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Original article

Prevalence of malnutrition and impact on clinical outcomes in cancer services: A comparison of two time points

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SUMMARY

Background: The prevention and management of malnutrition is increasingly recognised as a significant element of cancer care. By identifying and comparing cancer malnutrition in two large cross-sectional cancer populations, this study aims to provide a greater understanding of clinical characteristics and trajectories relating to cancer malnutrition.

Methods: A multi-centre point prevalence study was conducted in Victoria, Australia at two time points (March 2012, May 2014). Adults with cancer receiving ambulatory chemotherapy, radiotherapy and multi-day inpatients were included. The presence of malnutrition was determined using Patient Generated-Subjective Global Assessment (PG-SGA). Demographic, clinical information and 30-day outcomes were collected.

Results: The study included 1677 patients in 2012 (17 sites) and 1913 patients in 2014 (27 sites). Older age, ≥5% weight loss, hospital admission and metastatic disease were factors significantly associated with malnutrition. Patients with upper gastrointestinal, head and neck and lung cancers were more likely to be malnourished. Malnutrition was associated with infection and poor outcomes at 30-days. Malnutrition prevalence reduced from 31% in 2012 to 26% in 2014 ($p = 0.002$). This reflects a reduction in patients with malnutrition receiving ambulatory chemotherapy, those with upper gastrointestinal or colorectal cancers and those residing in regional areas.

Conclusion: The study has provided a comprehensive description of cancer malnutrition prevalence representative of all treatment settings, tumour types and stages of disease. This provides valuable insight into cancer malnutrition enabling oncology services to identify opportunities to embed identification and prevention strategies into models of care, resulting in improved patient outcomes and reduced health care costs.

1. Introduction

In 2012, the global incidence of cancer reached 14.1 million new cases, while 32.6 million people were living with a cancer diagnosis [1]. Cancer treatment is often associated with significant acute toxicities that negatively impact on the ability to achieve an adequate nutritional intake with a subsequent increased risk of malnutrition. Malnutrition due to starvation, disease or ageing has been defined as "a state resulting from lack of uptake or intake of nutrition leading to altered body composition (decreased fat free mass) and body cell mass leading to diminished physical and mental function and impaired clinical outcome from disease [2]. International evidence based guidelines highlight the severe negative impact on patient

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outcomes, including reduced survival, increased health care costs and recognise malnutrition as a significant supportive care need [3–5]. Understanding the magnitude of the problem and in which groups the greatest need exists is a vital step toward the recognition and management of cancer malnutrition.

Cancer patients have one of the highest prevalence of malnutrition [6]. Cross-sectional and point prevalence studies using a variety of malnutrition assessment techniques, across various oncology populations have been undertaken in a number of countries [7–10]. These studies have largely focused on particular patient populations including patients with advanced cancer or those in the inpatient or ambulatory setting.

The Patient Generated-Subjective Global Assessment (PG-SGA) is a standardised tool for assessing nutritional status [11] and has been validated as having the ability to detect patients with malnutrition in oncology settings [12,13]. It has also widely used in other studies of malnutrition in cancer populations [10,14–16].

There is currently a lack of data regarding malnutrition prevalence in patients undergoing active cancer treatment across all treatment settings, tumour types and disease stage. This study aimed to identify and compare the prevalence of cancer malnutrition at two time points for both inpatients admitted for cancer related care and ambulatory patients receiving chemotherapy and/or radiotherapy.

2. Methods and measures

2.1. Study design and setting

This prospective multi-centre point prevalence study was conducted in public and private health services across the state of Victoria, Australia at two time points, March 2012 and May 2014. Seventeen sites participated in 2012, which represented greater than 70% of the cancer treatments delivered in the state, and included the highest volume cancer services in metropolitan and regional Victoria. In 2014 the study was conducted in a total of 27 sites, all original sites and 10 additional sites.

During a common two-week period at each time point, participating health services collected data for multi-day inpatients, ambulatory radiotherapy patients and chemotherapy day patients. Dietitians employed at each of the health services completed data collection. All dietitians received standard training regarding data collection methods at both time points.

2.2. Participants

Eligible participants were patients aged 18 years and over: admitted to hospital for a cancer treatment or related management as a multi-day stay; ambulatory patients attending for radiotherapy; or day-only admission to receive an intravenous (IV) chemotherapy agent. Chemotherapy treatments included cancer-suppressing agents including all cytotoxic agents, hormonal and biological therapies, but not supportive treatments such as blood transfusions and bi-phosphonates.

Patients were excluded if attending for ambulatory medical appointment only or other day procedures; undergoing investigations without a confirmed cancer diagnosis; end-stage disease (less than 30 day life expectancy); if admitted to hospital for medical management unrelated to their cancer treatment; where participation was deemed too burdensome by nursing staff, data collector or at the patient's request; or when patients were unable to give consent.

Ethics approval was granted at each individual health service and all patients gave verbal consent to participate. All measures selected were those commonly used in clinical practice and reflect the information collected within standard care. No additional tests or investigations were requested.

2.3. Measures

2.3.1. Demographic and clinical data

Demographics (age, gender, location of usual residence, living arrangements), site of primary malignancy, presence of distant metastatic disease, and modality of current cancer treatment were collected.

The presence of two complications linked to nutritional status were collected on the study day for inpatients only; use of antibiotics as a marker of the presence of a current infection (excluding those for prophylaxis), and the presence of a hospital acquired pressure ulcer.

2.3.2. Malnutrition screening

Dietitians screened for malnutrition risk using the Malnutrition Screening Tool (MST) [17,18] which has been validated in oncology settings [19,20]. The MST consists of two questions regarding recent unintentional weight loss and appetite. An MST score of 2 or greater indicates risk of malnutrition.

2.3.3. Nutrition assessment

No further nutritional assessment was completed for patients not at-risk of malnutrition (MST <2) and they were considered to be well nourished. Participants identified as at risk of malnutrition (MST $\geq$2) were assessed using the Patient Generated-Subjective Global Assessment (PG-SGA). The PG-SGA consists of two sections: (1) a patient reported component assessing weight loss, dietary intake, symptoms and functional status, and (2) a clinician determined section assessing metabolic demands and a physical examination of subcutaneous fat loss, muscle wasting and oedema. The PG-SGA generates a score and a global rating (A - well nourished; B – mild to moderately malnourished; C - severely malnourished). Patients were defined as malnourished if they were assessed to be PG-SGA category B or C.

2.3.4. Anthropometry

Weight and height were recorded using usual equipment within each hospital and used to calculate Body Mass Index (BMI, kg/m^2), the healthy weight range was adjusted for older adults.[5]

2.4. Outcomes

Thirty days after the study day, dietitians collected length of stay, planned or unplanned multi-day inpatient admissions to the same hospital within this period and mortality data from the electronic medical record at each hospital. Length of stay was defined as the duration of stay from admission to discharge, or from admission to the day of the study plus 30 days if still in hospital.

2.5. Statistical analysis

Data analysis was completed using STATA version 13.1 (StataCorp LP). Statistical significance is reported at a two-sided p-value

[5] BMI (kg/m^2) weight ranges were adjusted based on age [21].

	18-64 years	≥65 years
Underweight	<18.5	<22
Healthy Weight Range	18.5–24.9	22–26.9
Overweight	25–29.9	27–29.9
Obese	≥30	≥30

of 0.05. Descriptive statistics for overall group related to each variable has been presented as mean (standard deviation) or median [inter-quartile range] proportions. Univariate analysis of odds ratio (OR) with a two-sided level of significance was determined for each categorical variable using chi-squared test. This is reported with the 95% confidence interval (CI), and level of significance (p-value).

A multivariate logistic regression analysis was carried out in order to identify independent risk factors for malnutrition. As no change in the associations between the variables and malnutrition were expected, data from both time points was grouped. A stepwise regression model was used and odds ratios (OR) with 95% confidence intervals (CI) were calculated. Variables that remained significant at the 0.05 levels are presented.

3. Results

A total of 1677 participants were included in 2012 and 1913 in 2014. The flow of participants is described in Fig. 1.

Participant characteristics were similar across both study groups, with details described in Table 1.

3.1. Overall malnutrition prevalence at each time point

Overall malnutrition prevalence was 31% (519/1677) in 2012 and 26% (501/1903) in 2014. This reduction in malnutrition prevalence between the two time points is statistically significant ($p = 0.002$). The proportion of well nourished, mild to moderate and severely malnourished patients at each time point is presented in Fig. 2.

3.2. Factors associated with malnutrition

At both time points, malnutrition was significantly associated age greater than 64 years, being underweight, weight loss ≥5 per cent of usual weight, being an admitted to hospital, and the presence of metastatic disease (Table 2). Male gender was associated with malnutrition in 2012 only. Living alone and treatment in a metropolitan hospital were associated with malnutrition in 2014 only. Factors statistically significantly associated with a lower prevalence of malnutrition were treatment with radiotherapy only and being overweight or obese. Due to the strongly significant difference seen by patient type (admitted or day-only), a multivariate analysis was undertaken for each of these subsets (Table 3). The factors independently associated with malnutrition for both groups were weight loss ≥5 per cent and metastatic disease. Chemotherapy and combined radiation-chemotherapy treatments also had an independent association with malnutrition in the ambulatory subset.

3.3. Malnutrition prevalence by tumour streams (Fig. 3)

The prevalence of malnutrition based on tumour type ranged from 62% in upper gastrointestinal cancer (2012) to 13% in breast cancer (2014). The tumour streams associated with the highest prevalence of malnutrition were upper gastrointestinal, head and neck, lung, haematological, gynaecological and colorectal. In the multivariate analysis, an upper gastrointestinal tumour was independently associated with malnutrition for both subsets of patients. Head and neck, lung, haematological and colorectal cancers were independently associated with malnutrition in ambulatory patient subset.

3.4. Changes in malnutrition prevalence between the two time points

No factor was associated with a statistically significant increase in malnutrition prevalence between the two study points. A statistically significant reduction in malnutrition was seen for patients receiving ambulatory treatments (OR 0.7, 95% CI 0.62–0.89, $p < 0.001$) or receiving chemotherapy only (OR 0.62, 95% CI 0.5–0.75, $p < 0.0001$); with colorectal (OR 0.64, 95% CI 0.4–0.9, $p = 0.015$) or upper gastrointestinal tumours (OR 0.6, 95% CI 0.4–0.9, $p = 0.0246$), the presence of metastatic disease (OR 0.66, 95% CI 0.53–0.84, $p < 0.001$) and in those aged greater than 64 years (OR 0.75, 95% CI 0.61–0.92, $p = 0.005$).

The overall number of patients being treated in regional sites had statistically increased in 2014 compared to 2012 (25% vs 29% $p = 0.008$). There was a reduction in malnutrition in patients whose usual residence was outside the metropolitan areas (OR 0.58, 95% CI 0.45–0.74, $p < 0.001$) or at regional treatment centres (OR 0.49, 95% CI 0.36–0.66, $p < 0.001$). There was no change in prevalence of malnutrition at metropolitan sites. No difference was seen in the malnutrition prevalence between new (24%) and original sites (26.5%) in 2014 ($p = 0.455$).

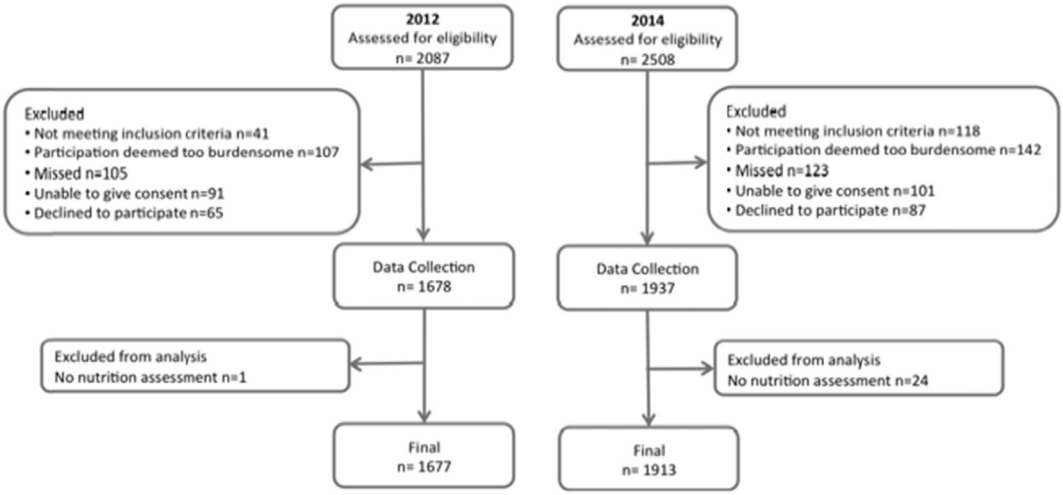

Fig. 1. Flow of participants.

Table 1
Characterises of study groups compared.

	2012 n = 1677	2014 n = 1913	P value
	N (%)	N (%)	
Gender			
Male	822 (49.0)	917 (47.9)	0.07
Female	855 (51.0)	996 (52.1)	
Age			
Mean ± SD years	62.8 ± 13.5	62.5 ± 13.8	
18–49 years	264 (15.7)	314 (16.4)	
50–64 years	570 (33.8)	670 (35.1)	0.52
65–79 years	689 (41.1)	745 (39.0)	0.19
≥ 80 years	154 (9.2)	182 (9.5)	0.73
Social supports			
Living with family/carer	1329 (79.3)	1538 (80.4)	
Living alone	329 (19.6)	360 (18.8)	0.51
Residential care	18 (1.1)	11 (0.6)	–
Unknown	1 (0.1)	4 (0.2)	–
Location of usual residence			
Metropolitan	1015 (61.5)	1172 (61.3)	0.31
Regional	400 (23.8)	367 (19.2)	**<0.001**
Rural	250 (14.9)	367 (19.2)	**<0.001**
Interstate	12 (0.7)	7 (0.4)	–
Body Mass Index (BMI) kg/m^2			
Mean [IQR]	25.9 [22.7–29.5]	26.8 [23.7–30.1]	
Underweight	225 (13.4)	184 (9.6)	**<0.01**
Healthy weight	618 (36.8)	723 (37.7)	0.56
Overweight	444 (26.3)	505 (26.4)	0.96
Obese	376 (22.4)	488 (25.5)	**0.03**
Unknown	14 (0.8)	13 (0.7)	–
Recent weight loss			
< 5%	1406 (83.8)	1481 (77.4)	
≥ 5%	267 (15.9)	235 (12.3)	0.06
Unknown	4 (0.2)	197 (10.3)	
Nutritional Status (PG-SGA category)			
Not at-risk of Malnutrition (MST<2)	1069 (63.7)	1290 (67.4)	**0.02**
Well Nourished SGA-A	89 (5.3)	122 (6.4)	0.17
Suspected-Mild Malnutrition SGA-B	444 (26.5)	418 (21.9)	**<0.01**
Severe Malnutrition SGA-C	75 (4.5)	83 (4.3)	0.85
Type of cancer			
Breast	330 (19.6)	413 (21.5)	0.15
Colorectal	312 (18.6)	291 (15.2)	**<0.01**
Genitourinary	171 (10.2)	155 (8.1)	**0.03**
Gynaecological	66 (3.9)	74 (3.9)	0.92
Haematological	294 (14.5)	342 (17.9)	0.79
Head & neck	110 (6.5)	117 (6.1)	0.59
Lung	140 (8.4)	187 (9.8)	0.14
Skin & melanoma	85 (5.1)	64 (3.4)	**0.01**
Upper gastrointestinal[a]	143 (8.5)	188 (9.8)	0.18
Other[b]	76 (4.5)	82 (4.3)	0.72
Presence of metastatic disease			
Yes	599 (35.7)	774 (40.5)	**0.04**
No	1078 (64.3)	1139 (59.5)	
Current treatment			
Surgery	120 (7.2)	85 (4.4)	**<0.001**
Chemotherapy	888 (52.9)	1129 (59.0)	**<0.001**
Radiotherapy	463 (27.9)	463 (24.2)	**0.02**
Chemo-radiotherapy	131 (7.8)	133 (6.9)	0.33
No treatment	75 (4.5)	103 (5.4)	0.21
Type of admission			
Admitted/Inpatients	337 (20.1)	350 (18.3)	0.17
Day only patients	1340 (79.9)	1563 (81.7)	
Location of treating hospital			
Metropolitan	1254 (74.8)	1355 (70.8)	**<0.01**
Regional	423 (25.2)	558 (29.2)	

Level of significance is p = 0.05 for all results.
[a] Upper gastrointestinal included endocrine & thyroid tumours.
[b] Other includes, central nervous system, bone and soft tissue, thoracic or other abdominal tumours and secondary tumours with unknown primary.

3.5. Complications and 30-day outcomes

Malnourished inpatients were twice as likely to be receiving antibiotics for a current infection at both time points (Table 4). Malnourished inpatients had a longer length of stay than well-nourished patients; in 2012 this was 20.1 (±16.5) vs 14.8 (±11.3) days, p = 0.002 and 21.9 (±18.0) vs 18.9 (±24.5) days, p = 0.2332 in 2014. Malnutrition also increased the likelihood of readmission and death within 30-days (Table 4).

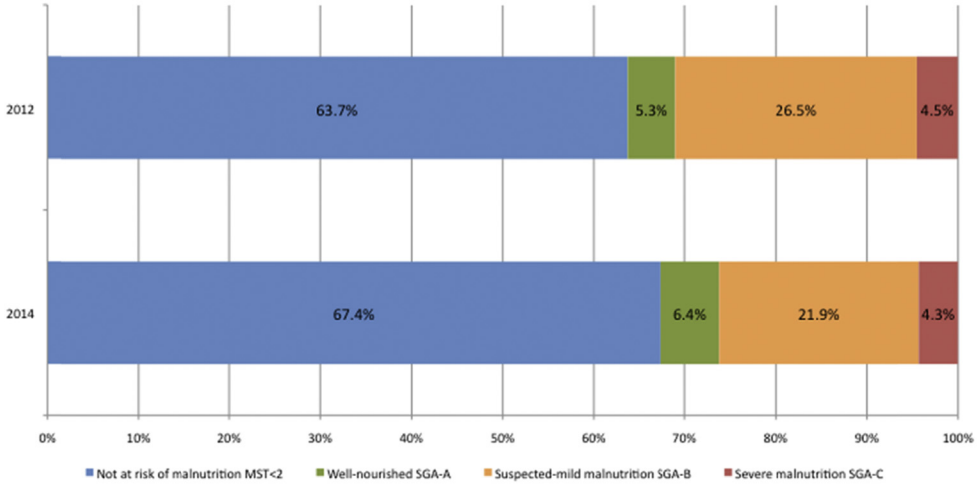

Fig. 2. Overall nutritional status of groups at the two time points.

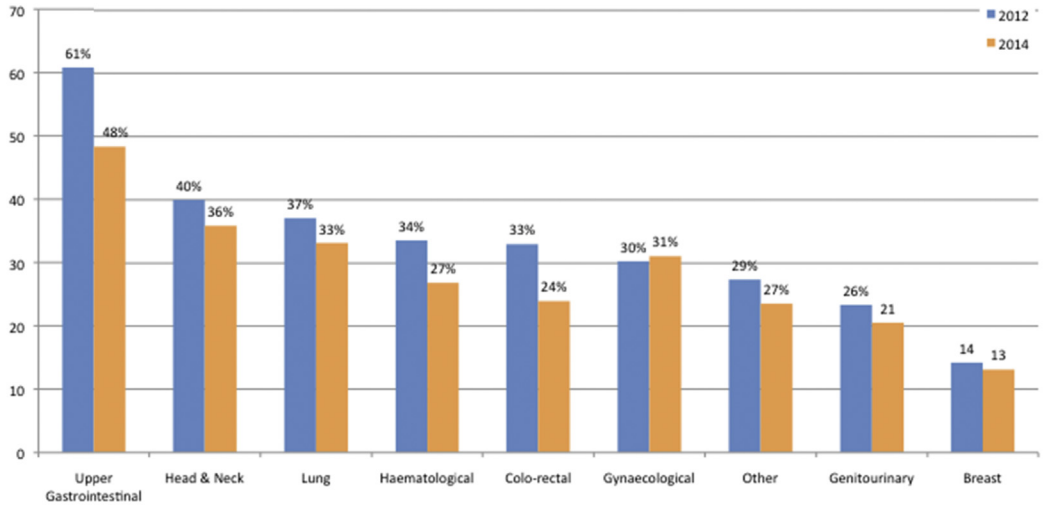

Fig. 3. Malnutrition prevalence by tumour type at the two time points. * Upper gastrointestinal included endocrine & thyroid tumours. # Other includes, central nervous system, bone and soft tissue, thoracic or other abdominal tumours and secondary tumours with unknown primary.

4. Discussion

This unique study conducted at two-time points, reports for the first time the prevalence and factors associated with cancer malnutrition from a population which is representative of all treatment settings, tumour types and stages of disease. Overall malnutrition prevalence was 31% in 2012 and 26% in 2014. This overall prevalence is lower than results reported in previous cross sectional populations, including the 2014 study of 1903 patients attending French hospitals [22], the 2005 Spanish study of 741 patients with advanced disease [10] and a smaller Australian study in chemotherapy patients [14].

Previous studies of malnutrition in general hospitalised populations have identified oncology patients to be at least 1.5 times more likely to be malnourished and report malnutrition prevalence in this group as 38–48% [6,22]. Malnutrition prevalence amongst inpatients was 56% at both time points. These results are higher than the results from French studies which report malnutrition prevalence as 44% [22] and 33% [23] for hospitalised patients and lower than the results from previous Australian studies [13,14] where the prevalence of malnutrition has been reported to be as high as 75%. This discrepancy may be explained by differences in the representation of patients from different tumour types, cancer treatments and stage of disease and differences in the method of assessing malnutrition. Additionally, enhanced standardisation in the management of malnutrition has occurred in Australia in the past decade with the introduction of national practice guidelines [24] and accreditation standards [25]. The prevalence of malnutrition in inpatients may possibly be higher than reported; as anecdotally it was observed that inpatients excluded due to the burden of participation frequently appeared malnourished. It is not possible to confirm this as these patients were too unwell to consent to the study and no data collected.

The majority of cancer malnutrition studies have been undertaken in ambulatory cancer patient populations [9,20,26–31]. These studies have reported the malnutrition prevalence between 17 and 65%. Differences can be explained by the use of a risk assessment rather than a tool to definitively diagnose malnutrition [26], regional setting [29], small sample size [20] and age of the study cohort [31]. A small number of studies have focussed on patients receiving radiotherapy only, these report malnutrition rates of 11% of all patients [19] and 30% for those with high nutrition risk tumours [9,32].

Table 2
Factors associated with malnutrition prevalence at each time point (univariate analysis).

	2012				2014			
	% MN	Odds Ratio	95% CI	P value	% MN	Odds Ratio	95% CI	P value
Gender								
Male	34.4	1.4	1.1–1.7	**0.002**	27.9	1.2	1.0–1.5	0.01
Female	27.4	1.0 (ref)			24.6	1.0 (ref)		
Age								
<65 years	27.0	1.0 (ref)			23.8	1.0 (ref)		
≥ 65 years	34.9	1.5	1.2–1.8	**<0.001**	28.7	1.3	1.0–1.6	**0.02**
Social supports								
Living with family/carer	30.0	1.0 (ref)			25.1	1.0 (ref)		
Living alone	35.3	1.3	1.0–1.7	0.06	30.8	1.3	1.0–1.7	**0.02**
Location of usual residence								
Metropolitan	29.9	1.0 (ref)			28.8	1.0 (ref)		
Regional	32.0	1.1	0.9–1.4	0.43	23.4	0.8	0.6–1.0	**0.05**
Rural	34.4	1.2	0.9–1.6	0.16	20.7	0.6	0.5–0.9	**0.003**
Body Mass Index (BMI) kg/m^2								
Underweight	59.2	2.8	2.0–3.8	**<0.001**	52.2	2.24	1.6–3.1	**<0.001**
Healthy weight range	34.6	1.0 (ref)			32.8	1.0 (ref)		
Overweight/obese	20.4	0.48	0.4–0.6	**<0.001**	16.6	0.41	0.3–0.5	**<0.001**
Weight loss								
<5%	20.1	1.0 (ref)			19.3	1.0 (ref)		
≥5%	88.8	31.6	21.1–47.0	**<0.001**	91.1	42.6	26.5–71.3	**<0.001**
Current treatment								
Radiotherapy	16.6	1.0 (ref)			17.9	1.0 (ref)		
Chemotherapy	32.6	2.4	1.8–3.2	**<0.001**	23.0	1.4	1.0– 1.8	**0.03**
Chemo-radiotherapy	38.9	3.2	2.1–4.9	**<0.001**	36.8	2.7	1.7–4.1	**<0.001**
Surgery	47.5	4.5	2.9–7.0	**<0.001**	44.7	3.7	2.3–6.0	**<0.001**
No treatment	58.7	7.1	4.2–12.0	**<0.001**	68.9	10.2	6.3–16.4	**<0.001**
Presence of metastatic disease								
Yes	39.6	1.8	1.5–2.3	**<0.001**	30.4	1.4	1.2–1.8	**<0.001**
No	26.2	1.0 (ref)			23.4	1.0 (ref)		
Type of admission								
Inpatient	56.7	4.0	3.1–5.2	**<0.001**	56.6	5.4	4.2–7.0	**<0.001**
Ambulatory/day-only patients	24.5	1.0 (ref)			19.4	1.0 (ref)		
Location of treating hospital								
Metropolitan	30.7	0.96	0.8–1.2	0.71	29.4	1.83	1.4–2.4	**<0.001**
Regional	31.7	1.0 (ref)			18.4	1.0 (ref)		

Level of significance is p = 0.05 for all results.

Table 3
Factors independently associated with malnutrition by multivariate analysis.

	Admitted n = 687		Ambulatory patients n = 2903	
	OR	95% CI	OR	95% CI
Underweight			1.6	1.2–2.3
≥5%Wt loss	26.9	13.4–54.3	31.2	21.4–45.5
Colorectal			1.6	1.1–2.5
Haematological			2.4	1.6–3.8
Head & Neck			3.3	1.9–5.6
Lung			2.0	1.3–3.2
Upper GI	3.2	1.2–8.7	3.8	2.4–6.0
Metastatic Disease	1.6	1.0–2.6	1.4	1.1–1.8
Chemotherapy			1.6	1.5–2.1
Chemo-radiotherapy			2.3	1.5–3.5

Older age [6,31] and living alone [33] have been identified as two independent risk factors for malnutrition in general hospitalized patient groups. While we did not measure factors such as falls, cognitive impairment and depressed mood, these factors have been shown to be independent risk factors for malnutrition in an elderly cancer population [31] and therefore may be related to the association with age in our cohort. The results of this study confirm these risk factors for patients with cancer and highlight the importance of early identification of such demographic factors to enable proactive nutrition monitoring and intervention to prevent the development of malnutrition.

This study provides further evidence of the negative impact of malnutrition on clinical outcomes at 30 days. Mortality, antibiotic use for treatment of infection and hospital readmissions were all higher in malnourished patients. This result confirms the finding from the French cancer centres [23], and the association with infections is concordant with results in medical care [34] and geriatric [35] units. This has implications not only on patient outcomes but also substantial cost implications for health service providers [36,37,38].

4.1. Reductions in malnutrition prevalence

Overall there has been a significant reduction in the prevalence of malnutrition in Victorian cancer services between 2012 and 2014. This reduction has been most strongly observed in patients with upper gastrointestinal and colorectal tumours, those receiving ambulatory chemotherapy and those over 64 years. This reduction may be a result of increased awareness of cancer malnutrition and local targeted improvements in the management of cancer malnutrition following the initial study in 2012. Additionally, concurrent state-wide redesign projects presented the opportunity to embed improved malnutrition screening practices in ambulatory chemotherapy day units. In the multivariate analysis time point was not independently associated with malnutrition. This points to a difference in the population of cancer patients sampled at each time point rather than a true reduction. The overall increase in the number of patients who are overweight and obese may be a confounding reason for reduction in malnutrition. This in itself may be representative of the change in the cancer population receiving cancer treatments and reflect the association between the risk of some cancers and obesity [39].

Table 4
Relationship between malnutrition and complications and outcomes at 30-days.

		2012					2014				
		Number	% MN	OR	95% CI	p value	Number	% MN	OR	95% CI	p value
Admitted Only	**Current infection (antibiotics)**										
	Yes	104	68%	2.1	1.3–3.5	**0.003**	125	65%	1.7	1.1–2.7	**0.023**
	No	227	51%	1.0 (ref)			224	52%	1.0 (ref)		
	Unknown	6					1				
	Pressure ulcers										
	Yes	12	83%	4.0	0.8–38.4	0.055	15	47%	1.0	0.3–3.6	0.975
	No	320	55%	1.0 (ref)			335	43%	1.0 (ref)		
	Unknown	5					–				
	Remaining as an inpatient										
	Yes	27	89%	7.9	2.3–41.6	**<0.001**	30	63%	1.6	0.7–3.8	0.265
	No	264	50%	1.0 (ref)			251	53%	1.0 (ref)		
	Deceased/unknown	28 / 18					43/26				
All Patients	**Admission/readmission**										
	Unplanned	158	49%	2.7	1.9–3.8	**<0.001**	69	40%	2.4	1.6–3.5	**<0.001**
	Planned	98	41%	2.0	1.3–3.0	**0.002**	44	27%	1.3	0.7–2.6	0.409
	No admission	1338	26%	1.0 (ref)			1567	23%	1.0 (ref)		
	Unknown/not applicable	83					223				
	Mortality										
	Deceased	36	81%	9.7	4.2–26.6	**<0.001**	54	72%	6.5	3.5–12.5	**<0.001**
	Alive	1598	30%	1.0 (ref)			1767	25%	1.0 (ref)		
	Unknown	43	–				92	–			

Level of significance is p = 0.05 for all results.

The reduction in malnutrition prevalence is not explained by the inclusion of additional sites, as no difference was seen in the malnutrition prevalence between new and original sites. The prevalence of malnutrition in regional sites almost halved between the two time points and may be a result of targeted service improvements to address the known poorer outcomes for patients in regional areas [40] which have occurred in the period between studies.

4.2. Limitations

The limitations of this study are acknowledged including the inability to follow patients over time and sampling restricted to only patients undergoing active cancer treatments and attending hospitals; there is no representation of cancer patients in other care settings such as community palliative care or the post-treatment cohort, where nutrition impact symptoms may still be significant and increase the risk of malnutrition. Bias due to reduced inter-rater reliability is possible due to the multiple data collectors across sites and time points. There was no opportunity for reliability testing to be conducted between sites. Standard training was conducted at all sites to ensure the understanding of all data elements and lead data collectors were familiar with conducting nutrition assessments using the PG-SGA through routine clinical practice strengthening the reliability of the results.

Strengths of this study are that it utilised a standardised nutritional assessment tool to assess the nutritional status in two large cohorts of patients. The large sample size and the heterogeneous nature of the populations at both time points makes the data transferable and applicable to a variety of other hospitals or care settings. Similarities in the prevalence of malnutrition seen between the two cohorts provide insight into the at-risk populations.

4.3. Implications for clinical practice

This study has confirmed the high prevalence of malnutrition in the cancer population. Further, while there is significant variance in malnutrition prevalence based on tumour type, treatment modality and stage of disease, specific sub-populations have been identified who are more likely to be malnourished which needs to be considered in the delivery of clinical oncology services. However, it is evident malnutrition can occur in all tumour types and in all settings. Services should be designed to ensure malnutrition risk screening occurs at the first point of contact and at regular intervals throughout treatment and care to ensure early intervention is provided to those at risk of malnutrition. Health services should identify opportunities to embed malnutrition identification and prevention strategies into models of care and support key enablers including education of all staff.

5. Conclusion

The study has provided a comprehensive description of malnutrition prevalence in cancer patients receiving active treatment across all treatment settings, tumour types and disease stage. Social, demographic and clinical characteristics have been identified that increase the likelihood of malnutrition. The findings of this study provide valuable clinical insight into cancer malnutrition that can inform the design and delivery of clinical oncology services to prevent the poor patient outcomes and increased health care costs associated with the condition.

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Conflict of interest

All authors declare no conflict of interest.

Authors contributions

Conception and design: Linda Nolte, Kathryn Marshall, Jenelle Loeliger.

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References

[1] International Agency for Research on Cancer Globocan Database. Estimated incidence, mortality and prevalence worldwide in 2012 fact sheet. 2012. http://globocan.iarc.fr/Pages/fact_sheets_cancer.aspx.
[2] Cederholm T, Bosaeus I, Barazzoni R, Bauer J, Van Gossum A, Klek S, et al. Diagnostic criteria for malnutrition e an ESPEN consensus statement. Clin Nutr 2015;34:335–40.
[3] Academy of Nutrition and Dietetics. Oncology evidence-based nutrition practice guideline. 2013. Available from: http://andevidenceanalysislibrary.com.
[4] Isenring E, Zabel R, Bannister M, Brown T, Findlay M, Kiss N, et al. Updated evidence-based practice guidelines for the nutritional management of patients receiving radiation therapy and/or chemotherapy. Nutr Diet 2013;70:312–24.
[5] August DA, Huhmann MB. Board of Directors of the American Society for Parentral and Enteral Nutrition: A.S.P.E.N Clinical Guidelines: nutrition support therapy during adult anticancer treatment and in hematopoietic cell transplantation. J Parenter Enteral Nutr 2009;33:472–500. https://doi.org/10.1177/0148607109341804.
[6] Agarwal E, Ferguson M, Banks M, Bauer J, Capra S, Isenring E. Nutritional status and dietary intake of acute care patients: results from the Nutrition Care Day Survey 2010. Clin Nutr 2010 2012;31:41–7.
[7] Bozzetti F. Screening the nutritional status in oncology: a preliminary report on 1,000 outpatients. Support Care Canc 2009;17:279–84.
[8] Hébuterne X, Lemarié E, Michallet M, de Montreuil CB, Schneider SM, Goldwasser F, et al. Prevalence of malnutrition and current use of nutrition support in patients with cancer. J Parenter Enteral Nutr 2014;38:196–204.
[9] Read JA, Choy STB, Beale P, Clarke SJ. An evaluation of the prevalence of malnutrition in cancer patients attending the outpatient oncology clinic. Asia Pac J Clin Oncol 2006;2:80–6.
[10] Segura A, Pardo J, Jara C, Zugazabeitia L, Carulla J, de Las Peñas R, et al. An epidemiological evaluation of the prevalence of malnutrition in Spanish patients with locally advanced or metastatic cancer. Clin Nutr 2005;24:801–14.
[11] Ottery F. Patient generated subjective global assessment. In: McCallum P, Polisena C, editors. The clinical guide to oncology. Chicago IL: The American Dietetic Association; 2000. p. 11–23.
[12] Bauer J, Capra S. Comparison of a malnutrition screening tool with subjective global assessment in hospitalised patients with cancer- sensitivity and specificity. Asia Pac J Clin Nutr 2003;12:257–60.
[13] Bauer J, Capra S, Ferguson M. Use of the scored Patient-Generated Subjective Global Assessment (PG-SGA) as a nutrition assessment tool in patients with cancer. Eur J Clin Nutr 2002;56:779–85. https://doi.org/10.1038/sj.ejcn.1601412.
[14] Isenring E, Cross G, Kellett E, Koczwara B, Daniels L. Nutritional status and information needs of medical oncology patients receiving treatment at an Australian public hospital. Nutr Cancer 2010;62:220–8. https://doi.org/10.1080/01635580903305276.
[15] Ravasco P, Monteiro-Grillo I, Vidal PM, Camilo ME. Nutritional deterioration in cancer: the role of disease and diet. Clin Oncol 2003;15:443–50. https://doi.org/10.1016/s0936-6555(03)00155-9.
[16] Martin L, Watanabe S, Fainsinger R, Lau F, Ghosh S, Quan H, et al. Prognostic factors in patients with advanced cancer: use of the patient-generated subjective global assessment in survival prediction. J Am Clin Oncol 2010;28(28):4376–83.
[17] Ferguson M, Capra S, Bauer J, Banks M. Development of a valid and reliable malnutrition screening tool for adult acute hospital patients. Nutrition 1999;15(6):458–64.
[18] Skipper A, Ferguson M, Thompson K, Castellanos VH, Porcari J. Nutrition screening tools: an analysis of the evidence. J Parenter Enteral Nutr 2012;36:292–8. https://doi.org/10.1177/0148607111414023.
[19] Ferguson M, Bauer J, Gallagher B, Capra S, Christie DR, Mason BR. Validation of a malnutrition screening tool for patients receiving radiotherapy. Australas Radiol 1999;43:325–7.
[20] Isenring E, Cross G, Daniels L, Kellett E, Koczwara B. Validity of the malnutrition screening tool as an effective predictor of nutritional risk in oncology outpatients receiving chemotherapy. Support Care Cancer 2006;14:1152–6. https://doi.org/10.1007/s00520-006-0070-5.
[21] Winter JE, MacInnis RJ, Wattanapenpaiboon N, Nowson CA. BMI and all-cause mortality in older adults: a meta-analysis. AJCN (Am J Clin Nutr) 2014;99:875–90. https://doi.org/10.3945/ajcn.113.068122.
[22] Pirlich M, Schutz T, Norman K, Gastella S, Lübke HJ, Bischoffet SC, et al. The German hospital malnutrition study. Clin Nutr 2006;25:563–72. https://doi.org/10.1016/j.clnu.2006.03.005.
[23] Pressoir M, Desne S, Berchery D, Rossignol G, Poiree B, Meslier M, et al. Prevalence, risk factors and clinical implications of malnutrition in French Comprehensive Cancer Centres. Br J Cancer 2010;102:966–71. https://doi.org/10.1038/sj.bjc.6605578.
[24] Watterson C, Fraser A, Banks M, Isenring E, Miller M, Silvester C, et al. Evidence based practice guidelines for the nutritional management of malnutrition in adult patients across the continuum of care. Nutr Diet 2009;66(Supp 3):S1–34.
[25] The Australian Council on Healthcare Standards: Introducing EQuIP National. http://www.achs.org.au/publications-resources/equipnational/.
[26] Bozzetti F, Mariani L, Lo Vullo S, SCRINIOWorking Group, Amerio ML, Biffiet R, et al. The nutritional risk in oncology: a study of 1,453 cancer outpatients. Support Care Cancer 2012;20:1919–28. https://doi.org/10.1007/s00520-012-1387-x.
[27] Gabrielson DK, Scaffidi D, Leung E, Stoyanoff L, Robinson J, Nisenbaum R, et al. Use of an abridged scored Patient-Generated Subjective Global Assessment (abPG-SGA) as a nutritional screening tool for cancer patients in an outpatient setting. Nutr Cancer 2013;65:234–9. https://doi.org/10.1080/01635581.2013.755554.
[28] Davidson W, Teleni L, Muller J, Ferguson M, McCarthy AL, Vick J, et al: Malnutrition and chemotherapy-induced nausea and vomiting: implications for practice. Oncol Nurs Forum doi 10.1188/12.ONF.E340–E345.
[29] Creaser N. Nutritional status of oncology patients admitted to a rural day chemotherapy unit as measured by the Patient Generated-Subjective Global Assessment. Nutr Diet 2010;67:231–6.
[30] Abbott J, Teleni L, McKavanagh D, Watson J, McCarthy A, Isenring E. A novel, automated nutrition screening system as a predictor of nutritional risk in an oncology day treatment unit (ODTU). Support Care Cancer 2014;22:2107–12.
[31] Paillaud E, Liuu E, Laurent M, Le Thuaut A, Vincent H, Raynaud-Simon A, et al. Geriatric syndromes increased the nutritional risk in elderly cancer patients independently from tumour site and metastatic status (The ELCAPA-05 cohort study). Clin Nutr 2014;33:330–5. https://doi.org/10.1016/j.clnu.2013.05.014.
[32] Isenring E, Bauer J, Capra S. The scored Patient-generated Subjective Global Assessment (PG-SGA) and its association with quality of life in ambulatory patients receiving radiotherapy. Eur J Clin Nutr 2003;57:305–9. https://doi.org/10.1038/sj.ejcn.1601552.
[33] Pirlich M, Schutz T, Kemps M, Luhman N, Minko N, Lübke HJ, et al. Social risk factors for hospital malnutrition. Nutrition 2005;21:295–300.
[34] Schneider SM, Veyres P, Pivot X, Soummer AM, Jambou P, Filippi J, et al. Malnutrition is an independent factor associated with nosocomial infections. Br J Nutr 2004;92:105–11.
[35] Paillaud E, Herbaud S, Caillet P, Lejonc JL, Campillo B, Bories PN. Relations between undernutrition and nosocomial infections in elderly patients. Age Ageing 2005;34:619–25.
[36] Elia M. A report on the cost of disease-related malnutrition in England and a budget impact analysis of implementing the NICE clinical guidelines/quality standard on nutritional support in adults. BAPEN; 2015. http://www.bapen.org.uk/information-and-resources/publications-and-resources/bapen-reports/cost-of-malnutrition-in-england.
[37] Rowell DS, Jackson TJ. Additional costs of inpatient malnutrition, Victoria, Australia, 2003-2004. Eur J Health Econ 2011;12:353–61.
[38] Correia MITD, Waitzberg D. The impact of malnutrition on morbidity, mortality, length of hospital stay and costs evaluated through a multivariate model analysis. Clin Nutr 2003;22:235–9. https://doi.org/10.1016/s0261-5614(02)00215-7.
[39] Bhaskaran K, Douglas I, Forbes H, dos-Santos-Silva I, Leon DA, Smeeth L. Body-mass index and risk of 22 specific cancers: a population-based cohort study of 5·24 million UK adults. Lancet 2014;384:755–65.
[40] Commonwealth of Australia, Department of Health. National cancer work plan. Commonwealth of Australia; 2012. http://www.health.gov.au/internet/main/publishing.nsf/content/cancer-national#plan.