ORIGINAL ARTICLE

JCSM Clinical Reports 2022; **7**: 79–92
Published online in Wiley Online Library (wileyonlinelibrary.com) **DOI:** 10.1002/crt2.55

Malnutrition and nutritional screening in patients undergoing surgery in low and middle income countries: A systematic review

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Abstract

Background There is a high incidence of preoperative undernutrition in hospitalised patients in low and middle-income countries (LMICs), leading to increased postoperative complications, length of hospital stay and early mortality. Review aims are to establish the prevalence of undernutrition and assess the use of validated nutritional screening tools in surgical patients across LMICs.

Methods Protocol was PRISMA compliant and Prospero registered (CRD42019126765). Twelve international databases were searched from January 1990 to April 2021. Included studies were on nutritional screening in adults (≥16 years) undergoing surgery in LMICs. Two researchers screened studies and assessed quality. Prevalence of undernutrition was presented as a weighted percentage with confidence intervals (CI).

Results Of the 4649 records identified, 16 studies (n = 4032) were eligible. Subjective global assessment (SGA) or patient generated (PG)-SGA were the tools used most widely. SGA and PG-SGA showed a high prevalence of undernutrition overall (0.61, 95% CI 0.50, 0.73), with a proportion identified with moderate undernutrition (0.44, 95% CI 0.31, 0.57) or severe undernutrition (0.32, 95% CI 0.19, 0.45).

Conclusions Data show the prevalence of undernutrition in surgical patients as high as three in five patients within LMICs. Results indicate that the SGA is suitable for assessing this group of patients and that it may be the most appropriate tool to use due to its subjectivity and reliability. PG-SGA although similar includes more symptom assessment, which is important for nutritionally depleted cancer patients. The limited data on validity and reliability of nutritional screening tools in LMICs indicates further research is required.

Keywords Low and middle income countries; Malnutrition; Nutritional screening; Surgical patients; Systematic review

Received: 13 December 2021; Revised: 20 July 2022; Accepted: 14 September 2022
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Introduction

It is estimated that nearly one in 10 (690 million) people worldwide are hungry, with an increase of almost 60 million since 2014.[1] Over 25% of the global population were affected by moderate or severe food insecurity in 2019, meaning that at best, a healthy balanced diet is unavailable, and at worst individuals may go for days without food.[1] The impact of COVID-19 is expected to add between 83 and 132 million undernourished individuals to the global total, and if recent trends continue, that figure will surpass 840 million by 2030.[2]

Many of those who are affected by hunger are found in low and middle-income countries (LMICs) with the majority of the world's undernourished found in the Asian subcontinent (381 million) and Africa (250 million), which has the highest prevalence (19%) of undernutrition across all regions.[2] Eradicating hunger has been identified as a global priority by the Sustainable Development Global Report (2020) published by the United Nations,[1] with a target to achieve zero hunger by 2030.

Malnutrition encompasses both over and undernutrition and has been redefined recently to clarify undernutrition, including phenotypes and etiological criteria.[3] The phenotypes can include unintentional weight loss, low muscle mass and/or a low body mass index (BMI). Symptoms can include inflammatory response and loss of appetite. For undernutrition to be identified there needs to be at least one phenotype and one etiological component present.

In high-income countries, up to 50% of people who are admitted to hospital are undernourished.[4] In contrast, 70% of hospital patients in LMICs are undernourished, and preoperatively the incidence of undernutrition ranges from 50% to 80%.[4] This is important as malnutrition, specifically, undernutrition, has been identified as a prognostic factor in relation to increased rates of postoperative complications, longer length of hospital stay, and increased overall mortality rates.[5]

In LMICs, surgery has been identified as an important public health intervention,[6] often providing the only chance of a cure in many solid tumours, particularly where chemotherapy and radiotherapy are unavailable. A previous study showed that death and complications following cancer surgery occur more frequently in LMICs compared with high-income countries.[7] In addition, postoperative complications can have more substantial consequences in these settings, including death, long-term disability and catastrophic healthcare expenditure.[8] Therefore, the identification and treatment of malnutrition perioperatively in LMICs have the potential to improve outcomes following surgery in LMICs.

There are strong links between undernutrition and poor postoperative outcomes, including mortality and morbidity.[9–11] Nutritional interventions administered in the perioperative period have shown a positive impact on postoperative complications,[12,13] specifically, decreasing infections,[14] preventing loss of muscle mass and reducing loss of total body weight postoperatively.[15] Data also exist demonstrating that perioperative nutrition support in patients undergoing gastrointestinal cancer surgery can halve postoperative complications, reduce postoperative stay and decrease surgical mortality.[16]

An annual prioritisation cycle led by LMIC surgeons recently identified measuring perioperative malnutrition as a research priority.[17] Prior to evaluating interventions for nutritional support, it is essential to determine assessment methods used in LMICs that identify and measure undernutrition.

The aims of this systematic review were to establish the prevalence of undernutrition and determine the validated and unvalidated nutritional screening methods used in patients undergoing surgery in LMICs. This also included identifying any data on validation of nutritional screening tools.

Methods

Protocol

The detailed methodology of the review, including study screening, selection, methodological assessment, data extraction and synthesis, which follow the PRISMA framework, has been documented in a protocol registered with the International Prospective Register of Systematic Reviews (PROSPERO). Registration: PROSPERO (2019 CRD42019126765).

Eligibility criteria

Study design

Study designs included were randomised control trials, controlled (nonrandomised) clinical trials or cluster trials where a nutritional screening tool had been used prior to randomisation and where baseline data were available on the results of the nutrition screening tool. Prospective or retrospective cohort or observational studies, case–control studies with more than five cases, clinical evaluations or case series, validation studies that reported on validity measured against a criterion measure and studies that looked at reproducibility using both interrater and intrarater reliability were also included. Comparison studies were included where different screening tools had been compared in the same cohort of patients. Only studies from January 1990 were included as the earliest nutritional screening tools were developed from 1992 onwards after a Kings Fund Report highlighted disease-related malnutrition in hospitalised patients.[8] The included articles had to describe original research published in a peer-reviewed journal. All languages were included and where possible non-English papers were translated using a translation service (Google translate or a translator from the country of origin).

Population
Adults (≥16 years) undergoing surgery, with nutritional state assessed preoperatively or postoperatively in a LMIC.

Interventions
Interventions included nutritional screening tools or methods of nutritional assessment that are used in hospitals to identify malnutrition, specifically undernutrition. Nutritional assessment criteria included the following: Anthropometry measurements or changes in anthropometry over time; biomarkers and dietary assessment; studies that compare different screening tools and assessment methods were also included.

Comparators
Articles were included that compared patients between different hospitals or before and after surgery.

Primary outcomes
Primary outcomes were prevalence of malnutrition according to screening tools, anthropometry and biomarkers and any validation of screening tools in LMICs.

Secondary outcomes
Secondary outcomes were postoperative outcomes and complications in patients undergoing surgery in LMICs.

Settings
Studies were included where participants were recruited from a hospital setting on surgical wards or surgical outpatient clinics awaiting surgery in LMICs. LMICs were defined as such by the criteria outlined by Organisation for Economic Co-operation and Development's (OECD) and the Development Assistance Committee (DAC) as of June 2021.[18]

Excluded
Studies including participants managed without surgical intervention, or undergoing caesarean section alone, were excluded. Hospitals in high-income countries and studies that were unobtainable were also excluded. Studies with interventions where nutritional status was measured using biochemical or immunological markers unvalidated for use as indicators of malnutrition were excluded. Studies where data were not specified for surgical patients separately from mixed generic hospital populations were also excluded.

Information sources

Literature search strategies were developed using medical subject headings (MeSH) and text words related to developing or underdeveloped countries, nutritional screening and malnutrition. The following electronic databases were searched from January 1990 onwards and included an extensive range to cover international literature: MEDLINE (Ovid interface), EMBASE (Ovid interface), CINAHL (Ovid interface), AMED, DARE, Cochrane Central Register of Controlled Trials (Wiley interface, latest issue), WHO Global Index Medicus database, Global health archive (Ovid interface), Index Medicus (WPRIM for the Western Pacific, IMSAR for the South Asian region), SciELO Scientific Electronic Library Online, Latin American and Caribbean Health Sciences Literature (LILACS) and the Philippine Health Research Development Information Network (HERDIN).

We checked reference lists of included studies and all reference lists of other reviews identified by the search to ensure literature search saturation. We also included searches of the World Health Organisations International Clinical Trials Registry platform for ongoing trials along with the US National Library of Medicine's clinical trials registry. Searches for conference abstracts in Zetoc and for dissertations on world cat dissertations were also carried out.

Search

The search strategy for Medline (Ovid) can be viewed in *Figure S1*. This was adapted for all other databases.

Study selection

Search results were uploaded to Covidence,[19] and eligibility assessment was carried out independently by two reviewers screening titles and abstracts. If eligibility was unclear, the full text of the publication was reviewed. Full texts were obtained for publications that met the inclusion criteria and were screened independently to confirm eligibility. Any disagreements were resolved by discussion.

Data collection process

Data were extracted using a standardised data extraction spreadsheet with predefined data fields. The following data were extracted for included studies: Author, year of publication, country, language, and study design. Details of the study population were recorded, including total numbers, age, gender, surgery type, how nutritional status was assessed and when nutritional assessment occurred. Any details of malnutrition specifically undernutrition prevalence and nutritional measurements were also extracted: malnutrition rate, anthropometry measurements such as weight and BMI, biomarkers and postoperative outcomes. Primary and secondary outcomes as detailed above were recorded. Both reviewers extracted the data independently and then cross-checked. Disagreements were resolved through discussion with a third reviewer.

The quality of evidence of individual studies

The quality of evidence from the studies was assessed using the Joanne Briggs critical appraisal tools.[20] Two authors independently assessed the studies and disagreements were resolved by discussion.

Synthesis methods

Meta-analysis was conducted on suitable data for the prevalence of undernutrition, and subgroup analyses were undertaken on studies reporting moderate and severe malnutrition. For binary data, the prevalence and the total number in the sample used were extracted and a random-effects model with inverse variance used to calculate the effect size. Binomial data were used to perform a meta-analyses and display 95% confidence intervals (CI) using standard error. Data were graphically displayed in forest plots and each study was weighted based on sample size using Stata (Version 16.1 StataCorp, Texas). In addition, we conducted a regression test using funnel plot asymmetry and Egger test in order to demonstrate any bias in the meta-analysis.

Bias and certainty assessment

No cohort or randomised controlled trial studies were identified in this review, and only one validation study was found. All studies were cross-sectional and descriptive. To assess the quality of cross-sectional studies, we used the Joanna Briggs Critical Appraisal Tool.

Difference between protocol and final methods

As there was only one study that looked at validation, the Quality Assessment of Diagnostic Accuracy Studies (QUADAS)[21] checklist and GRADE Pro[22] were replaced with the Joanna Briggs tool as it was more appropriate for cohort and cross-sectional studies. Additionally, the population inclusion criteria were narrowed-down to focus only on studies where patients were undergoing surgery, which was not clearly defined in the original protocol.

Results

Study selection

Sixteen studies, including 13 cross sectional studies, two cohort studies and one diagnostic study were identified for inclusion in the review. The searches were last conducted on 21 April 2021, providing a total of 4649 studies (*Figure 1*). After excluding duplicates, 4013 remained. Of these, 3583 records were excluded after reviewing the titles and abstracts, as they did not meet the inclusion criteria. An additional 315 records were excluded as they included patients who were not awaiting surgery. The full texts of the remaining 115 records were examined in more detail and 99 records did not meet the inclusion criteria (*Figure 1*). Sixteen studies met the inclusion criteria and were included in the systematic review. No additional studies that met the criteria for inclusion were identified by reference checking or citation tracking. No suitable unpublished studies were identified.

Design

Of the 16 studies included in the review, 13 were cross-sectional studies, where malnutrition was measured at one time point, and of these, 12 were prospective[23–34] and one was retrospective.[35] Two collected cross-sectional nutritional data across two sites[36] and preoperatively and postoperatively.[36,37] One study was diagnostic,[38] evaluating the Vajira Screening nutritional screening tool against the gold standard, validated Subjective Global Assessment (SGA) tool.

Setting

Included studies were conducted across 10 LMICs. Five studies were conducted in Brazil,[23,30,31,34,35] three in India,[27,28,33] and one each in Benin,[24] Peru,[25] Philippines,[26] Turkey,[36] Thailand,[38] Malawi,[29] Malaysia,[37] and Vietnam[32] (*Figure 2*).

Study characteristics

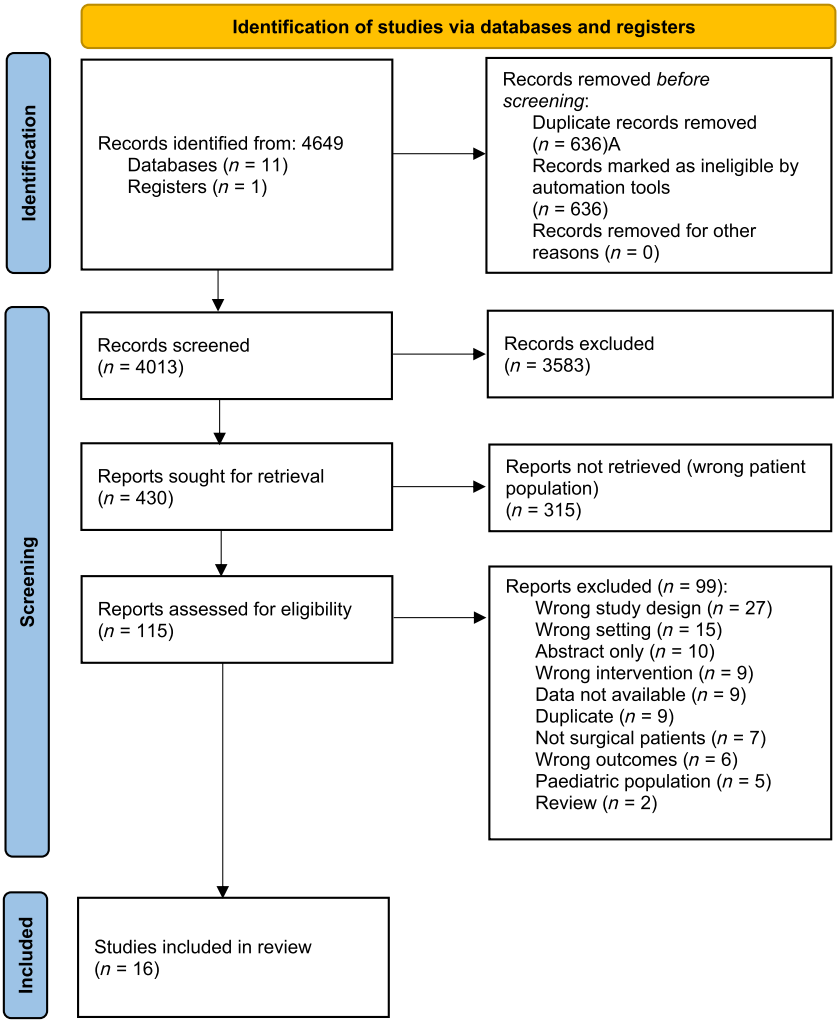
Population

There were 4032 patients undergoing surgery in the included studies, of these 1819 were male, 1933 were female and 280 are of unknown gender as this was not reported by one study.[28] The mean number of patients per study was 252, (range 25–928). Eight studies included patients undergoing surgery for cancer,[26–28,30,31,33–35] four were for gastrointestinal surgery,[24,25,32,36] three were for general surgery[23,37,38] and one was for emergency laparotomy[29] (*Table 1*).

Intervention

All studies recorded the prevalence of malnutrition, with 12 studies measuring malnutrition preoperatively,[23,25–27,29–35,38] two measuring postoperatively[24,28] and two measuring both preoperatively and postoperatively.[36,37] Anthropometry measures were recorded by 12 studies,[23–25,29–37] blood markers by six studies[23–25,31,34,36] and two studies recorded di-

Figure 1 PRISMA flow diagram



From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71

For more information, visit: http://www.prisma-statement.org/

etary intake.[24,30] Postoperative outcomes were also recorded by 12 studies.[25–35,37]

Comparators

Five studies measured malnutrition with SGA and compared it with other tools or measurements.[23,25,27,28,34] Two studies compared two or more nonvalidated tools or measurements.[24,31] One was a diagnostic study and aimed to validate the Vajira nutritional screening tool against the SGA tool.[38] One study compared patients across two hospitals and measured malnutrition before and after surgery,[36] and one study compared prevalence of malnutrition preoperatively and postoperatively.[37]

Quality assessment

The quality of the studies was assessed using the appropriate Joanna Briggs Institute critical appraisal tool for the study design. Four of the studies were judged high quality,[25–27,32] eight were judged medium quality[29,30,33–38] and four were judged low quality[23,24,28,31] (*Table S1*).

Figure 2 Location of included studies on world map

Table 1 Study and patient characteristics

Authors	Design	*n*	Age years mean (SD/range)	Gender	Patient group	Assessment point
Acuna 2003	Cross sectional	149	M: 38 (12.7) F: 33(8.8)	M: 37 F: 112	Mixed	24 h Pre-surgery.
Alassani 2018	Cross sectional	90	55 (6.32)	M: 52 F: 38	GIT	Post-surgery. Timings NR
AlvarezBaca 2012	Cross sectional	136	47.19 (18.04)	M: 85 F: 51	GIT	Pre-surgery. Timings NR
Caballero 2013	Cross sectional	103	54 (18–84)	M: 38 F: 65	Cancer	Pre-surgery. 24–48 hrs after admission
Erdim 2017	Cross sectional	100	Grp 1: 4 (39–65) Grp 2:54 (37–65)	M: 54 F: 46	GIT cancer	Pre & post-surgery. Timings NR
Garcia 2013	Cross sectional	565	52.8 (15.6)	M:275 F: 290	Cancer	Pre-surgery. 0–36 hrs after admission
Jayanth 2020	Cross sectional	342	Median (IQR) 52 (44–60)	M: 134 F: 208	Cancer	Pre-surgery. Timings NR
Kamal 2016	Cross sectional	280	NR	NR	Cancer/trauma	NR
Kamonrut-pibul 2010	Diagnostic	200	50.5 (11.5)	M: 72 F: 128	Mixed	Pre-surgery. Timings NR
Katundu 2018	Cross sectional	25	Median 38 (28.5–49)	M: 13 F: 12	Laparotomy	Pre-surgery. During hospital stay
Latiff 2016	Cohort	50	50.4 (13.88)	M:11 F: 39	Mixed	Pre and post-surgery. Timing NR
Leandro-Merhi 2012	Cross sectional	235	53.0 (17.9)	M: 126 F: 109	Trauma/cancer	Pre-surgery. Within 48 hrs of admission
Leandro-Merhi 2011	Cross sectional	928	≤60: *n* 661 (71%) > 60: *n* 267 (29%)	M: 462 F: 466	Cancer/noncancer	Pre-surgery. Timings NR
Pham 2006	Cross sectional	438	NR	M: 218 F: 220	GIT	Pre-surgery. During hospital stay
Shirodkar 2005	Cohort	266	Median (range) 50 (14–73)	M: 165 F: 101	Cancer	1–3 days pre-surgery
Thieme 2013	Cross sectional	125	58.5 (14.9) >60 years *n* 61(49%)	M: 77 F: 48	GIT cancer/ noncancer	Pre-surgery. During hospital stay

Abbreviations: F: female, GIT: gastrointestinal, grp: group, hr: hours, IQR: interquartile range, M: male, *N*/*n*: number, NR: not reported; SD: standard deviation, yrs: years, tract.

Outcomes

Malnutrition

All studies recorded prevalence of undernutrition (*Table 2*). Nine studies measured malnutrition using the SGA tool[23,25,27–29,32,34,36,38] and of these, two used additional validated tools for measuring malnutrition (Malnutrition Universal Screening Tool, MUST)[27] and risk of malnutrition (Nutritional Risk Index tool, NRI).[27,34] Three studies used a modified version of the SGA to measure malnutrition, two

Table 2 Malnutrition outcomes

Authors	Validated tool	Malnutrition *n* (%)	Weight mean (SD) [kg]	BMI mean (SD) [kg/m^2]
Acuna 2003	SGA validated	SGA: 0 (0) ISM: 18(12) BMI: 3 (2)	M: 71.8 (15.3) F: 60.9 (10.7)	M: 25.9 (4.9) F: 25.2 (4.1)
Alassani 2018	No validated tools used	BMI $<$ 18.5 kg/m^2: 42 (47) Weight loss: 30 (33)	Weight loss *n* (%) $<$2% 30(33.33%) $\geq$2% 60(66.67%)	BMI *n* (%) Low 42 (47) Healthy 30 (33) Overweight 13 (14) Obese 5 (6)
AlvarezBaca 2012	SGA validated	SGA 61 (44.9) Albumin 74 (54.5) Lymphocyte 80 (58.9) BMI 26 (19.1) MAMC 69 (50.7)	NR	23.05 (3.84)
Caballero 2013	PG-SGA validated	PG-SGA 86 (84) (45.6% moderately and 37.8% severely)	NR	NR
Erdim 2017	SGA validated	SGA Pre-op: Group 1: 39 (75) (19% SGA-B 56% SGA-C) Group 2: 39 (81) (21% SGA-B 60% SGA-C) SGA Post-op: Group 1: 42 (81) (23% SGA-B 58% SGA-C) Group 2: 40 (83) (29% SGA-B 54% SGA-C)	Weight mean (min-max) grp 1: 61 (48–78) grp 2: 59 (45–82) p 0.125 Weight loss mean (SD) group 1: 7.7 (2.8) group 2: 8.5 (2.1) p 0.197	Group 1: 21.7 (2.2) Group 2: 19.0 (1.8) p 0.001
Garcia 2013	MST validated for nutrition risk	MST: 187 (33.1) average or high nutritional risk	Weight loss *n* (%) 1–5 kg: 102 (18) 6–10 kg: 59 (10.4) 11–15 kg: 33 (5.8) $>$15 kg: 27 (4.8)	NR
Jayanth 2020	All validated	Malnourished: MUST 160 (46.8), SGA 149 (43.5), NRI: 154 (45) Severely malnourished: MUST 97 (28.4), SGA 47 (13.7), NRI: 51 (14.9)	NR	NR
Kamal 2016	SGA validated	SGA: 112 (40) Malnutrition risk: 90 (32)	NR	NR
KamonrutPibul 2010	SGA validated	SGA: 89 (44.5) (70 (35) SGA-B, 19 (9.5) SGA-C)	NR	NR
Katundu 2018	SGA validated	SGA: 20 (80) (13 (52) SGA-B, 7 (28) SGA-C)	Healthy (76%) overweight (6%) underweight/obese(0%)	NR
Latiff 2016	PG-SGA validated	Pre surgery PG-SGA: 16 (32) (16 (32) SGA-B, 0 SGA-C) Post-surgery: 46 (92) (29 (58) SGA-B, 17 (34) SGA-C)	Pre-surgery: 67.64 (15.73) Post-surgery 66.96 (15.73)	NR
Leandro-Merhi 2012	No validated tools used	Anthropometry and energy intake $<$75%: 47 (20) Energy intake $<$75%: 106 (45) Recent weight loss: 65 (25.7)	Benign: 69.1 (14) Malignant: 62.0 (15) Weight lost: 9.45 (6) Weight gain: 6.45 (5)	25.0 (5.4)
Leandro-Merhi 2011	No validated tools used	BMI: 97 (11.4) Weight loss: 453 (49) Lymphocytes: 154 (33.8) Haemoglobin: 243 (42.1)	Weight loss (*n* 923) Yes: 453 (49%) No: 470 (50.9%)	$<$18.5 kg/m^2 *n* (%): 97 (11.4)
Pham 2006	SGA validated	SGA: 244 (55.7) 126 (28.8) SGA-B, 118 (26.9) SGA-C	NR	median (range): 19 (11.8–37.2)
Shirodkar 2005	Modified SGA nonvalidated	Modified SGA: 114 (42.8) 98 (36.8) SGA-B, 16 (6.0) SGA-C BMI: 110 (41.8)	NR	Preop BMI: Median (range) 19.0 (11.8–37.2) SGA-A: 20.9, SGA-B: 18.1, SGA-C: 17.3
Thieme 2013	SGA and NRI validated	SGA: 82 (65.6)	Mean weight loss in 6 months: 9.7 (10.5)	23.14 (4.70)

(*Continues*)

Table 2 (continued)

Authors	Validated tool	Malnutrition *n* (%)	Weight mean (SD) [kg]	BMI mean (SD) [kg/m^2]
		(60 (48) SGA-B, 22 (17.6) SGA-C) NRI: 110 (88), BMI: 38 (30.4), Lymphocytes: 93 (74.4), albumin: 85 (68)	60 patients reported no body weight loss 6 months before the interview.	

Abbreviations: BMI: body mass index, F: Female, ISM: Index Suggestive of Malnutrition, M: Male, MAMC: Mid Arm Muscle Circumference, MST: Malnutrition Screening Tool, MUST: Malnutrition Universal Screening Tool; NR: not reported; NRI: Nutritional Risk Index, PG-SGA: Patient Generated Subjective Global Assessment, SD: standard deviation, SGA: Subjective Global Assessment, SGA-A: well nourished, SGA-B: moderately malnourished, SGA-C: severely malnourished.

used the patient generated SGA (PG-SGA)[26,37] and the other used a nonvalidated version of the SGA.[33] One study used the Malnutrition Screening Tool (MST) from Australia, which is validated for nutritional risk.[35] The remaining studies recorded nutritional measurements only and did not make use of a screening tool. Of these, one study used BMI, weight loss and blood markers,[31] one used BMI and weight loss,[24] and one used anthropometry, weight loss and energy intake.[30]

Of the nine studies that used SGA, seven reported that the prevalence of preoperative malnutrition ranged from 44% to 81% of patients[25,27,29,32,34,36,38] and one of these also showed prevalence of postoperative malnutrition was 83%.[36] One study that did not report timings of assessment, recorded a prevalence of 40%.[28] In contrast, the one remaining study that used SGA recorded 0% malnutrition.[23] As a result of the SGA findings, this one study went on to use BMI and identified 2% of participants as underweight and an unvalidated index suggestive of malnutrition (ISM) identified 12% as malnourished. ISM was not in agreement with BMI (kappa = 0.07).

Of the two studies that used the scored PG-SGA to measure malnutrition, one showed a particularly high prevalence of malnutrition (84%) specifically in patients with cancer preoperatively.[26] In patients undergoing general surgery procedures, malnutrition prevalence increased substantially from 32% preoperatively to 92% postoperatively (P = 0.0001); this included participants identified as having moderate and severe malnutrition using SGA.[37]

Meta-analysis of the prevalence of malnutrition before surgery using SGA and PG-SGA across studies is displayed in forest plots (*Figure 3*). Overall prevalence of undernutrition was 0.61 (95% CI 0.50, 0.73) with high heterogeneity between studies (I^2 = 96.92%), prevalence of moderate malnutrition was 0.44 (95% CI 0.31, 0.57) with heterogeneity between studies (I^2 = 94.87%), and severe malnutrition was 0.32 (95% CI 0.19, 0.45) with heterogeneity between studies (I^2 = 97.92%). Funnel plot asymmetry was undertaken and showed substantial scatter in the plot with Egger test of P = 0.126 (*Figure S2*).

The two studies that used additional nutritional screening tools in combination with SGA showed that both MUST and NRI overestimate malnutrition compared with SGA. One study recorded malnutrition as 57% (SGA), 75% (MUST) and 60% (NRI).[27] The other recorded malnutrition as 66% (SGA) and 88% (NRI).[34] One of these studies found that the MUST tool had 88% agreement with SGA.[27]

Where the unvalidated version of the SGA was used, changes were made to the scoring system to suit the study population, who could not recall usual body weight. The results of this study were similar to the other eight studies using the validated SGA, with a preoperative malnutrition rate of 56% reported.[33]

The MST nutritional risk tool was used by one study and showed that 44% of patients with cancer were at risk of malnutrition prior to surgery.[35]

Three studies were identified that used nutritional measures alone. One showed that malnutrition was common in postoperative patients (47%) based on BMI.[24] On admission to hospital, a lower prevalence of malnutrition was shown with 20% of surgical patients malnourished and 28% with weight loss.[30] Using anthropometry, weight loss and blood markers, varying rates of malnutrition were reported depending on the measurement used (11% by BMI, 49% by weight loss, 34% by lymphocyte count, 42% by haemoglobin level).[31] Two of these studies found that malignant disease increased malnutrition in surgical patients.[30,31]

Anthropometry, serum biomarkers and postoperative outcomes

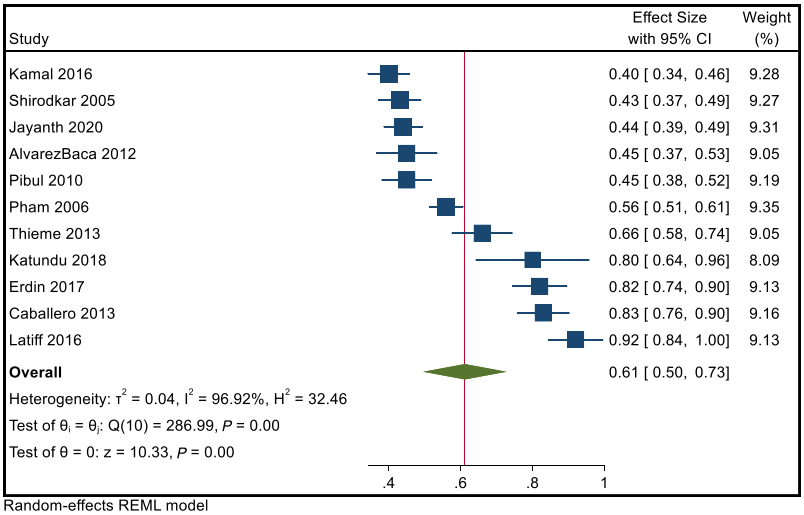
In addition to measuring malnutrition many studies recorded additional measures relating to nutritional status. Twelve studies measured the patient's anthropometry[23–25,29–37] (*Table 2*), 12 studies recorded postoperative outcomes[25–35,37] (*Table 3*), six studies recorded serum biomarkers[23–25,31,34,36] (*Table 4*) and two studies recorded dietary intake.[24,30]

Of the 12 studies that recorded anthropometry, three measured skinfolds, arm circumference and mid-upper arm circumference[23,30,36] (see *Table S2* for details). One study recorded handgrip strength in kilograms (preoperatively: 22.3 range 20–33, postoperatively: 18.4 range 14–27 $P < 0.0001$).[29]

Of the six studies that recorded serum biomarkers, four measured albumin levels. Two studies did not find any low al-

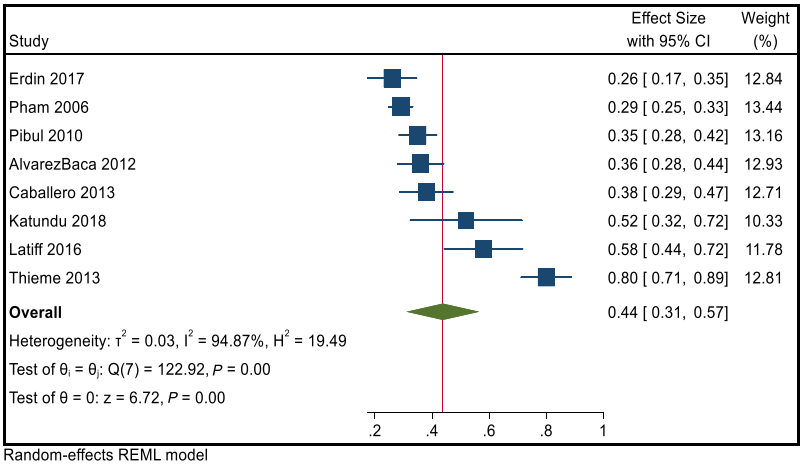
Figure 3 Prevalence of malnutrition using either Subjective Global Assessment (SGA) or the Patient Generated version

(A) Total prevalence of both moderate (SGA-B) and severe (SGA-C) malnutrition



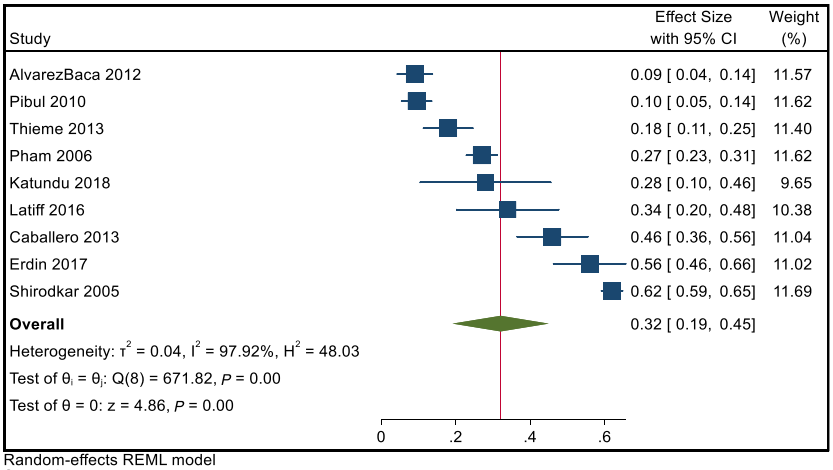
Random-effects REML model
Sorted by: _meta_es

(B) Prevalence of moderate (SGA-B) malnutrition



Random-effects REML model
Sorted by: _meta_es

(C) Prevalence of severe (SGA-C) malnutrition



Random-effects REML model
Sorted by: _meta_es

Table 3 Post-operative outcomes

Authors	LoS mean (SD) [days]	Mortality *n* (%)	Complications *n* (%)
AlvarezBaca 2012	NR	10 (7.35%)	Total 44 (32.4) Minor 30 (68) Major 27 (61) Major and minor: 13 (30)
Caballero 2013	SGA-A: 7.53 (4.03) SGA-B: 14.09 (11.65) SGA-C: 15.13 (11.52)	NR	Major: 5 (4.8) SGA-A: 0, B: 3(2.9), C: 2(1.9) Minor: 5 (4.8) SGA-A: 1(1), B: 3(2.9), C: 1(1)
Garcia 2013	High nutritional risk: median 12 days Medium nutritional risk: median 6.5 days	NR	NR
Jayanth 2020	10.9 (7.834), LoS $>$ 10 days in 120 (35%)	NR	135 (39.5)
Kamal 2016	NR	30 days mortality: 15 (13) malnourished 5 (6%) at risk 2 (3%) well nourished	23 (20.565) malnourished 4 (5.12) well nourished
Katundu 2018	Median (range) 5 (4–7) SGA-C: 8 (7–9) SGA-B: 5 (4–5) SGA-A: 4 (4–4)	NR	18 (72)
Latiff 2016	NR	NR	6 (12): 2 (4) nosocomial pneumonia, 3 (6) wound infection, 1 (2) readmission
Leandro-Merhi 2012	7.7 (9.4)	6 (8.1)	NR
Leandro-Merhi 2011	$\leq$3 days: 540 (58.2%) 4–7 days: 234 (25.2%) $>$ 7 days: 153 (16.5%)	NR	NR
Pham 2006	NR	NR	Inf comps in major surgery: SGA-A 4/61 (6%), SGA-B 9/97 (9%), SGA-C 39/116 (33.6%)
Shirodkar 2005	Median (range) 6 (1–40) Prolonged stay: SGA-A: 39/152 SGA-B: 27/98 SGA-C: 9/16	4 (1.5) 30 day mortality: SGA-A: 0/152 SGA-B: 3/98 SGA-C: 1/16	Median antibiotic days 6 (1–38) Adverse events occurred: SGA-A: 12/152 SGA-B: 17/98 SGA-C: 4/16
Thieme 2013	19.9 (23.9)	18 (14.4)	63 (50.4): Inf comps 33 (26) Non-inf comps 30 (24)

Abbreviations: Inf comps: infectious complications, LoS: length of hospital stay, NR: not reported; SGA: Subjective Global Assessment, SGA-A: well nourished, SGA-B: moderately malnourished, SGA-C: severely malnourished.

Table 4 Blood marker outcomes

Authors	Haemoglobin mean (SD) g/dl	Haematocrit WBC mean (SD)	Lymphocytes mean (SD) mm3	Prealbumin mean (SD) g/dl	Albumin mean (SD) g/dl
Acuna 2003	NR	M: 41.2% (3.4) F: 35.9% (3.6)	M: 1943.7 (611.4) F: 1883.1 (640.6)	NR	M: 3.9 (0.3) F:3.6 (0.343)
Alassani 2018	Anaemia *n* 74 (82%) if hb $<$ 12 g/L	Hyperleukocytosis 58 (64%)	NR	NR	NR
AlvarezBaca 2012	NR	NR	1573.2 (995.18)	NR	3.41 (0.68)
Erdim 2017	grp 1: 9.6 (1.2) grp 2: 8.7(1.0)	grp 1: 36.7 (3.5) grp 2:35 (3.0)	NR	grp 1: 0.2 (0.01) grp 2: 0.16 (0.01)	grp 1: 4.05 (0.6) grp 2: 3.7 (0.4)
Leandro-Merhi 2011	*n* 577 Low Hb *n* 243 (42%)	NR	*n* 456 Nil: *n* 302 (66%) Mild: *n* 54 (12%) Mod: *n* 53 (12%) Severe: 47 (10%)	NR	NR
Thieme 2013	NR	NR	1642.6 (1,076.8)	NR	3.12 (0.70)

Abbreviations: F: female, grp: group, Hb: haemoglobin, M: male, Mod: moderate; *n*: number, NR: not reported.

bumin levels in their study populations.[23,36] The other two studies found that albumin levels were useful in detecting malnutrition due to the statistically significant relationship with postoperative outcomes ($P < 0.005$)[25] and that low albumin levels were significantly associated with higher noninfectious complications ($P = 0.0015$).[34]

Dietary intake was measured preoperatively by assessing habitual food intake of patients on admission (45% of patients had energy intake below 75% of their requirements)[30] and postoperatively using a 72-h food diary, where a low energy and protein intake in 67% and 62% of patients respectively was reported.[24]

Many studies reported on postoperative outcomes with the six studies that used SGA,[25,27–29,32,34] two studies that used PG-SGA[26,37] and one study that used an unvalidated SGA[33] concluding that malnutrition was associated with postoperative complications. Malnutrition was shown to negatively impact specific postoperative outcomes, including increased length of hospital stay,[25–27,33–35] lack of appetite and altered taste,[26] increased mortality,[33,35] increase in poor clinical outcomes,[29,33] increased infectious complications[32] and noninfectious complications.[34] Studies also found that older age,[24,35] reduced energy intake,[24] low BMI[25] and weight loss[24,30,31] were all associated with malnutrition. Malnutrition was also shown to be associated with malignant disease,[30,35] low serum albumin,[25,34] abnormal lymphocyte count[25,31] and abnormal haemoglobin levels.[31]

Discussion

Summary of evidence

This review investigated the prevalence of malnutrition in surgical patients in LMICs and assessed nutritional assessment tools. All studies showed malnutrition to be a common occurrence in surgical patients' perioperative. Nearly all the studies used validated tools to measure malnutrition, with SGA being the most widely used tool and only four out of 16 studies used unvalidated tools.[24,30,31,33]

Nutritional screening with either SGA or PG-SGA to assess malnutrition concluded that the rate of malnutrition was high in patients scheduled for surgery (32% to 84%) and even higher postoperatively (81% to 92%). In particular, it was noted that malnutrition prevalence was high in patients scheduled for gastrointestinal cancer surgery where malnutrition was measured in two hospitals and showed a small increase of 2% and 6% from preoperatively to postoperatively.[36]

The two studies that used PG-SGA detected the highest rates of malnutrition in patients undergoing surgery across all studies, reporting 84% preoperatively[26] and 92% postoperatively.[37] It was suggested that this may be attributed to the higher levels of sensitivity of PG-SGA in detecting malnutrition in patients with cancer and the inclusion of a high proportion of patients with gastrointestinal malignancies.[26] Patients with gastrointestinal malignancies often have nausea, vomiting, constipation, diarrhoea, or a combination of symptoms that affect nutritional status.[39] This suggests that the PG-SGA may have advantages over SGA, when measuring malnutrition specifically in cancer surgical patients.

The meta-analysis conducted in this review demonstrated an overall prevalence of malnutrition of 0.61 (CI 95% 0.50, 0.73) using SGA or PG-SGA in patients before surgery. Heterogeneity for preoperative malnutrition across studies was high for the main meta-analysis (overall malnutrition) and both sub meta-analyses (moderate and severe malnutrition). The funnel plot asymmetry also displayed a wide scatter so indicating significant bias within the meta-analysis. Although these studies used either SGA or PG-SGA to measure malnutrition, the studies themselves were carried out across several different countries, using patients with differing diagnoses who were undergoing different types of surgeries, which may explain some of the variation.

Alongside validated and unvalidated nutritional measurement tools, many studies also assessed nutritional status by measuring anthropometry, dietary intake and blood serum markers, specifically serum albumin levels[25,34] and comparing preoperatively and postoperative handgrip strength.[29] However, the usefulness of these traditional techniques, which can be costly and inefficient in terms of time have been questioned due to the lack of assessment around patient history and physical examination (subjective assessment).[40] In addition, serum albumin is a poor measure of an individual's nutritional status.[41,42] SGA or PG-SGA overcome some of these disadvantages with the benefit of inclusion of symptom and dietary assessment along with establishing disease states.

The SGA is a validated tool[43] that can be used as a prognostic instrument for accurately predicting outcomes during hospitalisation.[44] It has been used worldwide since its inception and is considered to be valid and reliable when assessing malnutrition in hospital settings in both high[45–50] and low income countries.[51] The SGA tool is also thought to be advantageous in terms of its subjectivity, simplicity and reliability whilst being inexpensive.[40] It is noteworthy that training is required for SGA to be performed at the bedside.[43] Interestingly, SGA incorporates all of the nutritional assessment criteria outlined in the Global Initiative on Malnutrition apart from BMI.[3]

PG-SGA compared with SGA incorporates additional assessment criteria, which extends the scope and usability to identify and prioritise patients with cancer who are malnourished in hospital.[52] The PG-SGA was modified from the original SGA[53,54] and has been shown to have a high level of accuracy when detecting malnutrition, specifically in cancer patients,[52] which has also been shown in the results of this review. The PG-SGA includes additional questions relating to

nutritional symptoms, short-term weight loss and was designed in part, for completion by patients. The advantages of this are that it identifies more nutritional impact symptoms and it is less time intensive.[46,52] In addition, the scoring of PG-SGA incorporates a continuous numeric scoring system that allows patients to be triaged for nutritional intervention.[46,52] The scored PG-SGA has been accepted by the Oncology Nutrition Dietetic Practice Group of the American Dietetic Association as the standard for nutritional assessment for patients with cancer[52] and it is also used internationally as the reference method for assessment in this patient group.[55] It is therefore not surprising that PG-SGA is recommended in the nutritional assessment of cancer patients in many countries as part of clinical guidelines.[3,52,56,57] As malnutrition is associated with decreased survival, it is important to identify malnutrition in patients with cancer so they can be offered nutritional support interventions.[58]

The results from the present review highlight a higher rate of undernutrition in LMICs in preoperative and postoperative surgical patients compared with data from high-income countries.[17,59] This is novel as the majority of research is focused on high-income countries and here we demonstrate that people in LMICs are exposed to pre-existing undernutrition in combination with disease-associated weight loss. This means that the high prevalence of undernutrition in populations living in LMICs[2] is combined with a higher incidence of preoperative and postoperative undernutrition in patients undergoing surgery.

Assessing nutritional status in LMIC is therefore highlighted as a real need that is supported by other research.[17,59] Interestingly, the presented data show narrow confidence intervals of weighted prevalence giving estimates within plus or minus 5% for the prevalence of overall, moderate and severe malnutrition. This indicates that both SGA and PG-SGA are useful in measuring nutritional status in oncology surgical patients. This has also been demonstrated by other researchers in high-income countries.[43,45–47,51] In addition, these results would appear to be reliable considering the robustness of the included studies: Our quality assessment concluded that all but one[28] were at least medium to high quality.

The results of this review indicate that the SGA and PG-SGA would be valid and reliable tools for assessing malnutrition in surgical patients in LMICs. We suggest that these tools should be used in line with the descriptions given by Detsky for the SGA[43] and Ottery for the PG-SGA.[53] This would include group training and formal testing of interrater reproducibility to ensure valid and reliable methods of assessment.[43] However, due to the limited data available for LMICs more detailed, high quality comparative studies should be considered to test validity and reliability of screening tools in the hospital settings of LMICs.

The use of validated tools for assessing malnutrition is essential within clinical practice to enable patients to be identified that would potentially benefit from nutritional support interventions.[60] However, the most appropriate assessment needs to be determined by evaluating validation data within a specific patient population.

Strengths and limitations

One of the strengths of this review is that the search strategy was conducted over multiple international databases so captured studies undertaken in Asia and Africa. Moreover, it was possible to perform a meta-analysis of proportions to provide summary prevalence estimates for undernutrition using SGA and the PG-SGA. Few studies were identified that measured malnutrition before and after surgery and those that did used different assessment tools, so formal comparisons were not possible. Just under half of the studies failed to include strategies to deal with confounding, such as gender and socio-economic status, so the results of these studies may be subject to bias. Despite using a comprehensive search strategy, almost all included studies were from middle-income countries, possibly reflecting the shortage of resources for such studies in low-income countries. This means that our findings cannot be fully generalised to low-income countries. Also, relatively few studies were found from North and South Africa, and Central, Eastern, and Western Asia. Studies conducted in China were also difficult to obtain when published in Chinese language and in Chinese medical journals.

Conclusions

Disease-related malnutrition is highly prevalent worldwide and imposes a substantial economic burden particularly on LMICs.[59] There is increasing demand to address the prevalence of malnutrition and its clinical consequences in surgical patients in LMICs, to improve surgical outcomes.[4] This emphasises the need in both high-income countries and LMICs to routinely assess nutritional status using a validated tool preoperatively. This would enable patients, who are malnourished preoperatively, to be identified at the start of their surgical journey so nutritional support could be initiated where appropriate.

Acknowledgements

All authors certify that they comply with the Ethical guidelines for authorship and publishing in the Journal of Cachexia, Sarcopenia and Muscle.[61] The manuscript is a review reporting on previously published studies and therefore does not contain any primary clinical studies or patient data.

Conflicts of interest

Debra Jones, Stephen R Knight, Jana Sremanakova, Marie Carmela M Lapitan, Ahmad U Qureshi, Thomas M Drake, Professor Stephen Tabiri, Dhruva Ghosh, Maria Thomas, Professor Pamela A Kingsley, Professor Sudha Sundar, Mayaba Maimbo, Edwin Yenli, Catherine Shaw, Apple P Valparaiso, Aneel Bhangu, Laura Magill, John Norrie, Professor Tracey E Roberts, Professor Evropi Theodoratou, Thomas G Weiser, Ewen M Harrison, and Sorrel T Burden declare no conflicts of interest.

Author contributions

SB developed the search strategy and carried out the search. SB, SK, SS, TD, ML, AQ, EH, DJ, PK, ST, MT and JS undertook the study selection, the risk of bias assessment, data extraction, data synthesis and collated results. DJ wrote the first draft of the manuscript. All authors read, provided feedback and approved the final manuscript.

Funding Information

Funded by Medical Research Council, grant number MR/S014527/1, and National Institute for Health Research (NIHR; NIHR 16.136.79) using UK aid from the UK Government to support global health research. The views expressed in this publication are those of the authors and not necessarily those of the NIHR or the UK Government. ET is supported by a CRUK Career Development Fellowship (C31250/A22804).

Online supplementary material

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Figure S1. Search strategy for MEDLINE Ovid platform.
Figure S2. Funnel plot asymmetry and Egger test of prevalence of malnutrition meta-analysis.
Table S1. Quality Assessment.
Table S2. Skinfold, arm and mid upper arm circumference data.

REFERENCES

1. United Nations. *The Sustainable Development Goals Report 2020*. USA: United Nations Publications; 2020. https://unstats.un.org/sdgs/report/2020/. Accesssed 16th June 2021.
2. FAO, IFAD, UNICEF, WFP, WHO. The State of Food Security and Nutrition in the World 2020. Transforming food systems for affordable healthy diets. Rome, FAO. 2020. https://www.fao.org/documents/card/en/c/ca9692en/. Accessed 16th Jun 2021.
3. Cederholm T, Jensen GL, Correia MITD, Gonzalez MC, Fukushima R, Higashiguchi T, et al. GLIM criteria for the diagnosis of malnutrition—A consensus report from the global clinical nutrition community. *Clin Nutr* 2019;**38**:1–9.
4. Nakahara S, Nguyen DH, Bui AT, Sugiyama M, Ichikawa M, Sakamoto T, et al. Perioperative nutrition management as an important component of surgical capacity in low- and middle-income countries. *Trop Med Int Health* 2017;**22**:784–796.
5. Shpata V, Prendushi X, Kreka M, Kola I, Kurti F, Ohri I. Malnutrition at the time of surgery affects negatively the clinical outcome of critically ill patients with gastrointestinal cancer. *Med Arch* 2014;**68**:263–267.
6. Meara JG, Hagander L, Leather AJM. Surgery and global health: a Lancet Commission. *Lancet* 2014;**383**:12–13.
7. GlobalSurg Collaborative. Surgical site infection after gastrointestinal surgery in high-income, middle-income, and low-income countries: a prospective, international, multicentre cohort study. *Lancet Infect Dis* 2018;**18**:516–525.
8. King's Fund Centre. 1992. A Positive Approach to Nutrition as Treatment. The role of enteral and parenteral feeding in hospital and at home. 126 Albert Street, London NW1 7NF. https://www.bapen.org.uk/pdfs/bapen_pubs/pub_kings_fund.pdf. Accessed 16th June 2021.
9. Narendra K, Kiss N, Margerison C, Johnston B, Chapman B. Impact of nutritional status/risk and post-operative nutritional management on clinical outcomes in patients undergoing gastrointestinal surgery: a prospective observational study. *J Hum Nutr Diet* 2020;**33**:587–597.
10. Allard JP, Keller H, Jeejeebhoy KN, Laporte M, Duerksen DR, Gramlich L, et al. Decline in nutritional status is associated with prolonged length of stay in hospitalized patients admitted for 7 days or more: A prospective cohort study. *Clin Nutr* 2016;**35**:144–152.
11. Riad AM, Knight SR, Ewen M, Harrison on behalf of GlobalSurg Collaborative. The effect of malnutrition on early outcomes after elective cancer surgery: an international prospective cohort study in 82 countries. *Br J Surg* 2021;**108**. https://doi.org/10.1093/bjs/znab282.024
12. Burden S, Todd C, Hill J, Lal S. Pre-operative nutrition support in patients undergoing gastrointestinal surgery. *Cochrane Database Syst Rev* 2012;**11**:CD008879.
13. Wobith M, Weimann A. Oral nutritional supplements and enteral nutrition in patients with gastrointestinal surgery. *Nutrients* 2021;**13**:2655.
14. Moya P, Soriano-Irigaray L, Ramirez JM, Garcea A, Blasco O, Blanco FJ, et al. Perioperative standard oral nutrition supplements versus immunonutrition in patients undergoing colorectal resection in an enhanced recovery (ERAS) protocol: a Multicenter Randomized Clinical Trial (SONVI Study). *Medicine (Baltimore)* 2016;**95**:e3704.
15. Burden ST, Gibson DJ, Lal S, Hill J, Pilling M, Soop M, et al. Pre-operative oral nutritional supplementation with dietary advice versus dietary advice alone in weight-losing patients with colorectal cancer: single-blind randomized controlled trial. *J Cachexia Sarcopenia Muscle* 2017;**8**:437–446.
16. Klek S, Sierzega M, Szybinski P, Szczepanek K, Scislo L, Walewska E, et al. Perioperative nutrition in malnourished surgical cancer patients—a prospective, randomized, controlled clinical trial. *Clin Nutr* 2011;**30**:708–713.
17. National Institute for Health Research Global Health Research Unit on Global Surgery. Prioritizing research for patients requiring surgery in low- and middle-income countries. *Br J Surg* 2019;**106**:e113–e120.
18. Organisation for Economic Co-operation and Development (OECD). DAC List of ODA Recipients. 2021. https://www.oecd.org/dac/financing-sustainable-development/development-finance-standards/daclist.htm. Accessed 16th June 2021.

19. Covidence systematic review software, Veritas Health Innovation, Melbourne, Australia. Available at www.covidence.org
20. Aromataris E, Munn Z. (2017) Joanna Briggs Institute Reviewer's Manual. The Joanna Briggs Institute. https://jbi.global/. Accessed 16th June 2021.
21. Whiting P, Rutjes AW, Reitsma JB, Bossuyt PM, Kleijnen J. The development of QUADAS: a tool for the quality assessment of studies of diagnostic accuracy included in systematic reviews. *BMC Med Res Methodol* 2003;**3**:1–13.
22. GRADEpro 2021. GDT: GRADEpro Guideline Development Tool [Software]. McMaster University and Evidence Prime, Available from: gradepro.org.
23. Acuña K, Portela M, Costa-Matos A, Bora L, Teles MR, Waitzberg DL, et al. Nutritional assessment of adult patients admitted to a hospital of the Amazon region. *Nutr Hosp* 2003;**18**:138–146.
24. Alassani AC, Hodonou AM, Dovonou AC, Gbessi GD, Ahoui S, Dossou FM, et al. Frequency and determinants of postoperative malnutrition in visceral surgery at the Koutoucou National Hospital and University Center Hubert Maga, Cotonou. *PAMJ* 2018;**29**:1–10.
25. Alvarez Baca D, Revoredo Rego F, Suarez Lazo M, Acevedo Rique I, Lloclla Kano P. Nutritional status morbility and mortality in patients with gastrointestinal anastomosis in the "Hospital Nacional Hipolito Unanue" (HNHU). *Rev Gastroenterol Peru* 2012;**32**:273–280.
26. Caballero CIA, Lapitan MC, Buckley BS. Nutritional assessment of adult cancer patients admitted at the philippine general hospital using the Scored Patient Generated Subjective Global Assessment Tool (PG-SGA). *Acta Med Philipp* 2013;**47**:12–17.
27. Jayanth KS, Maroju NK. Utility of nutritional indices in preoperative assessment of cancer patients. *Clin Nutr ESPEN* 2020; **37**:141–147.
28. Kamal F, Fazal MI, Cheema MA. Nutritional status of patients admitted in a general surgical ward at a tertiary hospital of Punjab. *J Coll Physicians Surg Pak* 2016;**26**:334–335.
29. Katundu KG, Mutafya TW, Lozani NC, Nyirongo PM, Uebele ME. An observational study of perioperative nutrition and postoperative outcomes in patients undergoing laparotomy at Queen Elizabeth Central Hospital in Blantyre, Malawi. *Malawi Med J* 2018;**30**:79–85.
30. Leandro-Merhi VA, Aquino JL. Investigation of nutritional risk factors using anthropometric indicators in hospitalized surgery patients. *Arq Gastroenterol* 2012;**49**:28–34.
31. Leandro-Merhi VA, Aquino JL, Camargo JG, Frenhani PB, Bernardi JL, McLellan KC. Clinical and nutritional status of surgical patients with and without malignant diseases: cross-sectional study. *Arq Gastroenterol* 2011;**48**:58–61.
32. Pham NV, Cox-Reijven PL, Greve JW, Soeters PB. Application of subjective global assessment as a screening tool for malnutrition in surgical patients in Vietnam. *Clin Nutr* 2006;**25**:102–108.
33. Shirodkar M, Mohandas KM. Subjective global assessment: a simple and reliable screening tool for malnutrition among Indians. *Indian J Gastroenterol* 2005;**24**:246–250.
34. Thieme RD, Cutchma G, Chieferdecker ME, Campos AC. Nutritional risk index is predictor of postoperative complications in operations of digestive system or abdominal wall? *Arq Bras Cir Dig* 2013;**26**:286–292.
35. Garcia RS, Tavares LR, Pastore CA. Nutritional screening in surgical patients of a teaching hospital from Southern Brazil: the impact of nutritional risk in clinical outcomes. *Einstein (Sao Paulo)* 2013;**11**:147–152.
36. Erdim A, Aktan AO. Evaluation of perioperative nutritional status with subjective global assessment method in patients undergoing gastrointestinal cancer surgery. *Turk J Surg* 2017;**33**:253–257.
37. Latiff NSMA, Ahmad N, Islahudin F. Complications associated with malnutrition in elective surgical patients in a Malaysian setting. *Trop J Pharm Res* 2016;**15**:1321–1325.
38. Pibul K, Manomaipiboon A, Techapongsatorn S, Boonyavanich S, Tosanguanrungruang T, Vitayaudom S. Vajira surgical nutritional screening tool compared with subjective global assessment test (SGA). *Vajira Med J* 2010;**54**:25–32.
39. Viana E, Oliveira IDS, Rechinelli AB, Marques IL, Souza VF, Spexoto MCB, et al. Malnutrition and nutrition impact symptoms (NIS) in surgical patients with cancer. *PLoS ONE* 2020;**15**:e0241305.
40. Ferguson M. Patient-generated subjective global assessment. *Oncology (Williston Park)* 2003;**17**:13–14, discussion 4-6.
41. Covinsky KE, Covinsky MH, Palmer RM, Sehgal AR. Serum albumin concentration and clinical assessments of nutritional status in hospitalized older people: different sides of different coins? *J Am Geriatr Soc* 2002;**50**:631–637.
42. Forse RA, Shizgal HM. Serum albumin and nutritional status. *JPEN J Parenter Enteral Nutr* 1980;**4**:450–454.
43. Detsky AS, McLaughlin JR, Baker JP, Johnston N, Whittaker S, Mendelson RA, et al. What is subjective global assessment of nutritional status? *JPEN J Parenter Enteral Nutr* 1987;**11**:8–13.
44. Detsky AS, Baker JP, Mendelson RA, Wolman SL, Wesson DE, Jeejeebhoy KN. Evaluating the accuracy of nutritional assessment techniques applied to hospitalized patients: methodology and comparisons. *JPEN J Parenter Enteral Nutr* 1984;**8**:153–159.
45. Allard JP, Keller H, Gramlich L, Jeejeebhoy KN, Laporte M, Duerksen DR. GLIM criteria has fair sensitivity and specificity for diagnosing malnutrition when using SGA as comparator. *Clin Nutr* 2020;**39**:2771–2777.
46. 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**:458–464.
47. Kyle UG, Kossovsky MP, Karsegard VL, Pichard C. Comparison of tools for nutritional assessment and screening at hospital admission: a population study. *Clin Nutr* 2006;**25**:409–417.
48. Detsky AS, Baker JP, O'Rourke K, Johnston N, Whitwell J, Mendelson RA, et al. Predicting nutrition-associated complications for patients undergoing gastrointestinal surgery. *JPEN J Parenter Enteral Nutr* 1987;**11**:440–446.
49. Baker JP, Detsky AS, Wesson DE, Wolman SL, Stewart S, Whitewell J, et al. Nutritional assessment: a comparison of clinical judgement and objective measurements. *N Engl J Med* 1982;**306**:969–972.
50. Baker JP, Detsky AS, Whitwell J, Langer B, Jeejeebhoy KN. A comparison of the predictive value of nutritional assessment techniques. *Hum Nutr Clin Nutr* 1982;**36**: 233–241.
51. Tran QC, Banks M, Hannan-Jones M, Do TND, Gallegos D. Validity of four nutritional screening tools against subjective global assessment for inpatient adults in a low-middle income country in Asia. *Eur J Clin Nutr* 2018;**72**:979–985.
52. 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**:779–785.
53. Ottery FD. Definition of standardized nutritional assessment and interventional pathways in oncology. *Nutrition* 1996;**12**:S15–S19.
54. Ottery FD. Rethinking nutritional support of the cancer patient: the new field of nutritional oncology. *Semin Oncol* 1994;**21**: 770–778.
55. Jager-Wittenaar H, Ottery FD. Assessing nutritional status in cancer: role of the Patient-Generated Subjective Global Assessment. *Curr Opin Clin Nutr Metab Care* 2017;**20**:322–329.
56. August DA, Huhmann MB, the American Society for Parenteral and Enteral Nutrition (A.S.P.E.N.) Board of Directors. A.S.P.E.N. clinical guidelines: nutrition support therapy during adult anticancer treatment and in hematopoietic cell transplantation. *JPEN J Parenter Enteral Nutr* 2009;**33**:472–500.
57. Carrico M, Guerreiro CS, Parreira A. The validity of the Patient-Generated Subjective Global Assessment Short-form(c) in cancer patients undergoing chemotherapy. *Clin Nutr ESPEN* 2021;**43**:296–301.
58. Argefa TG, Roets L. Malnutrition and the survival of cervical cancer patients: a prospective cohort study using the PG-SGA tool. *Nutr Cancer* 2021;**74**:605–612.
59. Correia M, Perman MI, Waitzberg DL. Hospital malnutrition in Latin America: a systematic review. *Clin Nutr* 2017;**36**:958–967.
60. Anthony PS. Nutrition screening tools for hospitalized patients. *Nutr Clin Pract* 2008;**23**:373–382.
61. von Haehling S, Morley JE, Coats AJS, Anker SD. Ethical guidelines for publishing in the journal of cachexia, sarcopenia and muscle: update 2017. *J Cachexia Sarcopenia Muscle* 2017;**8**:1081–1083.