20.0%) and the 271 other patients had breast cancer ($N = 108$, 20.8%), urinary tract cancer ($N = 71$, 13.7%), prostate cancer ($N = 52$, 10.0%), or cancer at other sites ($N = 40$, 7.7%).

Overall, MNA scores indicated malnutrition in 20.7% (95%CI, 17.1–24.1) of patients and a risk of malnutrition in 43.5% (39.3–47.8) of patients. As expected, the prevalence of patients with malnutrition assessed by MNA was higher in the group with metastases than in the group without metastases (30.1% vs 11.5% at $p < 0.001$) and in digestive than non-digestive (Table 1). Similarly to the MNA results, all others nutritional parameters (weight loss, BMI, and albuminaemia) were more frequently impaired in the digestive-cancer group (Table 1). A significant quantitative interaction was found between digestive tumour site and metastatic disease i.e the link between metastasis and malnutrition was higher in patients with non-digestive tumours (crude OR $_{\text{metastasis vs non metastasis}} = 7.06$ [3.01–16.54]) than digestive tumours (crude OR $_{\text{metastasis vs non metastasis}} = 2.27$ [1.12–4.61]; p for heterogeneity = 0.04). Therefore we stratified the entire analysis on digestive tumour site ($n = 248$) versus non-digestive tumour site ($n = 271$). Patients with digestive tumours had higher prevalences of anorexia and diarrhoea and others functional digestive symptoms compared to patients with non digestive cancer (Table 1). No significant difference was found between the two groups regarding age, gender, metastatic status, functional status (ECOG-PS and ADL), depressed mood, or cognitive impairment (Table 1).

MNA highly correlated (absolute value of correlation coefficients $\geq$ 0.4) with ECOG-PS, ADL), anorexia, weight loss, BMI and albuminaemia the CIRS-G co-morbidity index, (Table 2). To avoid colinearity, these seven variables were not included in the analysis of factors associated with malnutrition.

Factors associated with malnutrition ($p < 0.20$) by univariate analysis in both the digestive and non-digestive groups were metastases, fall risk, incontinence, depressed mood, cognitive impairment, history of heart or respiratory failure, cardiac arrhythmia (Table 3). Moreover, in the non-digestive-cancer group,

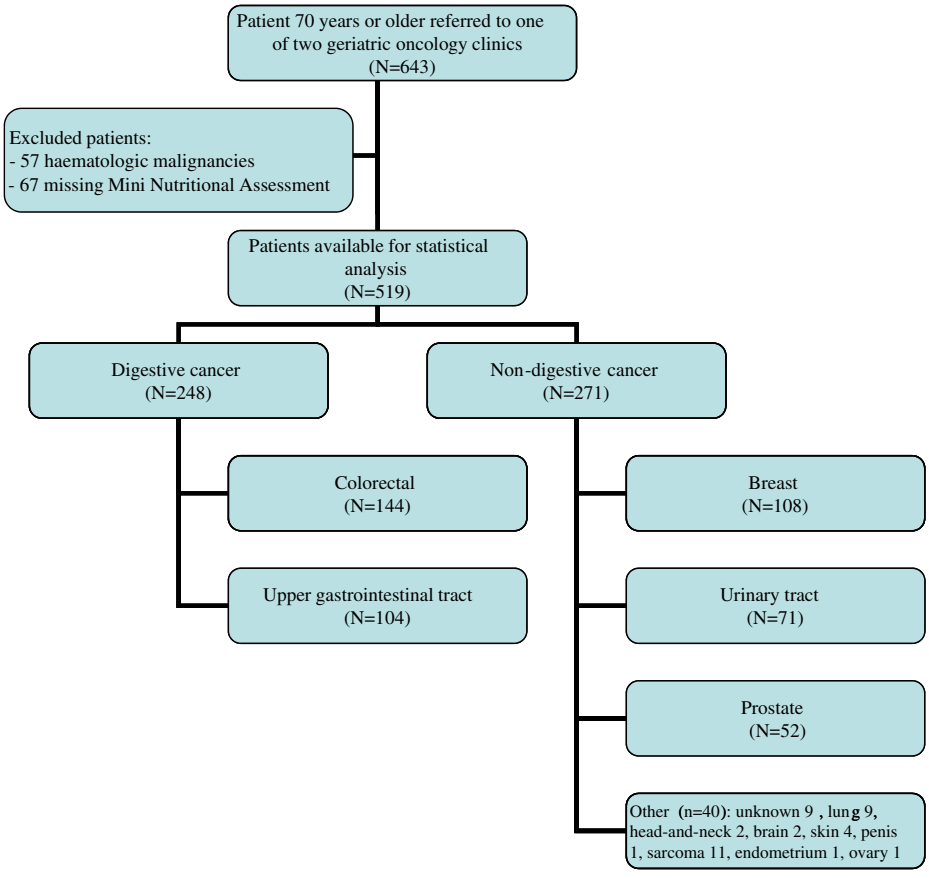

Fig. 1. Flow chart of the ELCAPA-05 study.

Table 1
Baseline characteristics according to tumour site : the ELCAPA-05 study.

	Overall $N = 519$	Non-digestive[a] $N = 271$	Digestive[a] $N = 248$	p Value[b]
Age, mean (SD)	80.0 (5.8)	79.6 (5.7)	80.5 (5.7)	0.10
Gender, male	250 (48.2)	124 (45.8)	126 (50.8)	0.25
Metastasis ($n = 516$)	239 (46.3)	115 (42.6)	124 (50.4)	0.07
ECOG-PS $\geq$2 ($n = 518$)	261 (50.4)	131 (48.3)	130 (52.6)	0.33
ADL, median [Q1-Q3]	6 [5–6]	6 [5–6]	6 [5–6]	0.79
Mini-GDS $\geq$1 ($n = 442$)	145 (32.8)	68 (29.6)	77 (36.3)	0.13
MMSE $\leq$24 ($n = 457$)	136 (29.8)	71 (30.5)	65 (29.0)	0.73
Nutritional parameters				
MNA, median [Q1-Q3]	21.5 [17.5–25]	23 [19–26]	20 [16–23.7]	<0.001
[23.5-30] (normal nutritional status)	186 (35.8)	124 (45.8)	62 (25.0)	<0.001
[17–23.5] (at risk for malnutrition)	226 (43.5)	111 (41.0)	115 (46.4)	
[0–17] (malnutrition)	107 (20.7)	36 (13.2)	71 (28.6)	
Weight loss (Kg) ($n = 500$), median [Q1-Q3]	3 [0–8]	1 [0–5]	5 [1–10]	<0.001
BMI (Kg/m^2) ($n = 507$), mean (SD)	25.3 (4.8)	26.0 (5.0)	24.5 (4.6)	0.001
<21	88 (17.4)	29 (11.0)	59 (24.3)	<0.001
Albuminaemia (g/L) ($n = 376$), mean (SD)	34.2 (7.3)	36.1 (7.4)	31.8 (6.4)	<0.001
<35	181 (48.1)	68 (33.3)	113 (65.7)	<0.001
Functional digestive symptoms				
Anorexia ($n = 516$)	219 (42.4)	78 (29.0)	141 (57.1)	<0.001
Constipation ($n = 447$)	193 (43.2)	99 (39.9)	94 (47.2)	0.12
Diarrhoea ($n = 429$)	80 (18.7)	28 (11.3)	52 (28.6)	<0.001
Oral/dental abnormalities ($n = 406$)	246 (60.6)	133 (58.6)	113 (63.1)	0.35
Dry mouth ($n = 418$)	230 (55.0)	126 (50.8)	104 (61.2)	0.04
Dysgueusia ($n = 419$)	82 (19.6)	35 (14.1)	47 (27.5)	0.001
Candidiasis ($n = 413$)	31 (7.5)	13 (5.3)	18 (10.6)	0.05
Cancer-related pain	191 (37.0)	100 (36.9)	91 (37.1)	0.95

Abbreviations: SD, standard deviation; ECOG-PS, Eastern Cooperative Oncology group Performance Status; ADL, Activities of Daily Living; Mini-GDS, Mini-Geriatric Depression Scale; MMSE, Mini-Mental State Examination; MNA, Mini-Nutritional Assessment; BMI, body mass index; Q1-Q3, 25th–75th percentiles.
[a] Non-digestive tumours: breast, prostate, urinary tract, unknown, lung, head-and-neck, brain, skin, penis, sarcoma, endometrium, ovary; digestive tumours: colorectal, upper gastrointestinal tract and liver.
[b] Pearson chi-square and Kruskal–Wallis tests as appropriate.

older age, severe renal insufficiency, and candidiasis were associated with malnutrition. Table 4 reports the results of the multivariate analysis. Factors independently associated with malnutrition were metastasis, fall risk, cognitive impairment, and depressed mood both in digestive and non digestive groups. The adjusted odds ratio of fall risk was not estimated in the multivariate model in the non-digestive group as 100% of malnourished patients were faller's in this group. Similarly incontinence, history of heart or respiratory failure and severe renal insufficiency were not either included in the multivariate model due to very few numbers of patients per modalities. Age was not significant after adjustment depression mood nor cognitive impairment.

Table 2
Correlations between Mini-Nutritional Assessment scores, other Comprehensive Geriatric Assessment parameters, and functional digestive symptoms: the ELCAPA-05 study.

	Correlation coefficients[a]
Living alone	0.00
ECOG-PS	0.52
ADL	0.55
Fall risk	0.29
Incontinence	0.29
MMSE	0.35
Mini-GDS $\geq$1	0.18
CIRS-G	−0.44
Number of medications per day	−0.18
Weight loss	0.63
BMI	0.41
Albuminaemia ($n = 376$)	0.54

Abbreviations: MNA, Mini-Nutritional Assessment; ECOG-PS, Eastern Cooperative Oncology group Performance Status; ADL, Activities of *Daily Living*; MMSE, Mini-Mental State Examination; Mini-GDS, Mini-Geriatric Depression Scale; CIRS-G, Cumulative Illness Rating Scale for Geriatrics; BMI, body mass index.
[a] Spearman's correlation coefficients for quantitative variables; intraclass correlation coefficients for qualitative variables.

4. Discussion

We highlighted a high prevalence of malnutrition in elderly cancer patients. We demonstrated that geriatric syndromes (fall risk, cognitive impairment and depressive mood) were associated with malnutrition independently from tumour site and metastasis status. We found that the link between metastasis and malnutrition was significantly much higher in elderly cancer patients with non-digestive tumour than digestive tumour. Cardiac respiratory and renal insufficiency may be additional associated factors.

To our best knowledge, no study was dedicated to prevalence and associated factors of malnutrition in elderly cancer patients. Studies in middle-aged patients found large variations of malnutrition prevalence depending on tumour site and spread, from 10% for breast cancer to 80% for oesophageal cancer.[9,13] Consistent with previous studies,[8,14] the prevalence of malnutrition in our cohort was higher in patients with digestive cancer and in those with metastasis. Moreover, we found a quantitative interaction between metastatic status and digestive cancer: metastasis was more strongly associated with malnutrition in the group with non-digestive cancer than in the group with digestive cancer.

Many methods are available for assessing nutritional status. The French National Authority for Health (HAS)[3] recommends the following criteria for diagnosing malnutrition in elderly patients: weight loss $\geq$5% in 1 month or $\geq$10% in 6 months, BMI $<$ 21 kg/m^2, serum albumin concentration $<$35 g/L, and global MNA score $<$17. We chose the MNA to assess nutritional status, because it is recommended by the International Society of Geriatric Oncology[5] In accordance with our results, studies that used the MNA found that 40%–51% of elderly cancer patients were at risk for malnutrition[4,11,15–17] and that 14%–25% had malnutrition.

Cognitive impairment, fall risk, depressed mood and chronic diseases including chronic kidney disease, chronic heart disease, and chronic obstructive pulmonary disease are known associated

Table 3
Univariate analysis comparing malnutrition groups according to tumour site: the ELCAPA-05 study.

MNA	Digestive cancer[a] ($n = 248$)				Non-digestive cancer[a] ($n = 271$)			
	Normal nutritional status [23.5–30] $N = 62$ (25.0%)	At risk for malnutrition [17–23.5] $N = 115$ (46.4%)	Malnutrition [0–17] $N = 71$ (28.6%)	p Value[b]	Normal nutritional status [23.5–30] $N = 124$ (45.8%)	At risk for malnutrition [17–23.5] $N = 111$ (41.0%)	Malnutrition [0–17] $N = 36$ (13.3%)	p Value[b]
Age, mean (SD)	81.0 (5.9)	80.4 (5.9)	80.0 (5.3)	0.64	78.5 (4.9)	80.7 (6.3)	80.2 (5.9)	0.01
Gender, male	32 (51.6)	57 (49.6)	37 (52.1)	0.93	57 (46.0)	48 (43.2)	19 (52.8)	0.61
Tumour characteristics								
Metastasis ($n = 246/270$)	29 (46.8)	49 (42.6)	46 (66.7)	0.01	36 (29.0)	53 (47.7)	26 (74.3)	<0.001
Geriatric parameters and co-morbidities								
Fall risk ($n = 247/271$)	26 (47.6)	62 (53.9)	62 (87.3)	<0.001	46 (37.1)	73 (65.8)	36 (100)	<0.001
Incontinence ($n = 245/271$)	0 (0)	6 (5.3)	6 (8.7)	0.05	2 (1.6)	12 (10.8)	13 (36.1)	<0.001
Living alone	25 (40.3)	41 (35.6)	28 (39.4)	0.79	50 (40.3)	45 (40.5)	16 (44.4)	0.90
Mini-GDS ≥ 1 ($n = 212/230$)	11 (22.4)	32 (31.4)	34 (55.7)	0.001	20 (17.4)	34 (37.8)	14 (56.0)	<0.001
MMSE ($n = 224/233$), median [Q1-Q3]	28 [27–29]	27 [24–29]	25.5 [20–27]	<0.001	29 [26–30]	26 [21–28]	24 [19–26]	<0.001
Severe renal insufficiency (clearance[c] ≤ 30 mL/min), mean (SD) ($n = 226/231$)	4 (7.1)	9 (8.5)	8 (12.5)	0.56	3 (2.8)	11 (11.7)	9 (29.0)	<0.001
Heart or respiratory failure ($n = 245/269$)	8 (12.9)	22 (19.3)	18 (26.1)	0.16	10 (8.1)	20 (18.3)	18 (50.0)	<0.001
Coronary artery disease ($n = 246/267$)	13 (21.0)	32 (28.1)	14 (20.0)	0.37	19 (15.4)	26 (23.8)	9 (25.7)	0.19
Cardiac arrhythmia ($n = 241/266$)	6 (10.0)	17 (15.2)	15 (21.7)	0.18	9 (7.4)	21 (19.4)	9 (25.0)	0.01
Diabetes mellitus ($n = 246/271$)	18 (29.0)	28 (24.6)	20 (28.6)	0.76	22 (17.7)	19 (17.1)	8 (22.2)	0.78

Abbreviations: MNA, Mini nutritional assessment; Mini-GDS, mini geriatric depression scale; MMSE, mini mental state examination.
[a] Non digestive tumor site: breast, prostate, urinary tract, unknown, lung, head & neck, brain, skin, penis, sarcoma, endometrial, ovary; Digestive tumor site: colorectal, upper digestive tract and hepatic.
[b] Pearson chisquare and Kruskal–Wallis tests as appropriate.
[c] Clearance of creatininemia was calculated using the Cockcroft and Gault method.

factors of in elderly patients without cancer.[18–23,25–27] A recent longitudinal study of 194 head-and-neck middle-aged cancer patients treated with radiotherapy, depressed mood was independently associated with malnutrition.[24] The originalities of our study is to demonstrate the association of the pre-cited factors in elderly cancer patients setting and to analyse jointly geriatric and cancer-related parameters to model nutritional risk. We demonstrated that, in elderly cancer patients, nutritional risk is not entirely explained by cancer-related parameters but also by geriatric parameters.

Our study has a number of important strengths. As previously mentioned, to our knowledge, it is the first study of factors associated with the nutritional risk in elderly cancer patient population. Our patients were routinely evaluated using an internationally validated scale for assessing malnutrition (the MNA), according to international recommendations. Moreover, our population included patients with a wide variety of cancers at various stages (from localised to metastatic), allowing us to determine the prevalence of malnutrition according to tumour site and metastatic status.

Several limitations to our study should be borne in mind. Our study population may not be completely extrapolated to the actual elderly cancer population. Indeed the oncologists did not routinely refer all elderly cancer patients to the geriatric oncology clinic and we had 10% of missing data regarding MNA. However, we could not use weight loss, because data on duration of weight loss was missing for many patients. Due to the relatively small size of subgroups by tumour site, we were not able to analyse data separately by tumour site. However, our stratification according to digestive site takes into account the major differences in term of prevalence of malnutrition and in term of link strength between metastasis and malnutrition. Finally, the cross-sectional design of our study precludes the identification of causal links between investigated factors and malnutrition.

Table 4
Factors associated with risk for malnutrition and malnutrition by multivariate analysis in the ELCAPA-05 patients.

MNA	Digestive cancer[a] ($N = 196$)		
	Normal nutritional status [23.5–30]	At risk for malnutrition [17–23.5]	Malnutrition [0–17]
Metastasis	1.00 (ref)	1.05 (0.51–2.16) $p = 0.89$	2.59 (1.08–6.24) $p = 0.03$
Fall risk	1.00 (ref)	1.27 (0.61–2.64) $p = 0.52$	4.68 (1.77–12.37) $p = 0.002$
Cognitive impairment (MMSE$\leq$24)	1.00 (ref)	2.29 (0.86–6.15) $p = 0.098$	3.93 (1.34–11.50) $p = 0.01$
Depressed mood (Mini-GDS ≥ 1)	1.00 (ref)	1.49 (0.66–3.38) $p = 0.34$	3.25 (1.29–8.15) $p = 0.01$
MNA	Non-digestive cancer[a] ($n = 213$)		
	Well nourished [23.5–30]	At risk for malnutrition [17–23.5]	Malnutrition [0–17]
Metastasis	1.00 (ref)	2.79 (1.44–5.42) $p = 0.002$	25.25 (5.97–106.75) $p < 0.001$
Cognitive impairment (MMSE$\leq$24)	1.00 (ref)	4.97 (2.30–10.75) $p < 0.001$	16.68 (4.89–56.90) $p < 0.001$
Depressed mood (Mini-GDS ≥ 1)	1.00 (ref)	3.13 (1.51–6.50) $p = 0.002$	11.11 (3.32–37.17) $p \leq 0.001$

Abbreviations: MNA, Mini-Nutritional Assessment; MMSE, Mini-Mental State Examination; Mini-GDS, Mini-Geriatric Depression Scale.
[a] Non-digestive cancers: breast, prostate, urinary tract, unknown, lung, head-and-neck, brain, skin, penis, sarcoma, endometrium, ovary; digestive cancers: colorectal and upper gastrointestinal tract.

Our results have two main clinical implications. First, for adequate estimation of nutritional risk in elderly cancer patient, both cancer and geriatric factors through geriatric oncology evaluation have to be taken into account and the weight of metastasis is much more higher for non-digestive locations than digestive locations. Secondly, the nutritional management of elderly cancer patients should be multidimensional intervention including the management of geriatric modifiable factors identified in this study (i.e. depression, fall risk, functional impairment).

In conclusion, the prevalence of malnutrition in elderly cancer patients was high and geriatric syndromes (included fall risk, cognitive impairment and depressive mood) were associated with malnutrition independently from tumour site and metastasis status. This suggests the need of a multidimensional management in elderly cancer patients in association with nutritional care.

Statement of authorship

EP conceived and designed the study and is the guarantor for the study.

EP wrote the initial draft of the article, to which PC, FCP contributed subsequently.

ML, EL and HV collected the clinical data.

AL contributed to the statistical analysis.

FCP, SBG contributed to the design, performed the statistical analysis, participated in data interpretation, and takes responsibility for the data analysis.

All authors had full access to the study data and take responsibility for the integrity of the data and accuracy of the data analysis.

All authors read and approved the final manuscript.

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Conflict of interest statement

The authors have declared no conflicts of interest.

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Appendix A. ELCAPA study group

We acknowledge the members of the ELCAPA study group: †The ELCAPA Study Group is composed of three oncologists (S. Culine, C. Tournigand, B. Rousseau), one radiotherapist (J.L. Lagrange), five geriatricians (P. Caillet, M. Laurent, E. Liuu, E. Paillaud, and H. Vincent), three epidemiologists (F. Canouï-Poitrine, S. Bastuji-Garin, E Audureau), one pharmacist (M. Carvahlo-Verlinde), one biostatistician (A. Le Thuaut), two clinical research physicians (N. Reynald, A Neyrand).

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