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Review

Hospital malnutrition in Latin America: A systematic review

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SUMMARY

Background: Disease-related malnutrition is a major public health issue in both industrialised and emerging countries. The reported prevalence in hospitalised adults ranges from 20% to 50%. Initial reports from emerging countries suggested a higher prevalence compared with other regions, with limited data on outcomes and costs.

Methods: We performed a systematic literature search for articles on disease-related malnutrition in Latin American countries published between January 1995 and September 2014. Studies reporting data on the prevalence, clinical outcomes, or economic costs of malnutrition in an adult (≥18 years) inpatient population with a sample size of ≥30 subjects were eligible for inclusion. Methodological quality of the studies was assessed by two independent reviewers using published criteria.

Results: We identified 1467 citations; of these, 66 studies including 29 ,474 patients in 12 Latin American countries met the criteria for inclusion. There was considerable variability in methodology and in the reported prevalence of disease-related malnutrition; however, prevalence was consistently in the range of 40%–60% at the time of admission, with several studies reporting an increase in prevalence with increasing duration of hospitalisation. Disease-related malnutrition was associated with an increase in infectious and non-infectious clinical complications, length of hospital stay, and costs.

Conclusion: Disease-related malnutrition is a highly prevalent condition that imposes a substantial health and economic burden on the countries of Latin America. Further research is necessary to characterise screening/assessment practices and identify evidence-based solutions to this persistent and costly public health issue.

1. Introduction

Disease-related malnutrition in hospitalised patients is a major public health issue in both industrialised and emerging countries around the world. Poor nutritional status is associated with increased morbidity and mortality, increased length of hospitalisation, more frequent re-admission, and increased healthcare costs [1–12]. However, despite the substantial health and economic burden, disease-related malnutrition remains a highly prevalent and frequently under-recognised and under-treated condition [5,13–16].

Malnutrition in the hospital setting can develop as a consequence of insufficient nutrient intake, impaired absorption or loss of nutrients due to illness or trauma, or increased metabolic demands during illness [17]. The definition of malnutrition remains a subject of debate, with various professional societies proposing different criteria—possibly explaining some of the variability in prevalence rates reported in the literature [18–20]. Generally, unintentional weight loss >5% in a short period of time and decreased food intake are associated with a deterioration in nutritional status.

The prevalence of disease-related malnutrition has been reported to be between 20% and 50%, although data vary considerably due to differences in study populations, ascertainment methods, and hospital setting [3]. The largest body of epidemiological evidence comes from Europe, where several large studies have reported prevalence figures in the range of 20%–30% [10,21–25], with a higher prevalence observed in the older adults (32%–58%) [2,26,27] and patients with malignant disease (31%–39%) [6,28,29]. Studies conducted in Asia have reported prevalence figures between 27% and 39% [8,14,15], with a higher prevalence in the older adults (88%) [30], the critically ill (87%) [31], surgical patients (56%)

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[32], and patients with gastrointestinal malignancies (48%) [33]. Prevalence data from studies conducted in North America and Australia range from 37% to 45% [34,35] and 23%–42% [5,36–39], respectively.

The Latin America region includes 20 countries with a geographic area of more than 19 million square kilometres and a population of 626 million. The estimated combined gross domestic product for the countries in Latin America is US$5.6 trillion. Healthcare delivery ranges from private to public funded universal healthcare, with a mix of semi-public and private healthcare in several countries. A 2001 multinational survey conducted in 13 countries in Latin America reported that malnutrition was present in 50.2% of the 9348 hospitalised adults included in the survey [40]. Despite the high prevalence, fewer than 9% of patients received parenteral or enteral nutrition, and only two of the 13 countries had national policies regarding best practices for nutrition therapy in hospitals or long-term care facilities. In the 15 years since this seminal survey, several studies have evaluated the prevalence and clinical consequences of disease-related malnutrition in different hospital settings throughout Latin America. Therefore, the aim of the present systematic literature review was to identify and summarise the available evidence regarding the prevalence, clinical consequences, and costs associated with disease-related malnutrition in Latin America.

2. Methods

2.1. Search strategy and selection criteria

The systematic literature review was performed according to the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) group [41]. We searched Medline, Embase, the Cochrane Database of Systematic Reviews, the Database of Abstracts of Reviews of Effects (DARE), the Cochrane Central Register of Controlled Trials (CENTER), EconLit, and the Latin American and Caribbean Centre on Health Sciences Information (LILACS) for articles on disease-related malnutrition in Latin American countries published in English, Spanish, or Portuguese between January 1995 and September 2014. The search terms encompassed three categories: disease, geographic region, and outcomes (the search protocol is available in the supplementary material). Studies reporting data on the prevalence, clinical outcomes, or economic costs of disease-related malnutrition in an adult (≥18 years) inpatient population with a sample size of at least 30 subjects were eligible for inclusion. We excluded editorials, narrative reviews, abstracts without full text articles, and studies that lacked sufficient information regarding the study population or analytic methods. Article titles and abstracts generated by the search were screened by two independent reviewers to identify relevant articles. Disagreement between reviewers was resolved by consensus through direct discussion. Information on study design, patient population, and prespecified outcomes was extracted and recorded on data extraction forms.

2.2. Quality assessment

The methodological quality of the studies was assessed by two independent reviewers using the Prevalence Critical Appraisal tool [42], a 10-item checklist designed to assess the internal validity of prevalence data (see supplementary material). Studies reporting economic outcomes were also appraised for methodological quality using an adapted version of the Drummond 10-point checklist (see supplementary material) [43]. Disagreement between reviewers regarding the methodological quality of the retrieved studies was resolved by consensus.

2.3. Data synthesis

Study results for all publications that met the criteria for inclusion are summarised descriptively according to patient population and outcome measurement. Prevalence data based on the Subjective Global Assessment (SGA) tool are reported as the combined proportion of patients with moderate and severe malnutrition (categories B and C, respectively); data based on the Malnutrition Universal Screening Tool (MUST) are reported as the combined proportion of patients with medium risk and high risk of malnutrition; and data based on the Mini Nutritional Assessment (MNA) are reported as the combined proportion of patients who are malnourished and at risk of malnutrition. Prevalence data based on the Nutritional Risk Screening 2002 (NRS 2002) screening instrument are reported as the proportion of patients with a combined score for nutritional risk and disease severity corresponding with a high risk of malnutrition (combined score ≥3).

3. Results

We identified 1467 citations, 85 of which were judged to be potentially eligible (Fig. 1). Manual review of references identified an additional two studies. Of the 87 published articles formally assessed for eligibility, 66 met the criteria for inclusion [40,44–108]. One multinational study reported data from 13 Latin

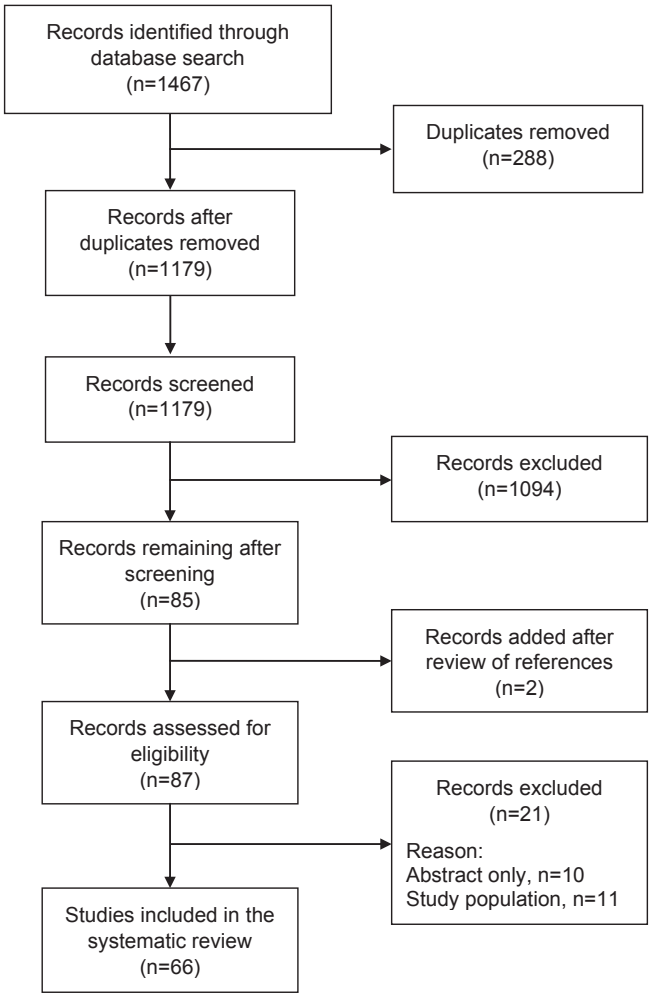

Fig. 1. Study flow diagram.

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American countries [40], 11 of which published country-level data separately. To avoid duplication, data from this study are reported only for patients from the two countries (Chile, Venezuela) for which there was no separate publication. The results of the methodological appraisal are shown in the supplementary material (pp. 4–6). In general, most studies were susceptible to bias due to sampling methods or incomplete reporting. Due to the heterogeneity of study design, patient populations, and ascertainment methods, no formal quantitative meta-analysis of the results was performed.

Table 1 summarises the distribution of studies and patients by country. The included studies comprised 29 ,474 patients from 12 Latin American countries. A majority of the studies were conducted in Brazil, which accounted for 57.7% of all patients in the included studies. Two studies conducted in Brazil (n = 4000) and Ecuador (n = 5355), respectively, accounted for nearly one third of the total number of patients in the included studies [46,64].

Twenty-nine studies reported prevalence data in a general medical or mixed population; 15 in surgical patients; 10 in older adult patients; five in patients with malignant disease; and one in critically ill patients. Six studies reported prevalence data in other populations, including heart failure (2), HIV/AIDS (2), liver cirrhosis (1), and trauma (1) (Table 2).

A variety of screening and assessment instruments were used to ascertain the nutritional status of subjects across studies. The most frequently used instruments were the SGA and body mass index (BMI); for the latter, most studies used a threshold value of <18.5 kg/m^2 for patients <60 years of age and a value of <22 kg/m^2 for patients ≥60 years. The MNA, a tool developed specifically for use in geriatric patients, was the most commonly used instrument in studies evaluating the prevalence of malnutrition in the older adults.

3.1. Prevalence of disease-related malnutrition

3.1.1. General population

Prevalence data in the general hospital population (n = 20 881) showed considerable variability, with the reported prevalence ranging from 2.6% to 73.2%. Despite the observed variability, examination of the findings across countries suggests that disease-related malnutrition is highly prevalent throughout the Latin America region. All of the studies conducted in Argentina [45], Colombia [59,60], Peru [68,69], and Venezuela [40] reported a prevalence of more than 45%, with each of the studies in Colombia reporting a prevalence of more than 60%. Prevalence figures from studies in Cuba were consistently in the range of 40% [61–63]. Results from studies in Brazil showed greater variability [46–57,65,66,70,71]; however, the majority of studies reported a prevalence of more than 40%, with the two largest studies reporting values of 48.1% and 39.3%–69.7%, respectively [46,49].

Table 1
Distribution of studies and patients by country.

Country	Studies, n (%)	Patients, n (%)
Brazil	43 (64.2)	17 017 (57.7)
Mexico	6 (9.0)	1117 (3.8)
Cuba	4 (5.9)	2452 (8.3)
Argentina	3 (4.5)	1604 (5.4)
Chile	2 (3.0)	575 (2.0)
Colombia	2 (3.0)	365 (1.2)
Peru	2 (3.0)	370 (1.3)
Bolivia	1 (1.5)	150 (0.5)
Costa Rica	1 (1.5)	281 (1.0)
Ecuador	1 (1.5)	5355 (18.1)
Uruguay	1 (1.5)	104 (0.3)
Venezuela	1 (1.5)	188 (0.6)
Total	67[a]	29,474

[a] One study in Chile (n = 525) and one study in Venezuela (n = 188) reported in the same publication [40].

3.1.2. Surgical population

A total of 15 studies assessed the prevalence of malnutrition in patients undergoing surgery (n = 5450), with substantial variability in prevalence observed across studies (Table 2) [72–86]. The highest prevalence was observed in patients undergoing gastrointestinal procedures, including resection of gastrointestinal tumours (66%) [76], abdominal surgery (61.5%) [84], colon surgery (63.6%) [85], and gastrointestinal or hernia surgery (55%) [72]. Incomplete reporting in the studies with the lowest observed prevalence precluded further assessment to determine whether the results might have been influenced by the relative proportion of patients undergoing elective versus non-elective procedures.

3.1.3. Critically ill population

Only one study included in the review assessed the prevalence of malnutrition in the critically ill [87]. A total of 185 adults consecutively admitted to the intensive care unit (ICU) of a single institution in Brazil, 30% of whom required mechanical ventilation, underwent a nutritional assessment within 48 h of admission. The prevalence of malnutrition according to the SGA was 54%, with 41.6% of patients categorised as moderately malnourished and 12.4% categorised as severely malnourished.

3.1.4. Older adults population

A total of 10 studies evaluated the prevalence of malnutrition in an older adult population (n = 1669; Table available on line) [88–97]. Of these, six measured prevalence using the MNA. Prevalence data from studies using the MNA ranged from 38.5% to 71%, with five of the six studies reporting a prevalence of more than 60% [89–92,94]. In the two studies that reported prevalence based on the SGA, 44.2% and 66% of patients were classified as malnourished [88,89]. Prevalence figures from studies that evaluated nutritional status according to BMI were generally lower than those from studies in which the MNA or SGA was used [94–97].

3.1.5. Diagnosis-related prevalence

Several studies assessed the prevalence of disease-related malnutrition in patients with specific diagnoses, including cancer [98–102], heart failure, [103,104] HIV/AIDS, [105,106] trauma, [107] and liver cirrhosis [108] (Table 2). Prevalence figures in patients with heart failure, HIV/AIDS, and liver cirrhosis were similar to those in the general population of hospitalised adults. A markedly higher prevalence was observed in the single study conducted in trauma patients, with 98% of patients characterised as malnourished [107]. While the reported prevalence of malnutrition in patients with cancer was within the range reported in the general population, several large studies in mixed or surgical populations reported that the presence of malignancy was an independent risk factor for malnutrition [44,46,64,72,79,82,86], with one study reporting as much as an 8-fold increase in malnutrition among cancer patients compared to patients without malignant disease [72].

3.1.6. Prevalence of malnutrition during hospital stay

Three studies included in the review assessed longitudinal change in the prevalence of malnutrition during the course of hospitalisation in the general population [48,49,64]. In a study of 1688 hospitalised patients in Brazil, longitudinal assessments of nutritional status performed at 7 day intervals showed that the prevalence of malnutrition increased with increasing length of stay [49]. The proportion of patients with malnutrition increased from 40.2% at the time of admission to 55.2% at day 7 and 64.6% at day 14.

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Table 2
Studies evaluating disease-related malnutrition in hospitalised adults in Latin American countries.

Population	Year	Country	n	Instrument	Prevalence, %
General/mixed					
Perman et al.[a] [44]	2000	Argentina	448	SGA	Reported in [45]
Wyszynski et al. [45]	2003	Argentina	1000	SGA	47.3
Waitzberg et al. [46]	2001	Brazil	4000	SGA	48.1
Correia et al. [47]	2003	Brazil	709	SGA	34.2
Rezende et al. [48]	2004	Brazil	244	SGA	63.1
Beghetto et al. [49]	2010	Brazil	1688	SGA	39.3–69.7
Sampaio et al. [50]	2011	Brazil	50	SGA	18
Zanin et al. [51]	2011	Brazil	166	SGA	49.1
Pasquini et al. [52]	2012	Brazil	109	SGA	33.2
Brito et al. [53]	2013	Brazil	417	SGA	52.4
Lammel Ricardi et al. [54]	2013	Brazil	398	SGA	43.7
Ordonez et al. [55]	2013	Brazil	396	SGA/BMI/lab [b]	45.7
Garcia et al. [56]	2013	Brazil	118	SGA	50.9
				NRS-2002	33.9
				BMI	3.5
Duarte et al. [57]	2014	Brazil	100	SGA	4
				MNA	49
				MNA-SF	53
				MUST	23
				NRS-2002	7
Humphreys et al. [58]	2002	Chile	50	SGA	70
Correia et al. [c] [46]	2003	Chile	525	SGA	37
		Venezuela	188	SGA	48.7
Giraldo Giraldo et al. [59]	2007	Colombia	138	SGA	63
Agudelo et al. [60]	2012	Colombia	227	SGA	69.3
Vega Moreno et al. [61]	2003	Cuba	158	SGA	40.5
Socarras Suarez et al. [62]	2004	Cuba	242	SGA	39.3
Barreto Penie et al. [63]	2005	Cuba	1905	SGA	41.2
Gallegos Espinosa et al. [64]	2014	Ecuador	5355	SGA	37.1
Leandro-Mehri et al. [65]	2007	Brazil	267	BMI	2.6
Leandro-Merhi et al. [66]	2009	Brazil	100	BMI	29
Fuchs et al. [67]	2008	Mexico	561	BMI	21.2
Ortiz Saavedra et al. [68]	2007	Peru	159	BMI	50.5
Veramendi-Espinoza et al. [69]	2013	Peru	211	Arm circumference	46.9
Micheli et al. [70]	2009	Brazil	247	NRS-2002	57
Raslan et al. [71]	2010	Brazil	705	NRS-2002	27.9
				MUST	39.6
				MNA-SF	73.2
Surgical					
Correia et al. [72]	2001	Brazil	374	SGA	55
Cardinal et al. [73]	2010	Brazil	125	SGA	17.6
				NRS-2002	20.0
Leandro-Merhi et al. [74]	2011	Brazil	350	SGA	21.1
				MNA	43.0
				BMI	14.1
Meireles et al. [75]	2012	Brazil	124	SGA	35.5
				NRS-2002	19.3
Poziomyck et al. [76]	2012	Brazil	74	SGA	66
Ruiz et al. [77]	2010	Costa Rica	281	SGA	45.2
Manzanares et al. [78]	2005	Uruguay	104	SGA	57.6
Garcia et al. [79]	2013	Brazil	565	MST	33.1
Bicudo-Salomao et al. [80]	2006	Brazil	1912	BMI	10.2
Dias et al. [81]	2009	Brazil	70	BMI	5.6 (adult) 32.4 (older adults)
Leandro-Merhi et al. [82]	2011	Brazil	928	BMI	11.4
Lunardi et al. [83]	2012	Brazil	75	BMI	52
Aguilar-Soto et al. [84]	2003	Mexico	200	BMI	61.5
Femenias Viera et al. [85]	1996	Brazil	33	Anthropometry	63.6
Leandro-Merhi et al. [86]	2012	Brazil	235	Anthropometry	20
Critically Ill (ICU)					
Fontes et al. [87]	2014	Brazil	185	SGA	54
Older adults					
Zamora et al. [88]	2010	Argentina	52	SGA	44.2
Gutierrez Reyes et al. [89]	2007	Mexico	97	SGA	66
				MNA	69
Gonzalez et al. [90]	2012	Mexico	78	MNA	62.7
Maciel et al. [91]	2008	Brazil	49	MNA	71
Oliveira et al. [92]	2009	Brazil	240	MNA	67.2
Leandro-Merhi et al. [93]	2011	Brazil	109	MNA	38.5
Azevedo et al. [94]	2007	Brazil	259	MNA	60.6
				BMI	51.7
Coehlo et al. [95]	2006	Brazil	197	BMI	29.7
Leandro-Merhi et al. [96]	2010	Brazil	441	BMI	30.8

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Table 2 (*continued*)

Population	Year	Country	n	Instrument	Prevalence, %
Bolet Astovitza et al. [97]	2004	Cuba	147	BMI	26.2
Cancer					
Dias do Prado et al. [98]	2013	Brazil	143	SGA	44.8
Ruiz Dominguez et al. [99]	2011	Bolivia	150	SGA + BMI	82.7
Sanchez-Lara et al. [100]	2012	Mexico	119	SGA	59.7
Ferreira et al. [101]	2013	Brazil	100	SGA	33
				BMI	6.3
Aquino et al. [102]	2011	Brazil	300	BMI	60.7
Cardiac					
Yamauti et al. [103]	2006	Brazil	106	SGA	51.9
Souza et al. [104]	2010	Brazil	104	BMI	25
HIV/AIDS					
Monteiro et al. [105]	2000	Brazil	30	BMI	51.7
Andrade et al. [106]	2012	Brazil	127	BMI	43
Other					
Perini et al.[d] [107]	2009	Brazil	49	Albumin	98
Landa-Galvan et al.[e] [108]	2012	Mexico	62	MUST	43.5
				NRS-2002	54.8
				BMI	1.6

Abbreviations: BMI = body mass index; MNA = mini nutritional assessment; MNA-SF = mini nutritional assessment-short form; MST = malnutrition screening tool; MUST = malnutrition universal screening tool; NRS = nutritional risk screening; SGA = subjective global assessment.

[a] Subset of patients from Wyszynski et al. [45]; assessed for clinical outcomes only.

[b] Malnutrition status determined subjectively based on combined results of SGA, BMI, and lab tests.

[c] Excludes patients from 11 countries that reported country-level prevalence data separately.

[d] Adult trauma patients.

[e] Adult liver cirrhosis patients.

Similar findings were reported in a multicentre study of 5355 hospitalised adults in Ecuador; the prevalence of malnutrition increased from 31.2% at the time of admission to 64.7% between days 16 and 30 [64]. Finally, in a study of 244 adults admitted to a community hospital in Brazil, 46% had moderate or severe malnutrition between days 1 and 5 compared with 68% between days 5 and 15, and 83% after day 15 [48].

Two studies evaluated the prevalence of malnutrition in surgical or intensive care units at different time points [72,87]. In a study of 374 patients undergoing gastrointestinal surgery or hernia repair, malnutrition was present in 37.1% within 48 h of admission compared with 57.7% in patients hospitalised between 8 and 14 days, and more than 80% among patients hospitalised for more than 14 days [72]. Similar results were observed in critically ill patients; the prevalence of malnutrition was 45.5% within the first 48 h of admission to the ICU and 70.3% when assessed after 48 h following admission [87].

3.1.7. Medical awareness

Despite the high prevalence of malnutrition across the Latin America region, several studies reported evidence of a general lack of medical awareness. In a large multicentre study of 4000 hospitalised adults in Brazil, fewer than 20% of patient charts contained any information regarding nutritional status [46]. A subsequent study of 1000 patients in 38 hospitals in Argentina found that only 39% of patient records contained information regarding nutritional status and less than 15% included any record of usual or current weight and height [45]. Only 13.9% of malnourished patients in another Brazilian study had a recorded diagnosis of malnutrition [52]. Finally, three studies reported that fewer than 10% of malnourished patients received enteral or parenteral nutrition during the course of hospitalisation [46–48], while only one study reported that a majority of malnourished patients (61%) received nutrition therapy [52].

3.2. Clinical consequences

Table 3 summarises the results of studies evaluating clinical outcomes in patients with malnutrition. Collectively, the studies reported evidence of an increased risk of clinical complications [44,47,53,83], including sepsis [44,47], pneumonia, [44] cardiac arrest [47], respiratory failure [47], pressure ulcers [53], post-operative pulmonary complications (atelectasis, tracheobronchitis, pneumonia) [83], reoperation [80], and wound dehiscence [44].

Clinical complications related to malnutrition were also associated with corresponding increases in the length of hospitalisation [44,46,47,55,67,74,79,80]. Compared with well-nourished patients, the length of stay for malnourished patients increased 3.5–17.1 days in studies reporting mean values and by 1–10 days in studies reporting median values. In the single study evaluating the nutritional status of patients in an intensive care unit, malnourished patients had a more than 2-fold increase in the risk of re-admission to intensive care compared with well-nourished patients [87]. Additionally, malnourished patients had a markedly elevated risk of deathcompared with well-nourished patients. Six of the seven studies that evaluated mortality reported a statistically significant increase in the risk of death among patients with moderate or severe malnutrition [44,47,52,55,79,87].

3.3. Cost of disease-related malnutrition

We identified only one study that evaluated the costs associated with malnutrition in Latin America [47]. Cost data from a national insurance provider were used to calculate the direct hospitalisation costs for 709 adult patients from 25 Brazilian hospitals. The mean daily cost of care was 61% higher in malnourished patients compared with those who were well-nourished (US$228 versus US$138). In patients who developed a respiratory infection—the most common infectious complication observed during the study—the cost of drugs and additional medical tests increased by 309% in patients who were malnourished relative to well-nourished patients.

4. Discussion

The current systematic review identified a substantial body of literature related to the prevalence of adult malnutrition in Latin American hospitals. While the variability in patient populations

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Table 3
Studies reporting complications related to disease-related malnutrition.

Clinical outcome	Year	Country	n	Population	Result[a]
Infectious/non-infectious complications					
Correia et al. [47]	2003	Brazil	709	General/mixed	27.0% vs 16.8%; RR = 1.60 (95% CI 1.20–2.14; p < 0.01)
Bicudo-Salomao et al. [80]	2006	Brazil	1912	Surgery	17.2% vs 12.5% (p = 0.55) [b]
					18.4% vs 6.8%; OR 3.1 (95% CI 1.41–6.86; p < 0.05) [c]
Lunardi et al. [83]	2012	Brazil	75	Surgery	31% vs 11% (p = 0.05) [d]
Pasquini et al. [52]	2012	Brazil	109	IM, ID, oncology	78.8% vs 12.3% (OR 19.8; p < 0.001)
Pulmonary infection					
Correia et al. [47]	2003	Brazil	709	General/mixed	5.9% vs 4.1% (p = NS)
Urinary infection					
Correia et al. [47]	2003	Brazil	709	General/mixed	3.7% vs 1.9% (p = NS)
Wound infection					
Correia et al. [47]	2003	Brazil	709	General/mixed	1.7% vs 2.1% (p = NS)
Intra-abdominal abscess					
Correia et al. [47]	2003	Brazil	709	General/mixed	2.1% vs 0.4% (p < 0.01)
Sepsis					
Perman et al. [44]	2000	Argentina	1000	General/mixed	9.9% vs 3.2%; OR 2.67 (95% CI 1.07–6.69; p < 0.05) [e]
					17.8% vs 3.2%; OR 4.03 (95% CI 1.41–11.54; p < 0.05) [f]
Correia et al. [47]	2003	Brazil	709	General/mixed	3.7% vs 1.1% (p < 0.01)
Pneumonia					
Perman et al. [44]	2000	Argentina	1000	General mixed	20.0% vs 6.3%; OR 3.02 (95% CI 1.53–5.97; p < 0.05) [e]
					21.4% vs 6.3%; OR 2.76 (95% CI 1.16–6.56; p < 0.05) [f]
Cardiac arrest					
Correia et al. [47]	2003	Brazil	709	General/mixed	5.8% vs 1.5% (p < 0.01)
Cardiac arrhythmia					
Correia et al. [47]	2003	Brazil	709	General/mixed	2.1% vs 1.5% (p = NS)
Cardiac failure					
Correia et al. [47]	2003	Brazil	709	General/mixed	2.5% vs 0.6% (p < 0.01)
Respiratory failure					
Correia et al. [47]	2003	Brazil	709	General/mixed	6.2% vs 1.3% (p < 0.01)
Wound dehiscence					
Perman et al. [44]	2000	Argentina	1000	General/mixed	2.9% vs 1.8%; OR 1.73 (95% CI 0.33–8.93; p = NS) [e]
					10.7% vs 1.8%; OR 6.93 (95% CI 1.23–38.96; p < 0.05) [f]
Correia et al. [47]	2003	Brazil	709	General/mixed	0.4% vs. 1.7% (p = NS)
Pressure ulcer					
Perman et al. [44]	2000	Argentina	1000	General/mixed	8.8% vs 2.7%; OR 2.29 (95% CI 0.83–6.28; p = NS) [e]
					12.5% vs 2.7%; OR 2.95 (95% CI 0.89–9.68; p = NS) [f]
Brito et al. [53]	2013	Brazil	417	General/mixed	OR 10.46 (95% CI 3.25–33.69; p < 0.05)
Length of stay [g]					
Perman et al. [44]	2000	Argentina	1000	General/mixed	19 d (11–47), 18 d (8–32), 9 d (5–17); p < 0·0001 [h]
Waitzberg et al. [46]	2001	Brazil	4000	General/mixed	30.0 ± 62.9 d, 23.3 ± 73.3 d, 12.9 ± 38.0 d (p < 0.05) [h]
Correia et al. [47]	2003	Brazil	709	General/mixed	16.7 ± 24.5 d vs 10.1 ± 11.7 d
Bicudo-Salomao et al. [80]	2006	Brazil	1912	Surgery	8 d (1–75) vs 4 d (1–44), p < 0.05 [b]
					7 d (1–41) vs 6 d (1–75), p = NS [c]
Fuchs et al. [67]	2008	Mexico	561	General/mixed	11.5 ± 15.2 d vs. 8.0 ± 11.9 d (p = 0.02)
Leandro-Mehri [74]	2011	Brazil	350	Surgery	10.1 ± 8.7 d vs 5.7 ± 5.8 d (p = 0.0005)
Ordonez et al. [55]	2013	Brazil	396	Internal medicine	14.5 d (2–76), 13.0 d (2–52), 9.0 d (1–30); p = 0.001 [h]
Garcia et al. [79]	2013	Brazil	565	Surgery	12 d (6–22), 6.5 d (3–13.5), 3 d (2–6); p < 0.001 [i]
Re-admission (ICU)					
Fontes et al. [87]	2014	Brazil	185	Critically ill (ICU)	OR 2.27 (95% CI 1.08–4.80; p < 0.05)
Reoperation					
Bicudo-Salomao et al. [80]	2006	Brazil	1912	Surgery	6.9% vs 3.9%; (p = 0.35) [b]
					10.5% vs 2.2%; OR 5.1 (95% CI 1.45–17.91; p < 0.05) [c]
Mortality					
Perman et al. [44]	2000	Argentina	1000	General/mixed	9.9% vs 2.3%; OR 2.51 (95% CI 0.83–7.59; p = NS) [e]
					23.2% vs 2.3%; OR 7.69 (95% CI 2.35–25.19; p < 0.05) [f]
Correia et al. [47]	2003	Brazil	709	General/mixed	12.4% vs 4.7%; OR 1.87 (95% CI 1.01–3.43; p < 0.05)
Bicudo-Salomao et al. [80]	2006	Brazil	1912	Surgery	6.9% vs 3.1% (p = 0.27) [b]
					6.6% vs 3.8% (p = 0.42) [c]
Pasquini et al. [52]	2012	Brazil	109	IM, ID, oncology	33.3% vs 4.1% (OR 3.03; p = 0.001)
Ordonez et al. [55]	2013	Brazil	396	Internal medicine	10.1%, 4.6%, 2.1% (p = 0.02) [h]
Garcia et al. [79]	2013	Brazil	565	Surgery	12.8%, 4.1%, 0.0% (p < 0.001) [i]
Fontes et al. [87]	2014	Brazil	185	Critically ill (ICU)	OR 8.12 (95% CI 2.94–22.42; p < 0.05)

Abbreviations: BMI = body mass index; 95% CI = 95% confidence interval; ICU = intensive care unit; ID = infectious disease; IM = internal medicine; OR = odds ratio; RR = relative risk; SD = standard deviation.

[a] Malnourished versus well nourished, unless otherwise noted.
[b] BMI ≤ 18.5 kg/m^2 versus >18.5 kg/m^2.
[c] BMI ≤ 24 kg/m^2 versus >24 kg/m^2.
[d] Postoperative pulmonary complications (atelectasis, tracheobronchitis, pneumonia).
[e] Moderately malnourished versus well nourished.
[f] Severely malnourished versus well nourished.
[g] Expressed as mean ± SD, [46,47,67,74] median (range), [44,55,80] or median (interquartile range) [79].
[h] Severely malnourished, moderately malnourished, and well nourished, respectively.
[i] High risk, medium risk, and low risk of malnutrition, respectively.

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and ascertainment methods precluded formal quantitative analysis of data from the included studies, examination of the results yielded several broadly generalizable observations regarding the prevalence and consequences of disease-related malnutrition in Latin American countries, which may also apply to other emerging countries.

First, disease-related malnutrition is highly prevalent among hospitalised patients in Latin America. Prevalence at the time of admission was consistently in the range of 40%–60%, with a higher prevalence observed in patients who were older adults, critically ill, or undergoing certain surgical procedures. Additionally, while the range of the reported prevalence of malnutrition in Latin American studies encompassed the range reported in studies in other regions, the upper limit of the range was higher in the Latin American studies compared with studies of comparable design from other parts of the world, including Europe [16,21–25], Asia [8,14,15], North America [34,35], and Australia [36,38,39]. Only three studies evaluating malnutrition in a general or mixed population in other regions during the 20-year period covered by the present review reported a prevalence of more than 50% [34,109,110]; of these, one reported a prevalence of 56.6% on day 12 following admission [34], and one reported a prevalence of 58.5% based on the MNA, but only 31.5%–35.3% using other instruments such as SGA, NRS-2002, and MUST [109]. In contrast, 11 of the 29 studies in a general or mixed population in Latin America reported a prevalence of more than 50%, with 6 studies reporting a prevalence of more than 60%.

Second, the prevalence of malnutrition increases significantly during the course of hospitalisation. Five studies in this systematic review showed an association between the prevalence of malnutrition and the length of hospital stay, including two studies that reported a prevalence of more than 80% among patients with a length of stay of at least 2 weeks. To our knowledge, only two other studies outside of Latin America have evaluated changes in the prevalence of malnutrition during the course of hospitalisation. Pichard and colleagues reported that malnutrition was present in 37% of patients within the first 48 h following admission and 55.6% of patients who were hospitalised more than 12 days [34], and Liang et al. [15] reported a significant increase in the prevalence of malnutrition between admission and discharge in a Chinese teaching hospital. It remains unknown whether the observed increase in the prevalence of malnutrition in patients with a longer duration of hospitalisation reflects more severe underlying disease in this population or whether the increased length of stay is the result of complications due to malnutrition. However, studies in ICU patients have demonstrated that energy deficits accumulate rapidly during the first week of hospitalisation and negative energy balance is associated with the occurrence of clinical complications [111,112]. Collectively, these findings underscore the vital importance of nutritional awareness and early therapeutic intervention, as well as the need for a high clinical index of suspicion in patients with longer durations of hospitalisation. Additionally, the positive association between the prevalence of malnutrition and length of hospital stay draws attention to an important consideration in the interpretation of data from epidemiologic studies, as the reported prevalence is likely to be higher in studies that assess nutritional status at the time of discharge or at any time during hospitalisation compared with those that measure prevalence at the time of admission.

Third, consistent with prior studies in developed countries [31,32,113–118], disease-related malnutrition was associated with significant adverse clinical consequences, including an increased risk of infectious and non-infectious complications, more frequent re-admission to the ICU, and increased mortality. Complications from malnutrition were associated with a longer duration of hospitalisation and a corresponding increase in the cost of care. While we identified only one study that formally evaluated the costs associated with disease-related malnutrition, the reported increase of 61%–309% is generally consistent with findings from other parts of the world [7,117–119]. Of note, a previous economic modelling analysis reported that the total combined cost of providing parenteral and/or enteral nutrition to each malnourished patient in Brazilian hospitals would represent only 0.33% of hospitalisation costs and 0.14% of total national healthcare expenditures [120]. Additionally, the authors estimated that every dollar invested in nutritional interventions would result in a savings of four dollars in total healthcare costs due to reductions in clinical complications and length of hospitalisation. While further study is necessary to fully elucidate the economic consequences of disease-related malnutrition in Latin American countries, the results of the cost study included in this review has potentially important implications for national healthcare policy—a 61% increase in the daily cost of care for each malnourished patient coupled with a prevalence of approximately 50% represents a staggering economic burden. In a region characterised by limited healthcare resources, such burden calls for robust and sustained efforts to identify and implement policies aimed at improved nutrition care.

Finally, despite the high prevalence and adverse clinical consequences of disease-related malnutrition, medical awareness and intervention is remarkably low. Fewer than one in five malnourished patients in one Brazilian study had a coded diagnosis of malnutrition in their medical record [52], and three separate studies showed that fewer than one in 10 malnourished patients received nutritional therapy [46–48]. Potential causative factors for the lack of awareness and appropriate therapeutic intervention include the absence of formal nutritional education in graduate and post-graduate medical training programmes, the lack of formal screening policies, and unfavourable reimbursement circumstances. Further investigation is needed to identify the chief contributors to the lack of awareness and effective medical intervention.

Several limitations to our study should be noted. First, substantial heterogeneity in patient populations and analytic methods precluded meta-analysis of prevalence data from the included studies; therefore, we were unable to derive precise estimates with corresponding confidence intervals. Second, while several studies demonstrated statistically significant relationships between malnutrition and adverse clinical outcomes, the cross-sectional design of the studies did not permit assessment of cause and effect. Accordingly, these findings should be interpreted in the limited context of associations. Third, most of the studies included in the review were susceptible to bias due to sampling methods or incomplete reporting. Finally, only one of the included studies evaluated the costs associated with disease-related malnutrition; the degree to which the findings are generalizable to other countries is unknown.

In conclusion, this systematic review shows that disease-related malnutrition is a highly prevalent condition that appears to impose a substantial health and economic burden on the countries of Latin America. Further research is urgently needed to characterise screening practices and identify practical evidence-based solutions to this persistent and costly challenge to health care systems, a still currently worldwide problem.

Conflict of Interest

Each author has submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest. Dr. Perman reports honoraria for lectures on parenteral nutrition from Fresenius Kabi Argentina. Dr. Correia reports honoraria for lectures on nutrition therapy from Abbott Nutrition, Baxter Nutrition, Fresenius Kabi and Nestlé. She also reports being part of one Advisory Board for Abbott. Dr.

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Waitzberg reports honoraria for lectures on nutrition therapy from Abbott, Danone, Fresenius and Nestlé.

Contributors

The study was sponsored by Fresenius Kabi. The sponsor participated in the design of the search protocol and analysis of the data. After article retrieval and data extraction, the sponsor analysed and maintained the data. MITDC, MIP, and DLW participated in protocol design and data analysis. Furthermore, MITDC, MIP and DLW were responsible for reporting of the results. All authors had full access to data and took responsibility for the integrity of the data and the accuracy of the data analysis.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.clnu.2016.06.025.

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