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Persistent malnutrition in a remote Australian hospital—Insights from a 10-year cross-sectional study

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Abstract

Aim: To describe the burden of malnutrition in an at-risk population and validate a screening tool.

Methods: A 10-year cross-sectional study was conducted in a remote hospital. Dietitians screened participants using the Malnutrition Screening Tool or the Adult Nutrition Tool. Participants scoring ≥2 utilising the Malnutrition Screening Tool or ≥4 utilising the Adult Nutrition Tool, or already under the care of a dietitian, were assessed for malnutrition using a Subjective Global Assessment. The validity of the Adult Nutrition Tool was compared to the Malnutrition Screening Tool in participants undergoing a Subjective Global Assessment.

Results: Of 980 study participants, 70.1% identified as Aboriginal Australian and 42.6% were at risk of malnutrition. Three-hundred and seventy-four (58.8%) participants were malnourished. The Adult Nutrition Tool showed superior area under the curve (0.74, 95% confidence interval [0.67, 0.81], $p < 0.001$) than the Malnutrition Screening Tool (0.64, 95% confidence interval [0.56–0.73], p 0.001). An Adult Nutrition Tool score ≥2 demonstrated superior sensitivity (98.2%) and specificity (16.7%) compared to a Malnutrition Screening Tool score ≥2 (sensitivity 97.2% and specificity 14.3%). An Adult Nutrition Tool score of ≥3 demonstrated reduced sensitivity (92.0%) but superior specificity (20.2%) than screening scores ≥2 for both tools.

Conclusion: Malnutrition risk is high in a remote Australian hospital. This study confirms the Adult Nutrition Tool and the Malnutrition Screening Tool are valid tools to predict malnutrition in a unique remote hospital, recommending an 'at-risk' threshold of ≥2 for the Adult Nutrition Tool to aid in the early detection of malnutrition.

KEYWORDS
First Nations, malnutrition screening, remote, Subjective Global Assessment

1 | INTRODUCTION

Malnutrition is a complex and prevalent condition in hospitalised adults internationally and within Australia. The prevalence of malnutrition in patients admitted to an acute care setting in Australia is between 30% and 50%.[1–4] Despite published research, malnutrition remains an ongoing burden due to its association with a longer length of hospital stay, more frequent inpatient admissions, increased healthcare costs and increased morbidity and mortality.[5–7]

The prevalence of malnutrition has been extensively studied in metropolitan and regional hospitals[1,2,8–10]; however, there are few studies in rural and remote settings.[4] People living in remote areas experience a higher burden of chronic disease, food insecurity, socioeconomic factors, and a large proportion of the population identify as Aboriginal Australian.[11] Due to the ongoing impact of colonisation, Aboriginal people experience higher rates of health disadvantage and lower life expectancy.[12] Living in remote areas further increases risk when compared to regional and metropolitan areas.[13] Further to this, there is a paucity of research on malnutrition prevalence in Aboriginal patients living in remote areas. A study by Morris et al.[4] of two regional and one remote Australian hospitals reported a 46.1% and 37.1% prevalence of malnutrition in Aboriginal and non-Aboriginal patients, respectively. This study further described a 56.7% prevalence of malnutrition among Aboriginal patients in a remote hospital.[4]

The classification of malnutrition in hospitals relies on healthcare professionals utilising valid nutrition screening and assessment tools. Within Australia, it is a requirement of acute health care facilities to screen patients on admission and weekly thereafter according to the National Safety and Quality Health Service Standards.[14] The Adult Nutrition Tool (ANT) is the only Malnutrition Screening Tool (MST) developed specifically for Aboriginal Australian patients and validated in both Aboriginal and non-Aboriginal medical inpatients.[15] An ANT score of greater than or equal to 2 is highly sensitive for predicting malnutrition.[15] A research gap remains in validating the ANT in routine clinical care of adult Aboriginal and non-Aboriginal Australian across multiple inpatient cohorts.

The assessment of malnutrition requires the use of a validated nutrition assessment tool. The Subjective Global Assessment (SGA) is a validated tool that is widely used by dietitians to diagnose malnutrition.[16] Diagnostic criteria can also be used, including the International Classification of Diseases 10th Revision and more recently, the Global Leadership in Malnutrition (GLIM) criteria.[17–19] Given the limited data on the prevalence of malnutrition in remote areas, the aim of this study was to determine the prevalence of malnutrition in a remote Australian hospital. The secondary aim of this study was to use this data to validate the ANT in detecting malnutrition in acute adult patients.

We respectfully use the term ‘Aboriginal’ throughout this publication as the preferred term when referring to Aboriginal Australian peoples of Central Australia.[20]

2 | METHODS

This cross-sectional study design included an annual point-prevalence malnutrition audit conducted between 2014 and 2023. The audit was completed in a large remote hospital within the Northern Territory (NT) of Australia.[21] The hospital services a vast catchment area, covering over 1 million sq km. This includes remote and very remote communities, towns and regions that extend into the bordering areas of the South Australia and Western Australia communities (Figure 1). The hospital has 207 inpatient beds with an average of 9163 emergency presentations each year between the study period.[22] Aboriginal peoples make up approximately 20.6% of the total population in Central Australia and account for 70% of hospital health service users within the NT.[22,23]

Adult patients aged 18 years and over admitted into the hospital's emergency department, medical and surgical wards, renal inpatient ward and continuing care or orthopaedic/rehabilitation ward were approached to participate in malnutrition screening and nutritional assessment. Exclusion criteria included patients under the age of 18 years, admitted with a primary mental health condition, critically unwell, pregnant women and patients who did not or were not able to provide informed consent.

Figure 2 outlines the recruitment of study participants. On the day of the audits, convenience sampling was used. At the beginning of each audit day, a hospital print out of all current admissions of the included wards was retrieved and study numbers were allocated by the principal investigators. Eligible patients who consented to participate in the audit recruited between 2014 and

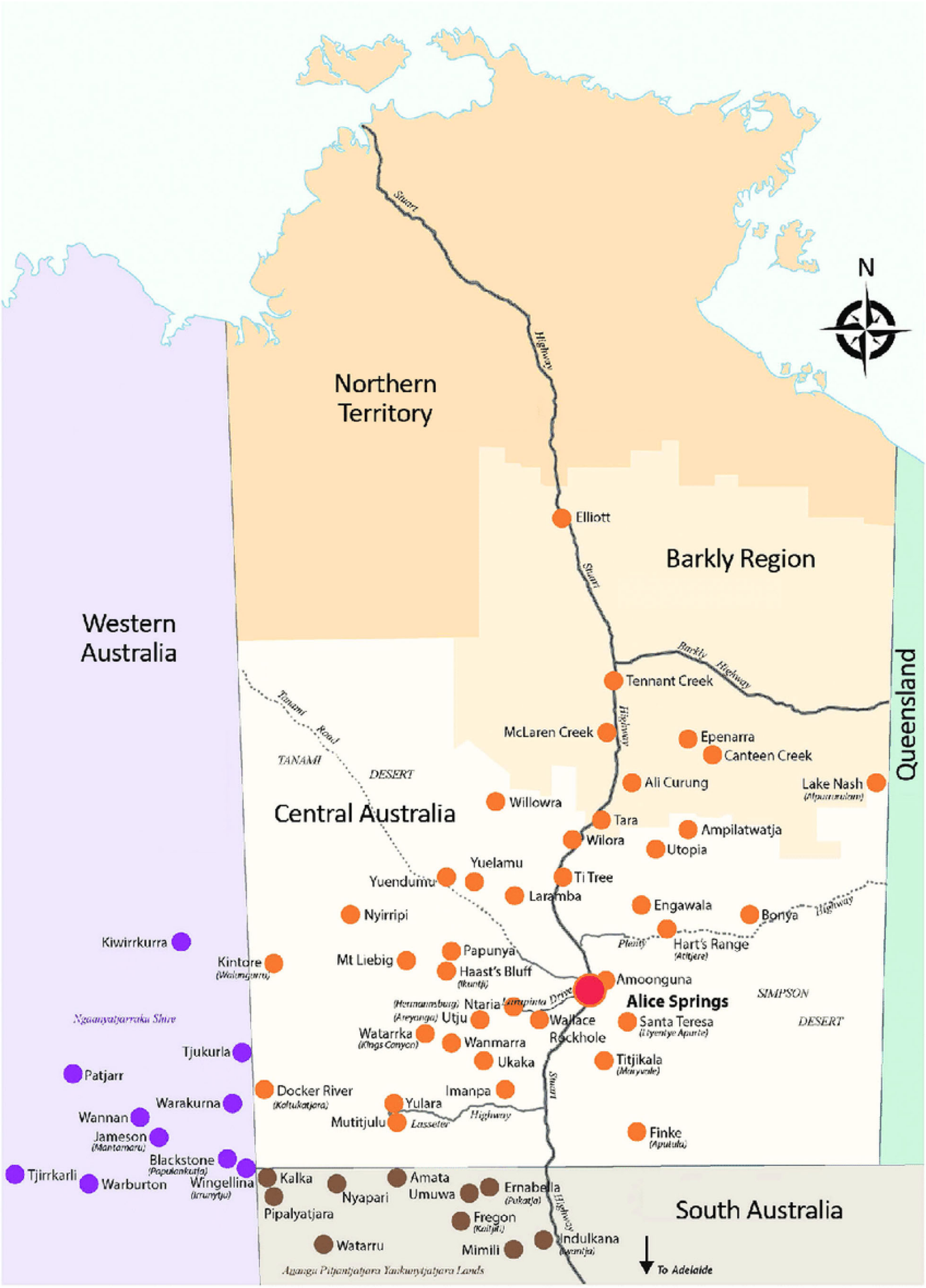

FIGURE 1 Map of catchment area for Alice Springs Hospital licenced under Creative Commons Licence by 4.0.

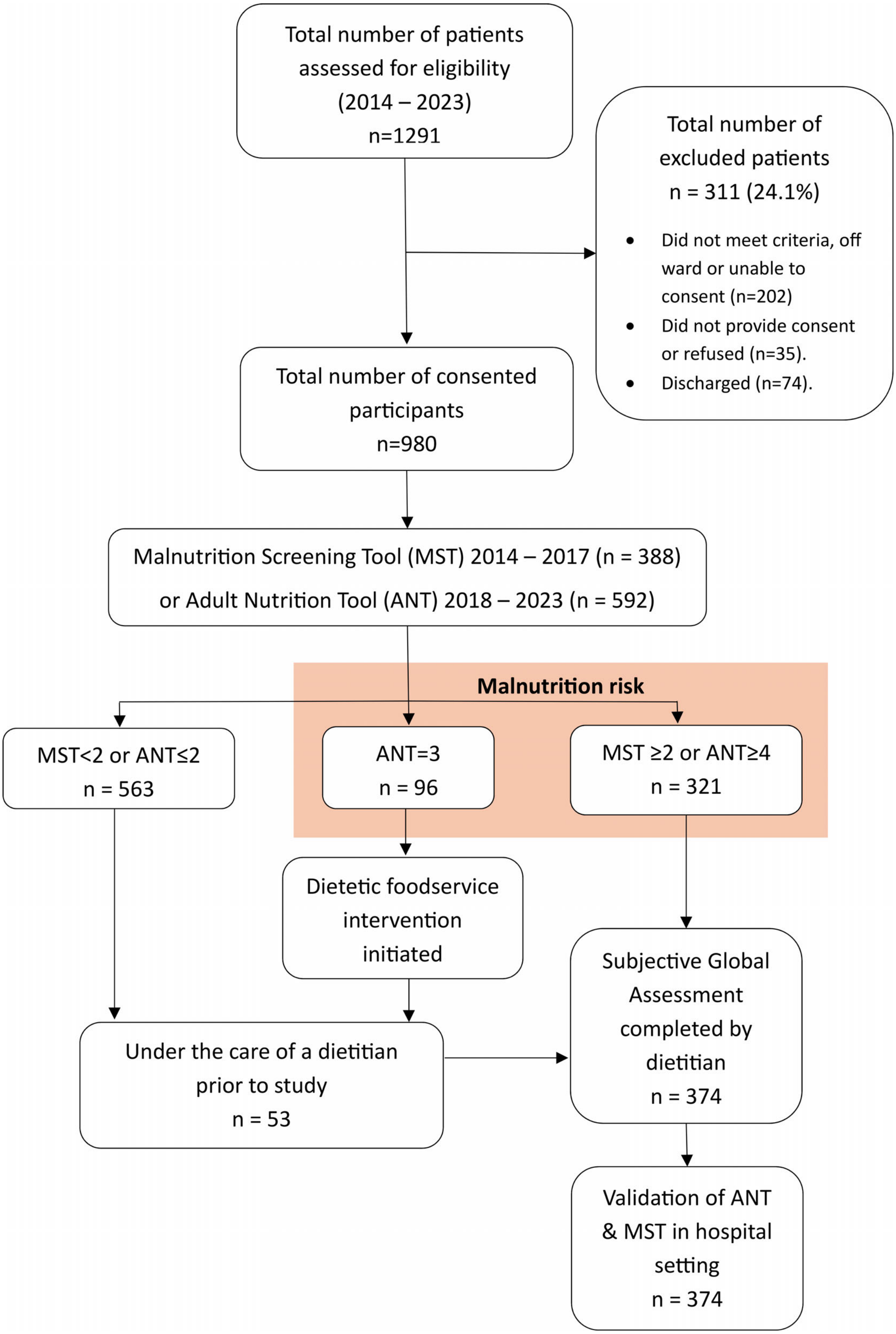

FIGURE 2 Study design and recruitment.

2017 were screened using the MST. The MST is a two-item screening tool used to detect patients at-risk of malnutrition and is validated in the acute care setting.[24]

Eligible patients who consented to participate in the audit recruited between 2018 and 2023 were screened using the ANT. The ANT is a three-item screening tool that was specifically developed and validated for use in both Aboriginal and non-Aboriginal medical inpatients.[15] The ANT was implemented into clinical practice at the hospital in 2018 to screen patients for malnutrition on admission and then weekly by nursing staff. As per the hospital's protocol, participants with an MST <2 or ANT <3 were classified as not at-risk of malnutrition, and if not already under the care of the hospital dietitian, ceased further nutrition assessment at this point. Participants with an ANT equal to 3 were initiated on a high-energy high-protein diet. Participants with an MST ≥2 or ANT ≥4, or already under the care of a hospital dietitian were then assessed for malnutrition using the SGA tool.

Participants with an SGA of A were classified as nourished and participants with an SGA of B or C were classified as malnourished.[16] All participants who had a SGA conducted were included in the validation study. An MST of ≥2 or ANT of ≥2 were used as cut-off points for this validation study as per the original published studies.[15,24] An ANT of ≥3 was also included as a cut-off point in this study as it triggered a dietary intervention as per the hospital's protocol.

Participant demographic data included age, gender and Aboriginality. Anthropometric data included weight (kg), height (m) and body mass index (BMI). Data were obtained from patient records utilising hospital electronic clinical systems, paper-based records, verbal interview between participants and investigators, and conducting measurements. Weight was measured using electronic standing, chair or hoist scales. Weight measurements within 1 week of the audit were considered current. For dialysis participants, participants' last prescribed dry body weight was recorded. Height was measured using a stadiometer or ulna length was used as a surrogate measure to estimate height based on age and gender. Historical height measurements were used if age appropriate. BMI was categorised as per the World Health Organization into underweight (BMI <18.5 kg/m^2), normal weight (BMI 18.5–24.9 kg/m^2) overweight (BMI 25.0–29.9 kg/m^2) and obesity (BMI ≥30.0 kg/m^2). Adjusted body weight for amputations were calculated and used for BMI measurements.[25]

Across the 10-year study period, 42 dietitian audit assessors were involved. To increase the inter-rater reliability over the 10-year investigation, annual training was conducted with the investigative team (Nutrition and Dietetics department) led by the dietitian principal investigators who had completed International Society for the Advancement of Kinanthropometry training. Training prior to the audit included MSTs in use, SGA, measuring ulna length and assessing body weight and fluid status where fluid status was affected by chronic kidney disease, liver disease and cardiac conditions. New assessors were also paired with an experienced assessor on the day of the audit.

Data were entered and coded in Microsoft Excel for Windows (version 2409) and IBM SPSS software (Version 29.0.2.0, IBM Corp, Armonk, NY) was used to analyse data. Descriptive analysis using univariate techniques is reported as frequencies and proportions, medians and the first and third interquartile ranges (IQR) and mean and standard deviation (SD) after assessing the normality of continuous data. Statistical inference between nutritional status and categorical and continuous data was analysed. The Pearson chi-square test was used for categorical variables, the independent *T*-test was used for parametric continuous data and the Mann Whitney *U* test was used for nonparametric continuous data. A p value <0.05 was used to indicate statistical significance. Data for all participants with a SGA ($n = 374$) were included to determine the unadjusted area under the receiver operator characteristic curve (AUC), the standard error (SE) for the total MST and ANT scores, the sensitivity and specificity, and accuracy rate for true positives and false negatives are reported for a cut-off points of MST ≥2, ANT ≥2 and ANT ≥3.

Ethical approval for this study was approved on 23rd September 2014 by the Central Australia Human Research Ethics Committee (Approval number: 14-264). Reporting of this study utilises the Strengthening the Reporting of Observational studies in Epidemiology statement for cross-sectional studies.[26]

3 | RESULTS

A total of 1291 participants were assessed for eligibility, of which 980 consented to participate in the study (75.9% response rate). Of the 311 patients who did not participate, reasons for exclusion included being off the ward, being discharged, withdrawal of consent or unable to provide informed consent (Figure 2). The demographic and clinical characteristics of study participants are reported in Table 1. Over half of the study population were female (55.9%), with a mean age of 54.4 years and two-thirds (70.1%) of participants identifying as Aboriginal. The median weight and BMI were 73.4 kg (61.9–89.0 kg) and 26.3 kg/m^2 (22.2–31.2 kg/m^2), respectively.

Malnutrition risk (MST ≥2 or ANT ≥3) was identified in 42.6% (417/980) of participants. As shown in Table 1, the majority of participants with a completed SGA were Aboriginal (269/374 [71.9%]), but the proportion of females to males was similar (52.1% vs. 47.9%). Compared to the total study population, those with a completed SGA were older (57.7 years of age [SD = 16.3]), had a lower body weight (67.7 kg [IQR 57.0–78.0 kg]), and were

TABLE 1 Demographic and clinical characteristics of the study population and participants without and with a completed Subjective Global Assessment.

	Total group (n = 980)	Without a SGA[a] (n = 606)	With a SGA[a] (n = 374)	
	Number (%)	Number (%)	Number (%)	p-Value
Age (years)[b]	54.4 (16.6), [53.4–55.4]	52.3 (16.4), [51.0–53.7]	57.7 (16.3), [56.1–59.4]	≤0.001*
Gender				0.064
Female	548 (55.9)	353 (58.3)	195 (52.1)	
Male	432 (44.1)	253 (41.7)	179 (47.9)	
Ethnicity				0.351
Aboriginal	687 (70.1)	418 (69.0)	269 (71.9)	
Non-Aboriginal	293 (29.9)	188 (31.0)	105 (28.1)	
Weight (kg)[c]	73.4 (61.9–89.0)	77.7 (65.3–94.4)	67.6 (57.0–78.0)	≤0.001*
Body mass index (kg/m^2)[c]	26.3 (22.2–31.2)	27.7 (23.7–32.9)	23.8 (20.4–27.3)	≤0.001*
Body mass index category				≤0.001*
Underweight BMI <18.5 kg/m^2	80 (8.2)	24 (4.0)	56 (15.0)	
Normal weight BMI 18.5–24.9 kg/m^2	334 (34.1)	177 (29.2)	157 (42.0)	
Overweight BMI 25–29.9 kg/m^2	271 (27.7)	175 (28.9)	96 (25.7)	
Obesity BMI ≥30 kg/m^2	295 (30.1)	230 (38.0)	65 (17.4)	
Malnutrition risk (MST ≥2 or ANT ≥3)	417 (42.6)	-	-	-
Nutrition status				-
Well-nourished (SGA A)	-	-	154 (41.2)	
Mild/moderately malnourished (SGA B)	-	-	181 (48.4)	
Severely malnourished (SGA C)	-	-	39 (10.4)	

Abbreviations: ANT, Adult Nutrition Tool; BMI, body mass index; MST, Malnutrition Screening Tool.
[a]Subjective Global Assessment (SGA).
[b]Age reported as mean (SD), 95% confidence interval.
[c]Weight and body mass index reported as median (interquartile ranges).
*indicates statistical significance (p < 0.05).

within the normal weight BMI category (23.8 kg/m^2 [IQR 20.4–27.3 kg/m^2]).

The prevalence of malnutrition in those screened at-risk of malnutrition or already under the care of a dietitian was 58.8% (220/374, Table 1) based on SGA classification of B or C. There were statistically significant differences in demographic data including age ($p \leq 0.001$), gender ($p \leq 0.001$) and Aboriginality ($p \leq 0.019$) when comparing participants' nutritional status (Table 2). When further analysing the age of malnourished participants, Aboriginality was considered. Of the 148 (67.1%) malnourished Aboriginal participants, Aboriginal participants were almost 12 years younger than non-Aboriginal malnourished participants (57.8 years [SD = 15.5] compared to 69.6 years [SD 13.6 years]).

Statistically significant differences were observed in the clinical characteristics of those malnourished compared to nourished participants including BMI ($p \leq 0.001$), BMI category ($p \leq 0.001$) and hospital ward ($p = 0.025$). Malnourished participants had a lower BMI than nourished participants (21.6 kg/m^2 [IQR 18.5–25.5 kg/m^2] vs. 26.8 kg/m^2 [IQR 23.6–32.2 kg/m^2]), respectively. Seventy-three percent (160/219) of malnourished participants were within the underweight (BMI <18.5 kg/m^2) or healthy weight range (BMI 18.5–24.9 kg/m^2) compared to just over 34% (53/155) of nourished participants.

Of the 374 study participants who had an SGA performed, nearly 61% (108/178) of participants screened were classified 'at-risk' of malnutrition utilising the MST score ≥2. Utilising an ANT score ≥2, 57.1% (112/196) participants were classified at-risk of malnutrition. The ANT demonstrated superior discrimination power than the MST (AUC = 0.74 [SE = 0.035, 95% confidence interval [CI] 0.67–0.81, $p < 0.001$] vs. AUC 0.64, SE = 0.042, 95% CI 0.56–0.73, $p = 0.001$). Utilising an ANT score ≥2 demonstrated the highest sensitivity than utilising an ANT

TABLE 2 Demographic and clinical characteristics of participants according to their nutrition status (well-nourished or malnourished) ($N = 374$).

	Well-nourished ($n = 154$)	**Malnourished ($n = 220$)**	
	Number (%)	**Number (%)**	***p*-Value**
Age (years)[a]	52.1 (15.2), [49.7–54.6]	61.7 (15.9), [59.6–63.8]	≤0.001*
Gender			≤0.001*
Male	51 (32.9)	128 (58.4)	
Female	104 (67.1)	91 (41.6)	
Ethnicity			≤0.019*
Aboriginal	121 (78.6)	148 (67.3)	
Non-Aboriginal	33 (21.4)	72 (32.7)	
Body mass index (kg/m^2)[b]	26.8 (23.6–32.2)	21.6 (18.5–25.5)	≤0.001*
Body mass index category			≤0.001*
Underweight BMI <18.5	3 (1.9)	53 (24.1)	
Normal weight BMI 18.5–24.9	50 (32.5)	107 (48.6)	
Overweight BMI 25–29.9	52 (33.8)	44 (20.0)	
Obesity BMI ≥30	49 (31.8)	16 (7.3)	
Ward			0.025*
Emergency	19 (12.3)	21 (9.5)	
Medical	50 (32.5)	93 (42.3)	
Orthopaedic and rehabilitation	19 (12.3)	42 (19.1)	
Renal	24 (15.6)	28 (12.7)	
Surgical	42 (27.3)	36 (16.4)	
Age according to ethnicity (years)[a]			-
Aboriginal	49.3 (14.0) [46.9–51.8]	57.8 (15.5) [55.3–60.3]	
Non-Aboriginal	57.1 (15.4) [57.1–68.0]	69.6 (13.6) [66.4–72.8]	

Abbreviation: BMI, body mass index.
[a]Age and age according to ethnicity reported as mean (SD), 95% confidence interval.
[b]Body mass index reported as median (interquartile ranges).
*indicates statistical significance ($p < 0.05$).

score ≥3 or MST score ≥2. Both an ANT score ≥2 and MST score ≥2 demonstrated 'very-low' specificity (16.7% vs. 14.3%) as participants with a MST and ANT score <2 (not at-risk) were not assessed for malnutrition using the SGA. Although an ANT score ≥3 demonstrated the ability to more correctly classify nourished patients, an ANT score ≥3 also demonstrated 'low' specificity of 20.2%. An ANT ≥2 demonstrated the highest negative predictive value of 87.5% when compared to an ANT ≥3 of 65.4% and MST ≥2 of 76.9% (Figure 3).

4 | DISCUSSION

This cross-sectional study found that nearly 43% of study participants were identified as at-risk of malnutrition. Of the participants at-risk for malnutrition or already under the care of a dietitian, nearly 60% were classified as malnourished and over two-thirds of participants with malnutrition were Aboriginal. The majority of malnourished patients were significantly older with a lower BMI compared to those nourished. Although patients within the underweight and healthy weight BMI categories made up the majority of the malnourished participants, malnutrition was still observed in over one quarter of participants within the overweight and obesity BMI categories. This study also showed the MST and ANT to be valid MSTs for use in Aboriginal and non-Aboriginal inpatients across inpatient settings. Utilising an ANT score of ≥2 is optimal for early detection but a cut-off of an ANT ≥3 may be better for triaging malnutrition risk within adult inpatients. The ANT is currently the only validated screening tool for Aboriginal peoples.[15]

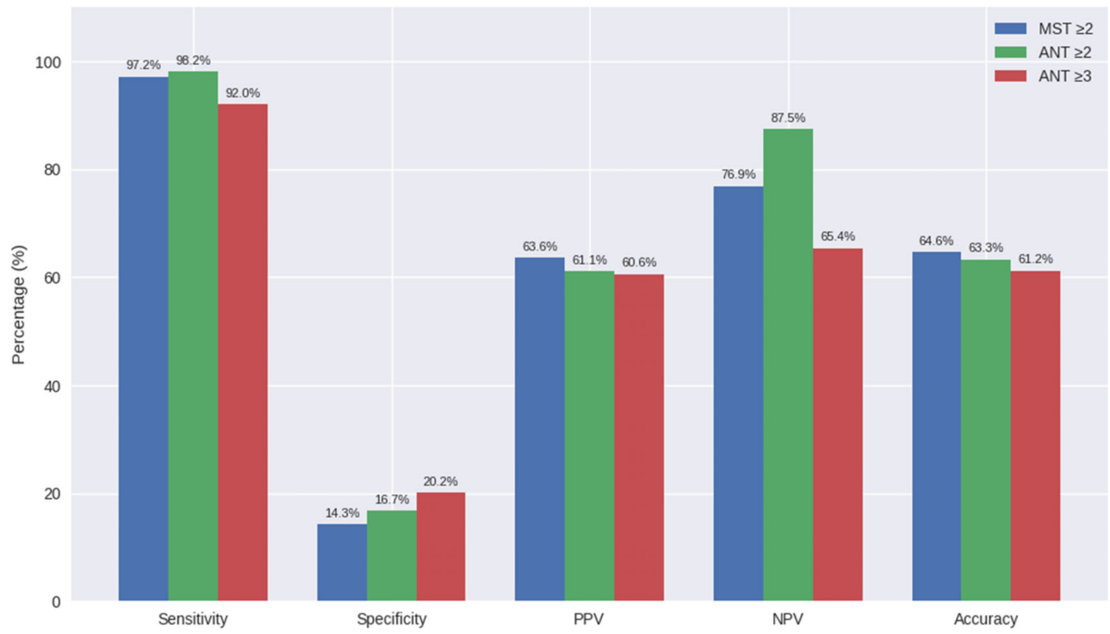

FIGURE 3 Diagnostic metrics comparison of the Malnutrition Screening Tool (MST) and Adult Nutrition Tool (ANT).[15]

Previous Australian studies on malnutrition prevalence have observed a rate of approximately 30%–50%.[1–4] One major limitation of this study was that malnutrition assessment was not completed for all study participants, namely those identified 'not at-risk' of malnutrition with a MST score <2 or ANT score <4 unless already under the care of a hospital dietitian. Despite this, very few previous prevalence studies have included data for remote hospitals.[4] It is known that those living in remote areas experience various challenges due to their geographic location and often have poorer health outcomes and increased burden of disease.[11] These challenges may include access to and use of primary healthcare services, cost and availability of nutritious food and socioeconomic disadvantage. When comparing the findings of this study to previous prevalence data from this region, there are more similarities. In 2018, Morris et al.[4] reported a prevalence rate of 46% of malnutrition in inpatients on a medical unit, of which 56.7% of malnourished patients were identified as Aboriginal. This study and the study by Morris et al.[4] confirm a higher burden of malnutrition when compared to metropolitan and regional areas.

Remote Australian populations are younger than those living in more populated areas and have a lower life expectancy than those living in more populated areas.[11] Within the sub-group population, those with malnutrition were nearly 10 years older compared to those who were nourished. When reviewing other Australian malnutrition studies, the average age of inpatients and those who were diagnosed as malnourished was 62–70 years old and 64–79 years of age, respectively.[1,7–10,27] Comparatively, in our study, participants and those identified as malnourished were younger with an average age difference of approximately 7–16 and 2–17 years, respectively, compared to metropolitan and regional studies. These data reflects a young population of remote Australians which could be further attributed to the number of participants identifying as Aboriginal in this study.

The age gap in life expectancy of Aboriginal people in 2022 was approximately 8.5 years less,[28] and current health and welfare statistics report a disease burden for Aboriginal people of more than two times the rate of non-Aboriginal people.[13] This age gap was similar in nourished participants in this study. Interestingly, when comparing the age gap in malnourished participants, those identifying as Aboriginal were 12 years younger compared to non-Aboriginal. Inflammation is a known driver for disease-related malnutrition in chronic diseases.[29,30] Morris et al.[7] also found acute and chronic disease severity indices were independent predictors for malnutrition among Aboriginal and non-Aboriginal people. Whilst not researched in this study, it could be postulated that this increased burden of multi-morbidity and co-existing malnutrition could further influence the life expectancy of remote Aboriginal Australians. This highlights the need for healthcare providers and specifically dietitians working in remote areas to understand the potential risk factors for malnutrition when planning and facilitating screening, assessment and interventions. Further research is required to investigate the potential link between chronic disease burden and malnutrition severity to better understand the implications that this may have on malnutrition screening and assessment.

This study utilised the SGA to assess malnutrition. This assessment tool combines a history and a physical examination and is used throughout hospitals as a valid, quick to administer and non-invasive tool to assess for malnutrition.[16] However, limitations exist including relying on trained clinicians, the collection of subjective data and potential respondent bias. Within this study, a higher proportion of participants identified as Aboriginal, reflective of the patient population for this hospital. As such, a higher prevalence rate was observed in this population compared to non-Aboriginal participants. However, when examining the proportion of participants with malnutrition, it was nearly 14 percent higher in non-Aboriginal participants (68.6%, $n = 72$) than Aboriginal participants (55.0%, $n = 148$), but non-Aboriginal participants were also nearly 12 years older. This could be accounted for by a further limitation of the SGA. The Aboriginality of participants has not been reported on in validation studies,[31,32] leading to the assumption that the SGA has not been specifically validated for use in Aboriginal patients.

Culturally appropriate assessment tools that account for cultural customs and language should be considered in this population. Within Central Australia, there are three main language groups, and numerous dialects are observed within each. The importance of culturally appropriate assessment tools that consider English as a second or third language and are tailored to include culturally appropriate terms should be considered in this remote context. It is feasible that, in the absence of a culturally appropriate and validated malnutrition assessment tool, some of the Aboriginal patients assessed as nourished may, in fact, be malnourished. The SGA also includes a physical component, relying on the experience of the clinician in detecting nutritional changes. The use of other nutrition assessment tools such as hand grip strength and mid-upper arm circumference have been shown to strongly correlate with malnutrition in this population.[4] Further consideration could be given to the potential role of these anthropometric measurements in the screening and assessment of malnutrition in this vulnerable population.

The identification of malnutrition in those living with overweight and obesity can also be challenging and is often overlooked. Within this study, over one quarter of malnourished participants were living with overweight and obesity. Similar challenges exist in using assessment tools to diagnose malnutrition in this population. Assumptions can be made that the validation studies were based on those living without obesity and as such may lack the sensitivity to detect malnutrition in this population. Over two-thirds of Australian adults are living with overweight and obesity, with the incidence increased based on rurality and remoteness alongside higher rates of chronic diseases and lower service usage.[11,33] Morris et al.[7] found malnutrition was an independent predictor of increased length of stay, morbidity and mortality associated with higher healthcare costs. Further research is required in considering chronic disease severity within screening and assessment of malnutrition within this population given the assumption of higher healthcare expenditure.

This study also aimed to validate the ANT in an inpatient setting. According to the original validation study by Morris et al.[15] an ANT score of ≥2 was highly sensitive in predicting malnutrition in medical inpatients despite a potential increase in referrals who were otherwise nourished. However, the generalisability of the Morris et al.[15] study was a major limitation, given it was only validated in medical inpatients. This study addressed this limitation and supported the findings of the original study, with an ANT score of ≥2 demonstrating superior sensitivity. Given an ANT score of ≥3 was utilised in this study, consideration for the implications of a lower referral score in practice should be considered. Given this, previous research has demonstrated utilising nutrition assistants in supporting dietitians with screening and associated malnutrition care can be effective and safe.[34]

As identified, there are a number of limitations to this study. The specificity values observed for both the MST and ANT in this study were lower than those reported in previous validation studies conducted in metropolitan and regional hospitals.[15,24] Whilst appropriate for clinical workflow, only participants who screened as 'at risk' or were already under dietetic care underwent SGA assessment, which limited the identification of true negatives and therefore inherently reduced specificity. Because only patients who screened at-risk underwent SGA assessment, the ability to accurately identify true negatives was limited, contributing to reduced specificity estimates for both the MST and ANT. The main limitation was not undertaking malnutrition assessments for all study participants. Additionally, although screening and assessment was conducted by researchers who were dietitians and received annual standardised training, the number of different assessors over the 10-year periods impacts the inter-rater reliability of this study. Despite these limitations, this study offers important insights into malnutrition in a unique, remote Australian context.

The 10-year cross-sectional study design, with a large cohort size, affords the research gathered to be generalisable to remote areas within Australia. Further to this, the large cohort size provided the opportunity to robustly validate the ANT within inpatient settings. Based on International statistical classification of diseases and health related problems, 10th revision, Australian modification (ICD-10-AM), a BMI <18.5 kg/m^2 has routinely been used in the acute care setting for the clinical diagnosis of malnutrition.[17] In this study, a BMI <18.5 kg/m^2 was not an inclusion criterion for a SGA, potentially underreporting the prevalence of malnutrition according to ICD-10-AM. However, in recent years, the GLIM released a diagnostic framework that considers phenotypic (low BMI, weight loss and/or reduced muscle mass) and etiological criteria (reduced intake or assimilation, disease burden or inflammatory condition) to diagnose malnutrition.[18] GLIM considers BMI, with the inclusion of an age and ethnicity (Asia only) adjusted BMI within its phenotypic criteria; however, it also requires at least one aetiologic criterion alongside this. Given the disease burden within this population, body composition and distribution of subcutaneous fat and muscle, the validation of GLIM for Aboriginal and non-Aboriginal people should be considered.

To conclude, this study identified that malnutrition is a significant problem in patients in a unique remote hospital in Central Australia servicing a very vast geographical area where people residing in very remote areas are extremely vulnerable to lack of health services and nutritious and affordable food. This study validated the ANT as a sensitive MST for use in an inpatient setting, with a score of ≥2 generating a referral to a dietitian. The implications of using an ANT score of ≥2 on dietetic referrals may need to be investigated to determine the impact on the provision of dietetic care. As there is a validated malnutrition screening tool for Aboriginal people, future research should now focus on the acceptability of malnutrition screening and assessment tools and validating a malnutrition assessment tool for this population.

AUTHOR CONTRIBUTIONS

LC, EJ and EN conceptualised and designed the research; RS, EN, LC, MS, EJ and TT conducted the research; RS and NF analysed and interpreted the data. All authors contributed to the draft and review of the manuscript; all authors read and approved the final manuscript. The authors acknowledge the contributions of dietitians at Alice Springs Hospital who collected data across the years.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

ETHIC STATEMENT

Ethical approval was approved on 23rd September 2014 from the Central Australian Human Research Ethics Committee (approval number: HREC: 14-264).

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