



RESEARCH ARTICLE

EPIDEMIOLOGICAL ASPECT OF POSTOPERATIVE GASTROINTESTINAL NUTRITIONAL DEFICIENCY IN NGAOUNDERE HOSPITALS, ADAMAWA REGION, CAMEROON

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Abstract

Background and objective: Undernutrition is defined as an insufficient intake of nutritional foods. The aim of this study was to evaluate the epidemiological aspect of postoperative gastrointestinal nutritional deficiency in Ngaoundere Hospitals.

Methods: It was a prospective, cross-sectional study with an analytical focus, over a 5-month period from July to November 2022. Undernutrition was defined by the presence of at least one phenotypic criteria plus one etiological criteria. Logistic regression for multivariate analyses, and the Chi-square test for univariate analyses, were used to identify the determinants of undernutrition. A difference was considered significant if $p < 0.05$.

Results: A total of 134 patients were included in the current study. Males were the most represented, with rates of 82.09%. The average age of patients was 36 ± 17.78 . Undernutrition at discharge was observed in 110 patients (82.09%). Endogenous risk factors associated with the occurrence of undernutrition were: Muslim religion, persistent symptoms, emergency surgery modality, nutritional grades, postoperative nausea, and diarrhea ($p < 0.0001$); the protective one was minor surgery ($p < 0.0001$). Exogenous risk factors for undernutrition included failure to meet carbohydrate, protein, and calorie targets on day-3 and at discharge ($p < 0.0001$). Finally, in multivariate analysis, persistent symptoms ($p = 0.02$), minor surgery ($p = 0.04$), presence of diarrhea ($p = 0.01$), and failure to meet caloric targets were independently associated with undernutrition at discharge.

Conclusion: The incidence of post-digestive surgery undernutrition is relatively high in the 2 hospitals in Adamawa, Cameroon. It, therefore, requires early detection and management.

Keywords: Gastrointestinal nutritional deficiency, knowledge and practices, Ngaoundere Hospitals, postoperation, refeeding, undernutrition.

INTRODUCTION

Undernutrition is defined as a deficiency in energy and/or protein intake in relation to the body's needs and together with obesity constitutes a double health burden in developing countries, affecting mainly children, but also adults¹. Worldwide, one person in ten suffers from malnutrition, with an estimated prevalence of 9.9% in 2020². In Africa, the prevalence of malnutrition is estimated at 21.0% in 2020². In Cameroon, a study of 19-year-olds in the cities of Yaounde, Douala, and Bandjoun found a 2.1% prevalence of undernutrition³. In healthcare settings, undernutrition among hospitalized patients is in the

order of 15% to 60%, depending on the type of admission⁴. 40 to 50% of surgical patients are undernourished, and this tends to worsen during hospitalization⁵. A 46.67% rate of undernutrition was found in postoperative gastrointestinal surgery patients in Benin (Cotonou)^{6,7}. In Cameroon, very few studies have addressed the problem of undernutrition in surgical gastrointestinal disorders. The nutritional risks of a surgical procedure are linked to the patient's condition, the presence of pre-existing undernutrition, the nutritional consequences of the surgical procedure itself due to the anatomical and/or functional modifications of the digestive tract that it entails, including intestinal resections, total gastrectomies, and

the occurrence of postoperative complications such as infections⁸. The postoperative period is the most critical, as the patient is subjected to both an inflammatory and endocrine response secondary to surgery; increased catabolism, and anorexia, the intensity and duration of which are proportional to the severity of the surgical procedure^{6,7}. Indeed, undernutrition alone constitutes a factor of postoperative complication, delayed healing, longer hospital stay, and even postoperative mortality⁹, and therefore deserves study interest, especially in developing countries, notably Cameroon, where postoperative food monitoring is limited. The aim of this study was to take stock of the epidemiological aspect of postoperative gastrointestinal nutritional deficiency in Ngaoundere Hospitals.

MATERIALS AND METHODS

A total of 134 patients, were collected 100 from Ngaoundere Patience Clinic and 34 from Ngaoundere Regional Hospital; 255 patients' attendants, 15 of whom were lost to follow-up¹⁰.

Type, period, and setting of study

We carried out a prospective, cross-sectional study with an analytical focus. It was carried out in the Ngaoundere Patience Clinic and Regional Hospital in the Region of Adamawa, Cameroon, and covered a period of five (5) months, from June to November 2022¹⁰.

Study population

The study population consisted of postoperative patients in the surgical departments of two hospitals.

Selection Criteria

Inclusion criteria

Included in the current study were all patients undergoing emergency or scheduled surgery for a gastrointestinal disease during the study period, from admission to discharge, and who had given their consent.

Exclusion criteria

Not included in the current study were patients who underwent surgery for a gastrointestinal disease but died before discharge and patients who were malnourished before surgery.

Studied variables

Sociodemographic variables: structure, age, gender, occupation, religion, marital status,

Phenotypic or anthropometric variables: percentage of weight loss, BMI, percentage of muscle wasting, etc. Etiological variables: food intake $\leq 50\%$ for 1 week, reduced absorption (malabsorption/maldigestion), aggression (inflammatory disease, surgery). Nutritional variables: caloric targets, carbohydrate targets, protein targets, lipid targets on day-3 and at discharge; nutritional status. Clinical variables: Comorbidity (>70 years; HIV⁺; diabetes; inflammatory syndrome; major surgical history; persistent symptoms (nausea, vomiting, early satiety, pain, dyspnoea, diarrhea)); surgical morbidity and mortality (surgical modality; type of surgical procedure); length of stay; prolonged young postoperative period.

Methodological approach to defining the state of undernutrition

The diagnosis was made on the basis of the presence of at least one of the etiological criteria plus one of the phenotypic criteria¹¹.

- Phenotypic criteria or anthropometrics were assessed preoperatively and at discharge and are noted on the questionnaire sheet that also served as our follow-up.

- ✓ Calculation of the weight curve: the patient's weight was recorded on a scale. We then applied the equation-

$$\text{Weight loss (\%)} = \frac{\text{Ideal weight} - \text{current weight}}{\text{Ideal weight}} \times 100$$

Weight loss was observed. If they are $\geq 2\%$ over a week, then it is considered a phenotypic criterion of undernutrition for those who have been hospitalized for at least 7 days, or those whose disease symptoms date back to at least 7 days preoperatively.

- ✓ BMI calculation: after measuring height with a measuring tape, weight is divided by the square of the height.

If it is < 3 percentile curve IOTF (International Obesity Task Force) (<18 years) or $\leq 18 \text{ kg/m}^2$ ([18-70] years) or $< 21 \text{ kg/m}^2$ (>70 years); it is considered phenotypic criteria of undernutrition and the severity or state of cachexia will increase as one moves further away from these values.

- ✓ Muscle wasting by measuring the brachial perimeter with the Shakir bracelet.
- Etiological criteria were represented by 3 sets of elements which are food intake $\leq 50\%$ of daily intake for 1 week; reduced absorption (malabsorption/maldigestion), and aggression (inflammatory syndrome, surgery, etc.).

Factors favoring the onset of undernutrition in postoperative patients are endogenous or clinical factors of undernutrition and exogenous factors

- Endogenous or clinical factors of undernutrition

In the pre-and intraoperative periods, we can mention 3 elements: preoperative comorbidities (recorded in the patient's file and noted on the patient's chart), the existence of preoperative undernutrition (evaluated using etiological and phenotypic criteria), and morbidity of surgery (if major or emergency).

This is in order to classify the risk of undernutrition in nutritional grade¹² to see the failure to initiate feeding with the grades either: Grade I (not undernourished, surgery not at risk of mortality, no comorbidities), Grade II (not malnourished, at least one comorbidity, or surgery at risk of mortality), Grade III (undernourished, surgery not at risk of mortality), and Grade IV (undernourished, surgery at risk of mortality).

In the postoperative period, we have 5 sets of elements that come into play, namely: symptoms accentuating undernutrition (recorded in the patient's file), prolonged postoperative fasting (assessed at discharge), length of stay, and non-initiation of nutrition (post-operative supplementary feeding of Grade I and II patients: if the

risk of intake < 60% (after 7 days) or Grade III and IV (24h post-operatively).

- Exogenous risk factors: reaching dietary targets

Data was taken from the from a previous study on the same patients¹⁰. Setting caloric-glucidic-lipidic-protein targets above 15 kcal/kg/day-2.25 g/kg/day- 0.5 g/kg/day- 0.5 g/kg/day for day-3 and 25 kcal/kg/day-3.75 g/kg/day- 0.8 g/kg/day-1.2 g/kg/day at discharge (after 7 days).

Ethical considerations

The experimental procedures used in this study were approved by authorization of the Department of Biomedical Sciences of the Faculty of Sciences of the University of Ngaoundere N° 022/1002/UN/R/DFS/CD-SBM from May 19, 2022. The Ngaoundere Regional Hospital and Patience Clinic, and authorization was obtained from the Regional Delegation of the Ministry of Health N° 598 AR/RA/DSP/BEP/NGE from July 15, 2022, to recruit participants for this study¹⁰.

Statistical analysis

Sphinx PlusV5 software was used to draw up the survey questionnaires; Microsoft Excel 2016 was used to collect responses and calculate phenotypic factors such as BMI in order to classify them into BMI classes according to age group, and to draw up graphs; finally, XLSAT 2016 software was used for statistical analysis, with Chi² and Fisher's exact statistical tests used to compare proportions, and logistic regression to search for determinants in multivariate analysis. $p < 0.05$ were considered statistically significant.

Study limitations

The period of three (3) days given for the study did not allow us to collect data from all hospitals in the Far North. Complementary analyses like Bioelectrical Impedance Analysis of the hospital entrance and discharge are indicators of undernutrition, which will enable us to determine body composition.

RESULTS

Males predominated, at 82.09%. The most represented age group was [18-70 years], at 73.35% (105). 62.68% (84) were married and 65.67% (88) were Muslim. Persistent symptoms were most associated with comorbidities (77.61%); 6/134 (4.51%) patients were

HIV-positive, 5/134 (3.73%) hypertensive, and 4 diabetics; 3/134 (2.23%) patients had undergone colostomy; 5/134 (3.73%) were elderly (>70 years), 16.42% of patients were received cold (scheduled) and 83.58% in emergency, 71.64% underwent minor surgery, and 7.46% of patients were undernourished. 74.63% of patients suffered from post-operative pain; 50% from nausea; 35.82% from diarrhea and 29.10% from anorexia. The average length of stay was 8 days, with an average postoperative fasting period of 6 days.

The majority of patients had not reached their caloric-carbohydrate-lipid-protein targets set at 15 kcal/kg/day-2.25 g/kg/day-0.5 g/kg/day-0.5 g/kg/day for day-3 and 25 kcal/kg/day-3.75 g/kg/day-0.8 g/kg/day-1.2 g/kg/day for discharge. Thus only 25.37%; 29.10%; 11.19%; and 20.90% respectively for caloric, carbohydrates, lipids, and protein targets at day-3 and 24.63%; 30.60%; 11.94%; 19.90% respectively for caloric, carbohydrates, lipids, and protein targets at discharge were achieved (Table 1).

Etiological and phenotypic criteria and incidence of undernutrition at discharge in surgical patients according to HAS classification

For etiological criteria at discharge, 100% of patients were assaulted, 70/134(52.23%) had reduced absorption and 45/73(61.64%) patients who had done at least 7 days had a food intake $\leq 50\%$. For phenotypic criteria, at discharge 5/19(26.31%) in the age <18 years group had a BMI class < 3 percentile IOTF (International Obesity Task Force) curve; 31/105(29.52%) in the [18-70 years] group had a BMI <18.5, and 8/10(80%) in the age>70 years group had a BMI <21, at a total of 44/134(32.83%) had a BMI below normal; 53/73(72.60%) had lost more than 2% of their body mass in 1 week, and 25/134(18.65%) had muscle wasting (Table 2). Taking into account that to be classified as malnourished, at least one etiological criterion plus one phenotypic criterion should be present, it was achieved an incidence of 82.09% (110/134) at discharge. Figure 1A illustrates the incidence of undernutrition at discharge.

Assessment of the risk of postoperative undernutrition

Figure 1B shows that we classified 21.64% as Grade I, 78.36% as Grade II.

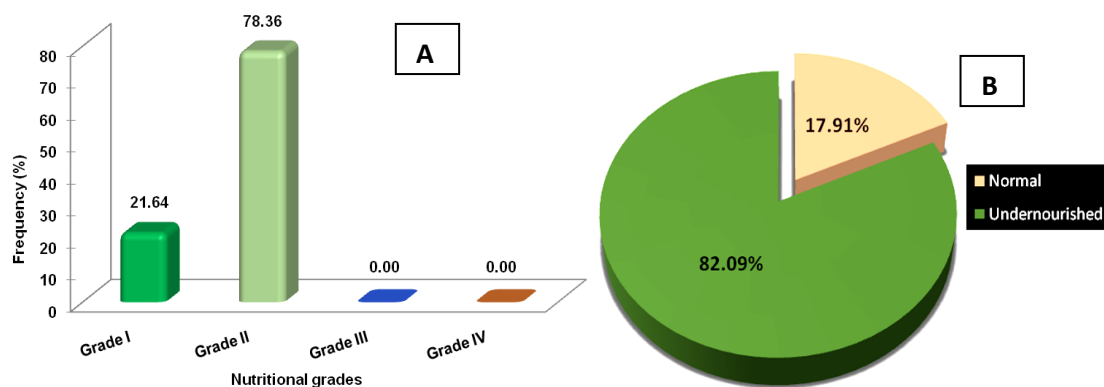


Figure 1: A: Distribution of patients by nutritional grade and B: incidence of undernutrition at discharge.

Table 1: General characteristics.

Variables	Effective (N)	Frequency (%)	Variables	Effective (N)	Frequency (%)
Sociodemographic parameters			Postoperative parameters		
Structure			Nausea		
NPC	100	74.63	Absent	67	50.00
NRH	34	25.37	Present	67	50.00
Gender			Pain		
Male	110	82.09	Absent	34	25.37
Female	24	17.91	Present	100	74.63
Age range (years)			Anorexia		
< 18	19	14.18	Absent	95	70.90
[18-70]	105	78.36	Present	39	29.10
> 70	10	7.46	Diarrhea		
Age (year)			Absent	108	64.18
Average, SD	36 +/- 17.78		Present	48	35.82
Religion			Target carbohydrates on day-3		
Animist	5	3.73	Reach	39	29.1
Christian	41	30.59	Not reach	95	70.9
Muslim	88	65.67	Target Lipids on day-3		
Matrimonial status			Reach	15	11.2
Unmarried	50	37.31	Not reach	119	88.8
Married	84	62.68	Target Protein on day-3		
Preoperative parameters			Reach	28	20.90
Comorbidities			Not reach	106	79.10
HIV			Target calories on day-3		
No	128	95.52	Reach	34	25.37
Yes	6	4.48	Not reach	100	74.63
High blood pressure			Target carbohydrates at discharge		
No	129	96.27	Reach	41	30.60
Yes	5	3.73	Not reach	93	69.40
No	129	96.27	Target Lipids at discharge		
Diabetes			Reach	16	11.94
No	130	97.01	Not reach	118	88.06
Yes	4	2.99	Target Protein at discharge		
History of small bowel resection			Reach	28	20.90
No	129	96.27	Not reach	106	79.10
Yes	5	3.73	Target calories at discharge		
History of colectomy			Reach	33	24.63
No	132	98.51	Not reach	101	75.37
Yes	2	1.49	History of pancreatectomy		
No	132	98.51	No	132	98.51
Yes	2	1.49	Yes	2	1.49
Age > 70 years			Age > 70 years		
No	129	96.27	No	129	96.27
Yes	5	3.73	Yes	5	3.73
Persistent preoperative symptoms			Persistent preoperative symptoms		
Absent	30	22.39	Absent	30	22.39
Present	104	77.61	Present	104	77.61
Morbi mortality			Morbi mortality		
Modality of surgery			Modality of surgery		
Emergency	112	83.58	Emergency	112	83.58
Scheduled	22	16.41	Scheduled	22	16.41
Type of surgery			Type of surgery		
Major	39	29.1	Major	39	29.1
Minor	95	70.9	Minor	95	70.9

Postoperative stay varies from [3-12] days with an average of 8 days; Average fasting duration 6 days with extremes [1- 10] days and 7 days in undernourished patients; N: Effective; SD: Standard deviation; NPC:Ngaoundere Patience Clinic; HRN: Ngaoundere Regional Hospital;HIV: Human Immunodeficiency Virus; Persistent symptoms: nausea, vomiting, early satiety, pain, dyspnoea, diarrhea.

Determinants of undernutrition

Univariate analysis of factors associated with undernutrition

The characteristics of 110 subjects with undernutrition at discharge were compared with those of 24 subjects with normal nutritional status. Univariate analyses of factors associated with undernutrition are presented in Table 3. Nutritional status at discharge was highly

dependent on religion for sociodemographic parameters; persistent preoperative symptoms, surgical modality, type of surgical procedure, and nutritional grade for preoperative and intraoperative determinants; nausea, and diarrhea for postoperative determinants; and caloric, carbohydrates, and protein targets on day-3 and at discharge for exogenous factors.

Table 2: Etiological and phenotypic criteria and incidence of undernutrition at discharge in surgical patients.

Variables	Effective (N)	Frequency (%)	Variables	Effective (N)	Frequency (%)
Etiological criteria			BMI class those >70 years (N=10)		
Food intake ≤ 50% For 1 week			< 21	8	80.0
Not reach	61	45.52	≥ 21	2	20.0
Reach	73	54.47	Weight loss within 1 week		
No	30	22.39	Not reach	61	45.52
Yes	43	32.09	Reach	73	54.47
Reduced absorption (malabsorption/maldigestion)			> 2% lost within 1 week	53	72.60
No	64	47.76	Melting muscles		
Yes	70	52.24	No	109	81.34
Aggression			Yes	25	18.65
No	0	0.0	Denutrition at least one etiological criteria + one phenotypic criteria		
Yes	134	100	Nutritional state		
Phenotypic criteria			Normal	24	17.91
BMI class those < 18 years (N=19)			Undernourished	110	82.09
< 3 percentile IOTF curve	5	26.31			
[3-97] percentile IOTF curve	14	73.68			
≥ 97 percentile IOTF curve	0	0.0			
BMI class those [18-70] years (N=105)					
<18.5	32	29.52			
[18.5-24.9]	59	56.19			
[25-29.9]	14	13.33			

N: Effective, %: percentage, BMI: Body Mass Index, IOTF: International Obesity Task Force

Table 3: Univariate analyses of factors associated with undernutrition.

Variables	Nutritional status at discharge		OR adjusted	CI-95%	p-Value
	Normal	Undernourished			
Sociodemographic parameters					
Gender					
Male	17	93	1	Reference	-
Female	7	17	0.44	0.16 - 1.2	0.112
Age range (years)					
< 18	5	14	0.7	0.12 - 3.90	0.7
[18-70]	17	88	1.29	0.28 - 5.8	0.562
> 70	2	8	1	Reference	-
Religion					
Animist	5	0	0.0	/	< 0.0001*
Christian	10	31	0.35	0.13 - 0.93	0.023*
Muslim	9	79	1	Reference	-
Matrimonial status					
Unmarried	5	45	1	Reference	-
Married	19	65	0.380	0.05 - 0.13	0.065
Comorbidities and other endogenous determinants pre- and per-operatively					
HIV					
No	23	105	1	Reference	-
Yes	1	5	1.095	0.17 - 7.03	0.9
Hypertension					
No	24	105	/	/	
Yes	0	5	/	/	0.287
Diabetes					
No	24	106	/	/	
Yes	0	4	/	/	0.3
History of small bowel resection					
No	24	105	/	/	
Yes	0	5	/	/	0.28
History of colectomy					
No	24	108	/	/	
Yes	0	2	/	/	0.52
History of pancreatectomy					
No	24	108	/	/	
Yes	0	2	/	/	0.50

Variables	Nutritional status at discharge		OR adjusted	CI-95%	p-Value
	Normal	Undernourished			
Age >70 years					
No	22	107	1	Reference	-
Yes	2	3	0.308	0.057 - 1.66	0.189
Persistent preoperative symptoms					
Absent	13	17	1	Reference	-
Present	11	93	6.465	2.53 - 16.51	< 0.0001*
Modality of Surgery					
Emergency	10	102	1	Reference	-
Scheduled	14	8	0.056	0.019 - 0.16	< 0.0001*
Type of surgery					
Major	1	38	1	Reference	-
Minor	23	72	0.082	0.015 - 0.44	< 0.0001*
Grade					
Grade I	14	15	1	Reference	-
Grade II	10	95	12.18	4.36 - 33.78	< 0.0001*
Grade III	0	0	/	/	
Grade IV	0	0	/	/	
Postoperative symptoms					
Nausea					
Absent	22	45	0.06	0.016 - 0.24	< 0.0001*
Present	2	65	1	Reference	
Pain					
Absent	7	27	0.790	0.3 - 2.05	0.63
Present	17	83	1	Reference	-
Anorexia					
Absent	19	76	0.588	0.2 - 1.6	0.32
Present	5	34	1	Reference	-
Vomiting					
Absent	24	109	0	/	0.63
Present	0	1	1	Reference	-
Diarrhea					
Absent	22	64	0.12	0.032 - 0.49	0.002*
Present	2	46	1	Reference	-
Exogenous determinants					
Target carbohydrates on day-3					
Reached	18	21	0.079	0.029 - 0.21	< 0.0001*
Not reached	6	89	1	Reference	-
Target Lipids on day-3					
Reached	5	10	0.38	0.12 - 1.18	0.098
Not reached	19	100	1	Reference	-
Target protein on day-3					
Reached	13	15	0.134	0.05 - 0.34	< 0.0001*
Not reached	11	95	1	Reference	-
Target calories on day-3					
Reached	17	17	0.07	0.02 - 0.204	< 0.0001*
Not reached	7	93	1	Reference	-
Target carbohydrates at discharge					
Reached	19	22	0.06	0.02 - 0.18	< 0.0001*
Not reached	5	88	1	Reference	-
Target Lipids at discharge					
Reached	5	11	0.42	0.13 - 1.30	0.13
Not reached	19	99	1	Reference	-
Target Protein at discharge					
Reached	13	15	0.13	0.05 - 0.34	< 0.0001*
Not reached	11	95	1	Reference	-
Target calories at discharge					
Reached	17	16	0.07	0.02 - 0.19	< 0.0001*
Not reached	7	94	1	Reference	-

N: Effective; HIV: Human Immunodeficiency Virus, *p-value<0.05 for chi² and Fisher's exact test; OR: Odds ratio; CI: Confidence Interval.

Thus, Christian patients were less likely to be malnourished at discharge than Muslims [adjusted *OR* (95% *CI*): 0.35 (0.13-0.93), *p*=0.023] and there was no risk of animists being malnourished at discharge

compared to Muslims [adjusted *OR*=0.0; *p*<0.0001]. Those with persistent preoperative symptoms were 6 times more likely to develop undernutrition at discharge than those without symptoms [adjusted *OR*

(95% CI): 6.4 (2.53-16.51), $p < 0.0001$]. Scheduled and minor surgery had a lower risk of undernutrition, respectively [adjusted OR (95% CI): 0.05 (0.019-0.16), $p < 0.0001$] and [adjusted OR (95% CI): 0.08 (0.015-0.44), $p < 0.0001$]. Undernutrition was 12 times more likely to occur in patients with nutritional grade II than in those with grade I [adjusted OR (95% CI): 12.18 (4.36-33.78), $p < 0.0001$]. Patients without nausea and diarrhea had a lower risk of undernutrition, respectively [adjusted OR (95% CI): 0.06 (0.016-0.24), $p < 0.0001$] and [adjusted OR (95% CI): 0.12 (0.032-0.49), $p = 0.002$]. 3.75 g/kg/day-1.2 g/kg/day for discharge had a lower risk of undernutrition, respectively [OR (95% CI): 0.07 (0.029-0.21), $p < 0.0001$] - [OR (95% CI): 0.12 (0.05-0.34), $p < 0.0001$] - [OR (95% CI): 0.07 (0.02-0.204), $p < 0.0001$] for day-3 and [OR (95% CI): 0.06 (0.023-0.189), $p < 0.0001$] for discharge. Finally, patients who had achieved their glucose-protein-caloric targets set at 15 kcal/kg/day-

2.25 g/kg/day-0.5 g/kg/day for day-3 and 25 kcal/kg/day.

Multivariate analysis of independent determinants of undernutrition

The independent determinants of undernutrition (Table 4), including persistent symptoms, type of surgery, postoperative diarrhea, and caloric target at discharge, remained significant. Those with persistent symptoms were 3 times more likely to be malnourished [adjusted OR (95% CI): 3.591 (0.101-128.1954.14), $p = 0.02$] than those without persistent symptoms; those with minor surgery were 0.2 times less likely to be malnourished [adjusted OR (95% CI): 0.2 (0.013-6.1), $p = 0.04$] than those operated on for major surgery; those with diarrhea were 8 times more likely to be undernourished [adjusted OR (95% CI): 8.2 (1.4 -47.89), $p = 0.04$]. Finally, patients who did not reach their caloric targets were 16 times more likely to be undernourished [adjusted OR (95% CI): 16.75 (3.16-76.720), $p = 0.001$] than those who did.

Table 4: Independent determinants of undernutrition.

Parameters		OR adjusted	(CI-95 %)	p-value
Religion	Animist	1	Reference	-
	Christian	1.7	0.025 - 118.58	0.84
	Muslim	5.56	0.1 - 298.1	0.34
Persistent symptoms	Absent	1	Reference	-
	Present	3.591	0.101 - 128.195	0.02*
Type of surgery	Major	1	Reference	-
	Minor	0.2	0.013 - 6.10	0.04*
Diarrhea	Absent	1	Reference	-
	Present	8.2	1.4 - 47.89	0.01*
Target calories at discharge	Reached	1	Reference	-
	Not reached	16.75	3.16 - 76.720	0.001*

OR: Odds ratios; CI: Confidence interval; * p -value <0.05 to logistic regression

DISCUSSION

General characteristics

The current study included 134 patients. The predominant gender was male with 82.09%. This may be explained by the fact that, during the current study period, the pathologies frequently encountered were strangulated and non-strangulated hernias, the latter affecting men. Obtained results are superior to the study conducted by Adébayo⁶ in Benin, which found that 57.78% of patients were male.

Preoperatively, we had no patients classified as Grade IV and III, or 0% compared with 21.64% and 78.36% for Grade I and II respectively. However, as the grade increases, so does the risk of malnutrition. This is justifiable, since we did not include malnourished patients preoperatively, and the nutritional grade classification depends on this parameter.

Postoperatively, there was a predominance of pain after the operation, at 74.63%, which is similar to the study by Adébayo⁶, who found a percentage of 77.78% of postoperative pain. This may be explained by the fact that significant surgical aggression in operated patients systematically leads to an inflammatory reaction, hence the pain.

Diagnosis of undernutrition

For etiological criteria, 100% of patients were assaulted. 70/134 (52.23%) had reduced absorption, and 45/73 (61.64%) with at least 7 days had food intake $\leq 50\%$. This may be explained by the fact that these were all post-surgeries, the predominant surgical technique was intestinal resection (33.96%), and the presence of postoperative digestive disorders (diarrhea, vomiting) hence the reduced absorption. With regard to phenotypic criteria, at discharge 44/134(32.83%) had a BMI below normal, or 5/19(26.31%) for BMI class < 3 percentile of the IOTF (International Obesity Task Force) curve, 31/105(29.52%) for BMI class < 18.5 kg/m² and 8/10(80%) for BMI class < 21 kg/m². Patients who lost more than 2% of their body mass in 1 week were 53/73(72.60%) and 25/134(18.65%) had muscle wasting. This is lower than those of Adébayo⁶, who found 46.67% of BMI class < 18.5 , and higher for weight loss, with 66.66% losing more than 2% body mass in the same study.

It was found, find that 82.09% of patients were malnourished at discharge. This is much higher than the study by Alassani⁷, which found 46.67% using BMI as the diagnostic method, the study by Vânia and José¹³ in Brazil, which found 15.98% using BMI as the diagnostic method, and the study by Yamamichi¹⁴

which found 26.3% postoperatively using subjective global assessment (SGA) as the diagnostic method. This high incidence could be explained by the fact that in the current study, for the diagnosis of undernutrition, we used the model recommended by the HAS, which associates the presence of an etiological criteria plus a phenotypic criterion, instead of using only BMI as done in some studies. This not only enabled us to broaden the current study by taking all age groups and the obese, in whom it is often difficult to assess undernutrition. (Incidence of 32.83% in the current study considering only the BMI phenotype).

Determinants of undernutrition

Exogenous factors

Patients tended to be undernourished when their carbohydrate, protein, and calorie targets were not met, with a p -value < 0.0001 reflecting the high significance of the link between calorie targets and undernutrition at discharge. This significance also persisted for the caloric objective factor at discharge when taken independently of the other determinants, with a 16-fold higher risk of being undernourished in patients who had not reached their caloric objectives [adjusted *OR* (95% *CI*): 16.75 (3.16-76.720), $p=0.001$]. This corroborates the study by Adébayo⁶ who found [adjusted *OR* (95% *CI*): 0.4 (0.26-0.75), $p=0.000$] taking low-calorie intake as the risk. This can be explained by the fact that, with reduced intake, the body draws on its reserves in addition to neoglucogenesis, resulting in a reduction in fat and muscle mass and hence undernutrition.

Demographic and endogenous factors

Muslims were more likely to be undernourished at discharge than patients of other religious persuasions, as most of our nurses were uneducated Muslims and were therefore not trained to manage the patient's diet according to the instructions provided by the nursing staff. Persistent symptoms, taken independently or in association with nutritional status, was a predictive factor of undernutrition $p<0.0001$ and [adjusted *OR* (95% *CI*): 3.591 (0.101-128.1), $p=0.02$]; this may be explained by the fact that these symptoms reduce caloric requirements by decreasing intake, which will potentiate the expenditure occasioned by the surgical assault. This differs from the study by Shim¹⁵ in Korea, which found comorbidities such as advanced age and laparotomy.

In terms of morbidity and mortality, patients undergoing emergency surgery were more undernourished ($p<0.0001$); this corroborates the study by Alassani⁷, who also found a significant predominance for the emergency surgery modality. This may be explained by the fact that emergency surgeries are performed within a short timeframe, resulting in a reduction in preoperative preparation such as the administration of nutritional supplements in patients at risk of postoperative undernutrition. In addition to surgical modality, the type of surgery also had an impact on nutritional status. Patients having undergone minor surgery, taken independently of other determinants, were less likely to be undernourished [adjusted *OR* (95% *CI*): 0.2 (0.013-6.1), $p=0.04$]. This can be explained by the fact that in major surgery,

intestinal resections are mostly performed (accounting for 33.93% of surgical techniques in our case) and cause malabsorption syndromes that potentiate caloric loss.

Nutritional grade also had a highly significant impact on nutritional status ($p<0.0001$). This is logical, since it reflects a patient's preoperative risk of developing undernutrition, and is constituted by taking into account preoperative nutritional status, morbidity/mortality, and comorbidities.

CONCLUSIONS

The incidence of nutritional deficiencies at hospital discharge is high in postoperative patients undergoing gastrointestinal surgery. Several determinants have an independent influence on the occurrence of undernutrition at hospital discharge, particularly internal risk factors represented by the persistence of comorbid symptoms; Postoperative diarrhea for postoperative symptoms. And an internal prophylactic agent in the form of a minor surgical procedure. Finally, external factors, such as failure to reach caloric goals associated with calorie debt, lead to nutritional deficiency at hospital discharge. Hence, it is necessary to train health care workers in nutrition concepts to alleviate this health problem.

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AUTHOR'S CONTRIBUTION

Sineche Ngunte R: methodology, writing. **Tsague MV:** methodology, writing, revision. **Nguimbou RM:** methodology, review. **Ngadjui Ngodjoum DR:** Analysis and interpretation of data. **Modjo GA:** statistical analysis. **Ze Minkande J:** study supervision. All authors revised the article and approved the final version.

DATA AVAILABILITY

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

CONFLICT OF INTEREST

No conflict of interest is associated with this work.

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