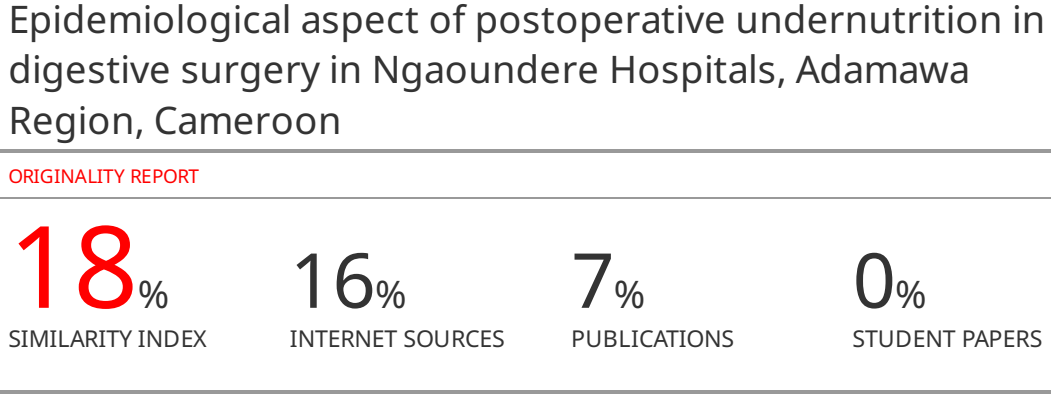
**Reviewer’s Comments**

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**Epidemiological aspect of postoperative undernutrition in digestive surgery in Ngaoundere Hospitals, Adamawa Region, Cameroon**

**Abstract**

Undernutrition is defined as a deficiency in energy and/or protein intake in relation to the body's needs. The aim of this study was to assess the epidemiological aspect of undernutrition in postoperative patients undergoing digestive surgery at Ngaoundere Hospital.

It was an observational, analytical, cross-sectional, prospective cohort study over a 5-month period from July to November 2022, focusing on postoperative digestive surgery patients. 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. A total of 134 patients were included in the 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. 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: Undernutrition, knowledge and practices, refeeding, postoperation, digestive surgery, Ngaoundere Hospitals

**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 adults[**1]**. Worldwide, one person in ten suffers from malnutrition, with an estimated prevalence of 9.9% in 2020 [**2]**. In Africa, the prevalence of malnutrition is estimated at 21.0% in 2020 [**2]**. In Cameroon, a study of 19-year-olds in the cities of Yaounde, Douala, and Bandjoun found a 2.1% prevalence of undernutrition[**3]**. In healthcare settings, undernutrition among hospitalized patients is in the order of 15% to 60%, depending on the type of admission[**4]**. 40 to 50% of surgical patients are undernourished, and this tends to worsen during hospitalization[**5]**.A 46.67% rate of undernutrition was found in postoperative visceral surgery patients at the Centre National Hospitalier et UniversitaireKoutoucou Hubert Maga, Cotonou[**6,7]**. In Cameroon, very few or no studies have addressed the problem of undernutrition in surgical inpatients. 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 infections [**8]**. 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 mortality [**9]**, 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 undernutrition in digestive surgery in the 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-up [**10]**.

**Type, period, and setting of study**

We carried out a cross-sectional, observational, analytical, and prospective cohort study. It was carried out in the Ngaoundere Patience Clinic and Ngaoundere Regional Hospital in the city of Ngaoundere in the Region of Adamawa Cameroon for a period of five (5) months, from June to November 2022[**10]**.

**Study population**

The study population consisted of postoperative patients in the post-surgery care department of the Ngaoundere hospitals

**Selection Criteria**

Included in our study were all patients undergoing emergency or scheduled surgery for a digestive disease during the study period, from admission to discharge, and who had given their consent. Not included in our study were patients who underwent surgery for a digestive 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 ≤ 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 (age >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 criteria [**11]**.

* 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 **(1).**

We find the weight loss. If they are ≥ 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 ≤ 18 kg/m2 ([18-70] years) or < 21 kg/m2 (>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 ≤ 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 morbi-mortality of surgery (if major or emergency).

This is in order to classify the risk of undernutrition in nutritional grade[**12]** 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 study by[**10]**on the same patients. Setting caloric-glucidic-lipidic-protein targets above 15kcal/kg/day-2.25g/kg/day-0.5g/kg/day-0.5g/kg/day for day-3 and 25kcal/kg/day-3.75g/kg/day-0.8g/kg/day-1.2g/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. Ngaoundere Regional Hospital and Ngaoundere 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 study[**10]**.

**Statistical analysis**

Sphinx Plus.V5 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**

Due to the short survey period, we were unable to visit all the hospitals in Ngaoundere. Complementary analysis such as 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], at 73.35% (105). 62.68% (84) were married and 65.67% (88) were Muslim. Persistent symptoms accounted for the majority of 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 (age>70 years), patients were seen cold (scheduled) in 16.42% of cases and emergency in 83.58%, underwent minor surgery in 71.64% of cases versus 28.36%, and patients were minority undernourished in 7.46% of cases versus 92.54% who were non-denourished. 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 15kcal/kg/day-2.25g/kg/day-0.5g/kg/day-0.5g/kg/day for day-3 and 25kcal/kg/day-3.75g/kg/day-0.8g/kg/day-1.2g/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 I**).

**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 ≤ 50%. For phenotypic criteria, at discharge 5/19(26.31%) in the <18 age group had a BMI class < 3 percentile IOTF (International Obesity Task Force) curve; 31/105(29.52%) in the [18-70] age group had a BMI <18.5, and 8/10(80%) in the >70 age group had a BMI <21, i.e. 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 II**). Taking into account that to be classified as malnourished, at least one etiological criterion plus one phenotypic criterion should be present, we 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, 21.64% as Grade I, and 78.36% as Grade II.

**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 III**.

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. Thus, Christian patients were less likely to be malnourished at discharge than Muslims [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 [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 [OR (95% CI): 6.4 (2.53-16.51), p < 0.0001]. Scheduled and minor surgery had a lower risk of undernutrition, respectively [OR (95% CI): 0.05 (0.019-0.16), p<0.0001] and [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 [OR (95% CI): 12.18 (4.36-33.78), p<0.0001]. Patients without nausea and diarrhea had a lower risk of undernutrition, respectively [OR (95% CI): 0.06 (0.016-0.24), p<0.0001] and [OR (95% CI): 0.12 (0.032-0.49), p=0.002]. Finally, patients who had achieved their glucose-protein-caloric targets set at 15kcal/kg/day-2.25g/kg/day-0.5g/kg/day for day-3 and 25kcal/kg/day-3.75g/kg/day-1.2g/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] - [OR (95% CI): 0.13 (0.05-0.34), p<0.0001] - [OR (95% CI): 0.07 (0.02-0.19), p<0.0001] for discharge.

**Multivariate analysis of independent determinants of undernutrition**

The independent determinants of undernutrition (**Table IV**), 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.

**Discussion**

**General characteristics**

Our study included 134 patients. The predominant gender was male with 82.09%. This can be explained by the fact that during our study period the majority (for patients), of pathologies encountered were strangulated and non-strangulated hernias and the latter affect men more than women. Our results are superior to the study conducted by Adébayo[**6]** in Benin who found 57.78% male predominance.

Preoperatively, we had no patients classified as Grade IV and III, or0% 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 Adébayo[**6]**, 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 ≤ 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 <18.5kg/m² and 8/10(80%) for BMI class<21kg/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 Adébayo[**6]**, 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.

We, therefore, find that 82.09% of patients were malnourished at discharge. This is much higher than the study by Alassani[**7]**, which found 46.67% using BMI as the diagnostic method, the study by Vânia and José[**13]**in Brazil, which found 15.98% using BMI as the diagnostic method, and the study by Yamamichi[**14]** 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 our study, for the diagnosis of undernutrition, we used the model recommended by the HAS, which associates the presence of an etiological criterion plus a phenotypic criterion, instead of using only BMI as done in some studies. This not only enabled us to broaden our study by taking all age groups and the obese, in whom it is often difficult to assess undernutrition. (Incidence of 32.83% in our 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 byAdébayo **[6]** 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 byShim[**15]**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 Alassani[**7]**, 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.

**Conclusion**

The incidence of undernutrition at discharge is high in postoperative patients undergoing digestive surgery. Several determinants have an independent impact on the occurrence of undernutrition at discharge, notably endogenous risk factors represented by persistent symptoms for comorbidities; postoperative diarrhea for postoperative symptoms; and an endogenous protective factor in the form of minor surgery. Finally, exogenous factors such as failure to reach caloric targets correlated with caloric debts are conducive to undernutrition at discharge. Hencea need to train healthcare staff in the concepts of nutrition to alleviate this health problem.

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**CONFLICT OF INTEREST**

No conflict of interest.

**AUTHOR’S CONTRIBUTION**

TsagueMarthe Valentine, Nguimbou Richard Marcel, SinecheNgunte Raoul: Methodology; Modjo Gabriel Archange, SinecheNgunte Raoul,Nguimbou Richard Marcel: Analysis and interpretation of data; SinecheNgunte Raoul, TsagueMarthe Valentine: Manuscript writing; Nguimbou Richard Marcel Critical revision; SinecheNgunte Raoul, Nguimbou Richard Marcel, NgadjuiNgodjoum Donald Roger: Statistical analysis; ZeMinkande Jacqueline: Study supervision

**Reference**

[1] Wu Y, Wang X, Gao F, Liao J, Zeng J, and Fan L. Mobile nutrition and health management platform for perioperative recovery: an interdisciplinary research achievement using WeChat Applet. Frontiers in Medicine (Lausanne). 2023;10:1201866. https://doi.org/10.3389/fmed.2023.1201866.

[2] FAO, ECA and AUC. Africa Regional Overview of Food Security and Nutrition 2019. Accra. 2020. https://doi.org/10.4060/CA7343EN.

[3] Pefura-Yone, E., Balkissou, A., Djenabou, A., Poka-Mayap, V, andKuaban, C**.** Prévalence et déterminants de la dénutrition au Cameroun. Revue Africaine de Medecine interne. 2018 ;5(1) : 22-27. http://www.rafmi.org/index.php/rafmi/article/download/237/79

[4] Uhl S, Siddique SM, Bloschichak A, McKeever W, D'Anci K, Leas B, Mull NK, Compher C, Lewis JD, Wu GD, and Tsou AY. Interventions for malnutrition in hospitalized adults: A systematic review and meta-analysis. Journal of Hospital Medicine. 2022; 17(7):556-564. https:// doi.org/10.1002/jhm.12891.

[5] DuránPoveda M, Suárez-de-la-Rica A, Cancer Minchot E, OcónBretón J, Sánchez Pernaute A, Rodríguez Caravaca G, and PREMAS Study Group. The Prevalence and Impact of Nutritional Risk and Malnutrition in Gastrointestinal Surgical Oncology Patients: A Prospective, Observational, Multicenter, and Exploratory Study. Nutrients. 2023; 15(14):3283. https://doi.org/10.3390/nu15143283.

[6]Adébayo C, Adrien M, Albert C, Gaspard D, Séraphin A, Francis M, and DelphinK. Frequency and determinants of postoperative undernutrition in visceral surgery at the Centre National Hospitalier and UniversitaireKoutoucou Hubert Maga, Cotonou. Pan African Medical journal. 2018; 29(1): 1-10. <https://doi.org/10.11604/pamj.2018.29.19.10805>.

[7] Alassani AC, Hodonou AM, Dovonou AC, Gbessi GD, Ahoui S, Dossou FM, and Mêhinto DK. Frequency and determinants of post-operative undernutrition in patients undergoing visceral surgery at the University Hospital Centre Koutoucou Hubert Maga, Cotonou. Pan African Medical Journal. 2018 ; 29:19. https://doi.org/10.11604/pamj.2018.29.19.10805.

[8] Loncar Y, Lefevre T, Nafteux L, Genser L, Manceau G, Lemoine L, Vaillant JC, and Eyraud D. Preoperative nutrition for severely malnourished patients in digestive surgery: A retrospective study. [Journal of Visceral Surgery](https://www.sciencedirect.com/journal/journal-of-visceral-surgery). 2020;[157(2](https://www.sciencedirect.com/journal/journal-of-visceral-surgery/vol/157/issue/2)): 107-111. https://doi.org/ 10.1016/j.jviscsurg.2019.07.007.

[9] Deenadayalan V, Olafimihan A, Ganesan V, Kumi D, and Zia M. Impact of protein-energy malnutrition on outcomes of patients with diffuse large B cell lymphoma admitted for inpatient chemotherapy. Proc (Bayl Univ Med Cent). 2023 ; 36(4):439-442. https://doi.org/ 10.1080/08998280.2023.2204285.

[10] Tsague MV, Nguimbou RM, NgahaDamndja W, SinecheNgunte R, Modjo GA, NgadjuiNgodjoum DR, ZeMinkande J. Evaluation of caloric intake, knowledge, and practices on postoperative refeeding in digestive surgery in Ngaoundere Hospitals, Adamawa Region, Cameroon. Universal Journal of Pharmaceutical Research 2023; 8(4):31-38. https://doi.org/10.22270/ujpr.v8i4.973

[11] HAS. Diagnosis of undernutrition in children and adults, Federation of French Nutrition. 2019. https://doi.org/10.1016/j.mmm.2022.07.004

[12] A'zim AZA, Zaid ZA, Yusof BNM, Jabar MF, andShahar ASM. Effectiveness of intensive perioperative nutrition therapy among adults undergoing gastrointestinal and oncological surgery in a public hospital: study protocol for a pragmatic randomized control trial. Trials. 2022;23(1):961. https://doi.org/10.1186/s13063-022-06898-2.

[13] Khan A, Wong J, Riedel B, Laing E, Beaumont A, Kong J, Warrier S, and Heriot A. The Impact of Peri-operative Enteral Immunonutrition on Post-operative Complications in Gastrointestinal Cancer Surgery: A Meta-Analysis. Annals Surgical Oncology. 2023; 30(6):3619-3631. https://doi.org/10.1245/s10434-023-13265-1.

[14] Yamamichi T, Ichinose J, Tamagawa S, Hashimoto K, Matsuura Y, Nakao M, Okumura S, andMun M. Impact of previous upper gastrointestinal cancer surgery on complications after lobectomy for lung cancer. Journal of Thoracic Disease. 2022; 14(10):3811-3818. <https://doi.org/10.21037/jtd-22-798>.

[15] Shim H, Cheong JH, Lee KY, Lee H, Lee JG, and Noh SH. Perioperative nutritional status changes in gastrointestinal cancer patients. Yonsei Medical Journal. 2013; 54(6):1370-1376. https://doi.org/10.3349/ymj.2013.54.6.1370

**Table I: General characteristics**

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

**Table II: Etiological and phenotypic criteria and incidence of undernutrition at discharge in surgical patients**

|  |  |  |  |
| --- | --- | --- | --- |
| **Variables** | | **Effective (N)** | **Frequency (%)** |
| **Etiologicalcriteria** | | | |
| **Food intake ≤ 50% For 1 week** | |  |  |
|  | Not reach | 61 | 45.52 |
|  | Reach | 73 | 54.47 |
|  | No | 30 | 22.39 |
| Yes | 43 | 32.09 |
| **Reduced absorption (malabsorption/maldigestion)** | |  |  |
|  | No | 64 | 47.76 |
| Yes | 70 | 52.24 |
| **Aggression** | |  |  |
|  | No | 0 | 0.0 |
|  | Yes | 134 | 100 |
| **Phenotypiccriteria** | | | |
| **BMI class those < 18 years (N=19)** | |  |  |
|  | < 3 percentile IOTF curve | 5 | 26.31 |
|  | [3-97[ percentile IOTF curve | 14 | 73.68 |
|  | ≥ 97 percentile IOTF curve | 0 | 0.0 |
| **BMIclass those [18-70] years (N=105)** | |  |  |
|  | <18.5 | 32 | 29.52 |
|  | [18.5-24.9] | 59 | 56.19 |
|  | [25-29.9] | 14 | 13.33 |
|  | ≥30 | 1 | 0.95 |
| **BMI class those >70 years (N=10)** | |  |  |
|  | < 21 | 8 | 80.0 |
|  | ≥ 21 | 2 | 20.0 |
| **Weightlosswithin 1 week** | |  |  |
|  | Not reach | 61 | 45.52 |
|  | Reach | 73 | 54.47 |
|  | < 2% lostwithin 1 week | 20 | 27.39 |
|  | > 2% lostwithin 1 week | 53 | 72.60 |
| **Fonte musculature** | |  |  |
|  | No | 109 | 81.34 |
|  | Yes | 25 | 18.65 |
| **Denutrition at least one etiological criteria + one phenotypic criteria** | | | |
| **Nutritional state** | |  |  |
|  | Normal | 24 | 17.91 |
|  | undernourished | 110 | 82.09 |
| **N** :Effective, **%**: percentage, **BMI**: Body Mass Index, **IOTF** :International Obesity Task Force | | | |

**Table III: Univariate analyses of factors associated with undernutrition**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Variables** | | | **Nutritionalstatus at discharge** | | | **OR adjusted** | | **CI-95%** | | | **P-Value** | | |
| **Normal** | **Undernourished** | |  |  | |  | | |
| **Sociodemographicparameters** | | | | | | | | | | | | |
| **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 | | / | / | | 0.287 | | |
|  | | Yes | 0 | 5 | | / | / | |
| **Diabetes** | | |  |  | |  |  | |  | | |
|  | | No | 24 | 106 | | / | / | | 0.3 | | |
|  | | Yes | 0 | 4 | | / | / | |
| **History of small bowel resection** | | |  |  | |  |  | |  | | |
|  | | No | 24 | 105 | | / | / | | 0.28 | | |
|  | | Yes | 0 | 5 | | / | / | |
| **History of colectomy** | | |  |  | |  |  | |  | | |
|  | | No | 24 | 108 | | / | / | | 0.52 | | |
|  | | Yes | 0 | 2 | | / | / | |
| **History of pancreatectomy** | | |  |  | |  |  | |  | | |
|  | | No | 24 | 108 | | / | / | | 0.50 | | |
|  | | Yes | 0 | 2 | | / | / | |
| **Age >70 years** | | |  |  | |  |  | |  | | |
|  | | No | 22 | 107 | | 1 | Reference | | - | | |
|  | | Yes | 2 | 3 | | 0.308 | 0.057 - 1.66 | | 0.189 | | |
| **Persistent preoperativesymptoms** | | | | |  |  |  | | |  | |
|  | | 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 | | **/** | **/** | |  | | |
| **Postoperativesymptoms** | | | | | | | | | | | | |
| **Nauseas** | | |  |  | |  |  | |  | | |
|  | Absente | | 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 | | - | | |
| **Exogenousdeterminants** | | | | | | | | | | | | |
| **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.

**Table IV: 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** | | | | |

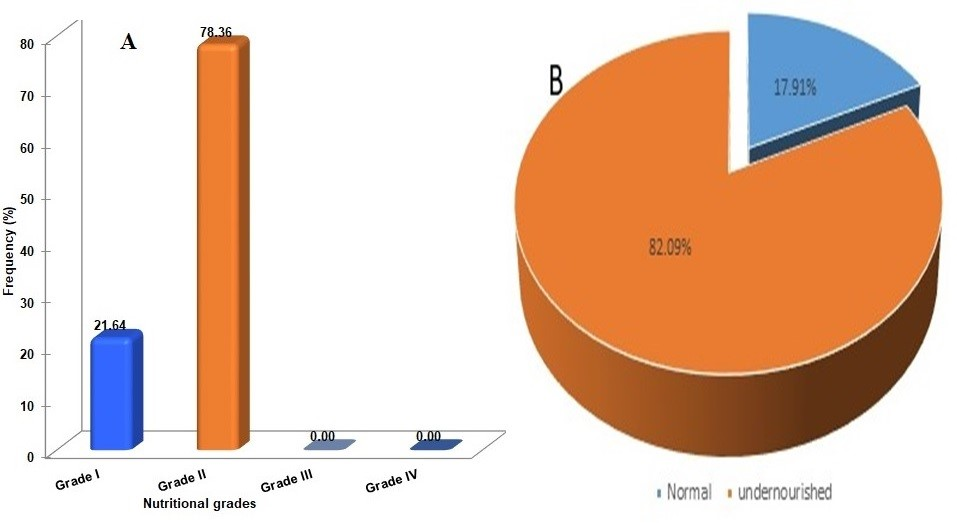


Figure 1: Distribution of patients by nutritional grade (A) and incidence of undernutrition at discharge (B)