

Research Article

# Disorders of Biochemical Parameters Associated with Protein-energy Malnutrition in Adults Hospitalized in Ouagadougou, Burkina Faso

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## Abstract

The assessment of the nutritional status of the hospitalized person is often considered secondary to the pathologies justifying hospitalization. A multicenter study conducted in six Belgian hospitals showed a risk of malnutrition in just over one in five patients. This malnutrition during hospitalization is more frequent in the elderly and those with chronic pathologies. However, malnutrition is a very serious prognostic factor for hospitalized people because it multiplies the risk of infectious pathologies by two to six and the duration of hospitalization by two to four. This study is part of the promotion of better holistic care at the Yalgado OUEDRAOGO University Hospital Center (YO UHC) in Ouagadougou, Burkina Faso, which includes the assessment of the nutritional status of hospitalized people. A descriptive cross-sectional study with analytical aims over a period of nine (09) months was conducted. The study population consisted of people aged 50 and over in outpatient or hospitalized patients, recruited in the internal medicine department of YO UHC. Study variables included anthropometric parameters, blood count, specific nutritional and inflammatory proteins such as transthyretin, albumin, orosomucoid and C-reactive protein (CRP), as well as nutritional indexes such as the Body Mass Index (BMI), the Mini nutritional assessment (MNA) and the Prognostic inflammatory and nutritional index (PINI). Statistical analysis was performed using Epi info version 7.2.1.0. Were included 102 individuals consisted of 42 men and 60 women with a male/female sex ratio of 0.7. The mean age was  $63 \pm 9$  years with extremes ranging from 50 to 72 years. The mean values of the various anthropometric parameters were significantly lower in hospitalized patients compared to outpatients ( $p < 10^{-3}$ ) with 50% of hospitalized patients having a  $BMI < 21 \text{ kg/m}^2$ . The mean value of the MNA score was  $13.67 \pm 4.83$  in hospitalized patients compared to  $21.57 \pm 3.24$  in outpatients ( $p < 10^{-4}$ ). The mean values of nutritional proteins were significantly lower in hospitalized patients with 55.9% having albuminemia  $< 35 \text{ g/L}$  and 47% having transthyretin  $< 200 \text{ mg/L}$ . For inflammatory proteins, the mean values were significantly higher in hospitalized patients with 29.4% having  $CRP > 20 \text{ mg/L}$ . The combined assessment reports that 50% of hospitalized patients had a  $PINI > 1$ , of which approximately 15% had a vital risk ( $PINI > 30$ ). The results show a high frequency of protein-energy malnutrition accompanied by

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inflammatory syndrome in hospitalized people. Therefore, it is important to monitor the nutritional status of hospitalized people in order to avoid complications and an increase in the length of hospitalization.

## Keywords

Nutritional Status, Biochemical Markers, Hospitalized Persons, Ouagadougou

## 1. Introduction

The assessment of the nutritional status of the hospitalized person is often considered secondary to the pathologies justifying the hospitalization. According to a multicenter study conducted in six hospitals in Belgium, among the 73.843 patients who took part in this research, a risk of malnutrition was present for 21.9% of them, or just over one in five patients [1]. This malnutrition during hospitalization affects all age groups but is more common in the elderly and those with chronic pathologies. Malnutrition due to hospitalization can come from insufficient consumption of foods or essential nutrients such as vitamins and minerals. It can appear or worsen in a hospital [2]. Indeed, hospitalized people may eat less for several reasons, including loss of appetite due to illness or medication, food may be unusual and unappetizing. Some people are subject to a restrictive diet, such as a low-fat or low-salt diet, which they may not like. Also, meals are served and removed at specific times. According to experts, malnutrition in the elderly is a problem that is most often overlooked and neglected by healthcare teams. It is also a very serious prognostic factor for hospitalized elderly people who suffer from it because it multiplies the risk of infectious diseases by two to six and the length of hospitalization by two to four [3, 4]. Indeed, Corish et al. in Ireland in 2000 showed that the nutritional status of patients hospitalized beyond twelve (12) days deteriorated in 66% of cases [5]. It also emerges from the study by Incalzi et al. in Italy in 1997 on the evolution of the nutritional status of elderly people hospitalized in geriatrics that, among patients whose nutritional status worsened during hospitalization, the length of stay was longer [6].

Thus, malnutrition in hospitalized people aggravates the disease, delays recovery, and often increases the length of stay [7]. Overall, epidemiological studies highlight a high prevalence in hospital (over 50%) and in geriatric institutions (10% - 30%) than at home (2% -5%), which has a direct impact on the cost of health [3, 8-10]. This study is therefore part of the promotion of better holistic care at the Yalgado Ouédraogo University Hospital Center (YO UHC) in Ouagadougou, Burkina Faso, which includes the assessment of the nutritional status of hospitalized people.

## 2. Materials and Methods

### 2.1. Study Population

This was a cross-sectional study with a descriptive aim over a period of 9 months which took place at the YO UHC in Ouagadougou, the capital city of Burkina Faso. The study population consisted of people aged fifty (50) years and over who were outpatients or hospitalized in the internal medicine department of the YO UHC and who did not benefit from enteral or parenteral nutrition. People with a deterioration in physical or mental condition as well as those with liver failure, kidney failure, and edema were not included in the study.

### 2.2. Variables Studied and Data Collection

All data were collected on an individual survey form after informed consent.

#### 2.2.1. Clinical Variables

The clinical variables explored were age, weight, height, brachial circumference (BC) and calf circumference (CC).

The clinical data were collected after an interview followed by the measurement of these data. Height, weight, BC and CC were measured respectively using a height gauge, a scale, and a tape measure.

#### 2.2.2. Nutritional Variables and Indexes

We also explored nutritional indexes such as the Body Mass Index (BMI), the Mini Nutritional Assessment (MNA) and the Prognostic Inflammatory and Nutritional Index (PINI). The BMI was calculated by using weight in kilograms (kg) divided by the square of height in meters (m<sup>2</sup>). The MNA score was established through a questionnaire [11] and the PINI was calculated according to the following formula:

$$PINI = \frac{CRP \text{ (mg/l)} \times \text{Orosomucoïd (mg/l)}}{\text{Albumin (g/l)} \times \text{Transthyretin (mg/l)}}$$

#### 2.2.3. Biological Variables

The biological variables were the blood count and specific proteins such as transthyretin, albumin, orosomucoid and C-reactive protein (CRP). Biological data were obtained after the collection of samples and the assay at the YO UHC biochemistry laboratory. For this purpose, venous whole blood

samples were collected from fasting subjects.

For the assay of specific proteins (transthyretin, albumin, orosomucoid and CRP), venous whole blood was collected in a dry tube and centrifuged at 3500 rpm for 5 minutes in accordance with the procedures for processing samples in biochemistry. The serum thus obtained was immediately aliquoted into cryotubes and then stored for a maximum of 7 days in a freezer at -20 °C until assay.

For the blood count, venous whole blood was collected in

an EDTA tube, and the analysis was carried out immediately after collection.

The dosage of specific proteins was carried out by immunoturbidimetry using the Architect® ci4100 from ABBOTT and the blood count by the principle of impedance variation and photometry using the ABX Pentra XL 80.

The normal values of the various biological variables and nutritional indices as well as their clinical interpretation retained from the literature [12, 13] are summarized in Table 1.

**Table 1.** Normal values of biological variables and nutritional indices [12, 13].

Parameters	Normal Values	Interpretation
Albumin	35-52 g/l	<35 g/L: moderate malnutrition <30 g/L: severe malnutrition < 25 g/L: very severe malnutrition
Transthyretin	200-400 mg/l	<200 mg/L: moderate malnutrition <150 mg/l: severe malnutrition <100 mg/l: very severe malnutrition
CRP	< 6 mg/l	>20 mg/l: inflammatory syndrome
Orosomucoid	0.5-1.20 g/l	>1.20 g/l: inflammatory syndrome
Blood count		
lymphocytes	1500-4000/mm <sup>3</sup>	≤1500/ mm <sup>3</sup> : infection
Neutrophils	1200-7500/mm <sup>3</sup>	> 7500/m <sup>3</sup> = infection
Hemoglobin	Women: 12-16 g/dl Men: 13-18 g/dl	hemoglobin <12 in women: anemia <13 in men: anemia
MNA	≥24	< 17: malnutrition 17≤ MNA ≤ 23.5: risk of malnutrition ≥24: normal
PINI	< 1	< 1: normal 1≤ PINI ≤ 30: increasingly high risk of complications > 30: vital risk

### 2.3. Statistical Analysis

Statistical analysis was performed using Epi info version 7.2.1.0. Quantitative variables were expressed as mean ± standard deviation and qualitative variables expressed as percentages. Comparison of means was performed by Student's t test and comparison of percentages by Pearson's chi-square test. A probability of less than 0.05 was considered significant for all variables.

### 3. Results

A total of 102 individuals were included in the study. The study population included 60 women (58.8%) and 42 men (41.2%) with a male/female sex ratio of 0.7. The mean age was 63±9 years with extremes ranging from 50 to 72 years. Patients aged between 50 and 59 years (48%) were the most numerous with 48%. In the study population, 79.4% came from urban areas and 20.6% from rural areas. Most of them (65.7%) lived with family and 34.3% lived alone. Of the 102 patients, 68 (66.70%) were outpatients and 34 (33.30%) were hospitalized. The mean length of hospitalization was 17.47±13.73 days.

The analysis combining the variations in mean values (Table 2) and the frequency of disorders associated with protein-energy malnutrition (Table 3) highlights an increased

risk of malnutrition and inflammatory syndrome in hospitalized patients compared to outpatients.

**Table 2.** Mean values of anthropometric, biological parameters and nutritional indices of the study population.

Parameters	Study Population (N=102)	Hospitalized (n= 34)	Outpatients (n=68)	p
Anthropometric data and MNA score				
Weight (kg)	68.55 ±14.99	61.72 ±12.84	71.97 ±14.89	0.0009
Height (cm)	1.64 ±0.07	1.66 ±0.08	1.64 ±0.07	NS
BC (cm)	29.72 ±5.00	27.57 ±4.45	30.79 ±4.94	0.001
CC (cm)	34.39 ±5.55	31.50 ±4.60	35.83 ±5.45	0.0001
BMI (kg/m <sup>2</sup> )	25.29 ±5.34	22.29 ±4.09	26.78 ±5.28	0.0001
MNA	18.49 ±5.34	13.67 ±4.83	21.57 ±3.24	< 10 <sup>-4</sup>
Biochemical data and PINI				
Albumin (g/l)	41.85 ±4.95	33.90 ±7.40	44.78 ±3.23	< 10 <sup>-4</sup>
Transthyretin (mg/l)	250.0 ±50.00	215.0 ±65.00	265.0 ±45.00	0.004
CRP (mg/l)	7.00 ±3.00	12.50 ±8.50	5.00 ±1.00	0.003
Orosomuco ï (g/l)	0.99 ±0.21	1.33 ±0.42	0.90 ±0.16	0.001
PINI	0.76 ±0.51	3.80 ±3.40	0.39 ±0.15	<10 <sup>-4</sup>
Hematological data				
Hemoglobin (Women)	11.61 ±2.00	10.33 ±2.25	12.00 ±1.77	0.004
Hemoglobin (Men)	12.02 ±2.60	10.67 ±2.56	13.23 ±1.96	0.0013
PNN (10 <sup>3</sup> /mm <sup>3</sup> )	3.63 ±1.73	3.80 ±2.27	3.63 ±1.73	NS
Lymphocytes (10 <sup>3</sup> /mm <sup>3</sup> )	34.39 ±5.55	31.5 ±4.6	35.83 ±5.45	NS

**Table 3.** Frequency of disorders of parameters associated with protein-energy malnutrition in the study population.

Parameters	Study Population total n (%) N=102	Hospitalized n(%) n=34	Outpatients n (%) n=68	p
BMI < 21 kg/m <sup>2</sup>	23 (22.50)	17 (50.00)	6 (8.80)	< 10 <sup>-5</sup>
MNA < 17	31 (30.40)	24 (70.60)	7 (10.30)	< 10 <sup>-4</sup>
Women: Hemoglobin < 12 g/dL	33 (55.00)	13 (92.90)	20 (43.50)	0.001
Men: Hemoglobin <13 g/dL	23 (54.80)	15 (75.00)	8 (36.40)	0.01
Lymphocytes < 1500 /mm <sup>3</sup>	36 (35.30)	17 (50.00)	19 (27.90)	0.02
PNN > 7500 /mm <sup>3</sup>	3 (2.94)	2 (5.90)	1 (1.50)	NS
Albumin < 35 g/L	21 (20.60)	19 (55.90)	2 (2.90)	< 10 <sup>-6</sup>
Transthyretin <200 mg/L	28 (27.50)	16 (47.10)	12 (17.60)	0.001
CRP > 20 mg/L	14 (13.70)	10 (2.41)	4 (5.88)	0.001
Orosomuco ï > 1,2 g/L	25 (24.50)	16 (47.06)	9 (13.24)	0.0001
PINI > 1	28 (27.50)	17 (50.00)	11 (16.20)	0.003

Parameters	Study Population total n (%) N=102	Hospitalized n(%) n=34	Outpatients n (%) n=68	p
Vital Risk: PINI >30	6 (5.90)	5 (14.70)	1 (1.50)	< 10 <sup>-4</sup>

The mean values of the various anthropometric parameters were significantly lower in hospitalized patients compared to outpatients ( $p < 10^{-3}$ ) with 50% of hospitalized patients having a BMI < 21 kg/m<sup>2</sup> and 8.80% among outpatients, with a significant difference ( $p < 10^{-5}$ ) (Table 3). In the study population, 22.50% had a BMI < 21 kg/m<sup>2</sup>.

Regarding the MNA score, 30.40% of the study population had poor nutritional status (MNA < 17) including 70.60% among hospitalized patients and 10.30% among outpatients with a significant difference ( $p < 10^{-4}$ ) (Table 3). The mean value of the MNA score was  $13.67 \pm 4.83$  in hospitalized patients compared to  $21.57 \pm 3.24$  in outpatients ( $p < 10^{-4}$ ). The mean values of nutritional proteins were significantly lower in hospitalized patients with 55.9% having albuminemia < 35 g/L and 47% having transthyretin < 200 mg/L. For inflammatory proteins, the mean values were significantly higher in hospitalized patients with 29.4% having CRP > 20 mg/L. The

combined assessment reports that 50% of hospitalized patients had a PINI > 1, of which approximately 15% had a vital risk (PINI > 30). Mean values of hemoglobin levels in both women and men were significantly lower in hospitalized patients compared to outpatients, however those of neutrophils and lymphocytes did not show any significant difference.

According to age groups, we observed that disorders of the parameters associated with protein-energy malnutrition were more frequent in the 50-59 age group (Figure 1), with a downward trend with increasing age.

According to the length of hospital stay, the frequency of disorders of the parameters associated with protein-energy malnutrition was higher in patients with a hospital stay of more than 14 days as well as those who had length of stay between 8-14 days (Figure 2) for all parameters except for CRP.

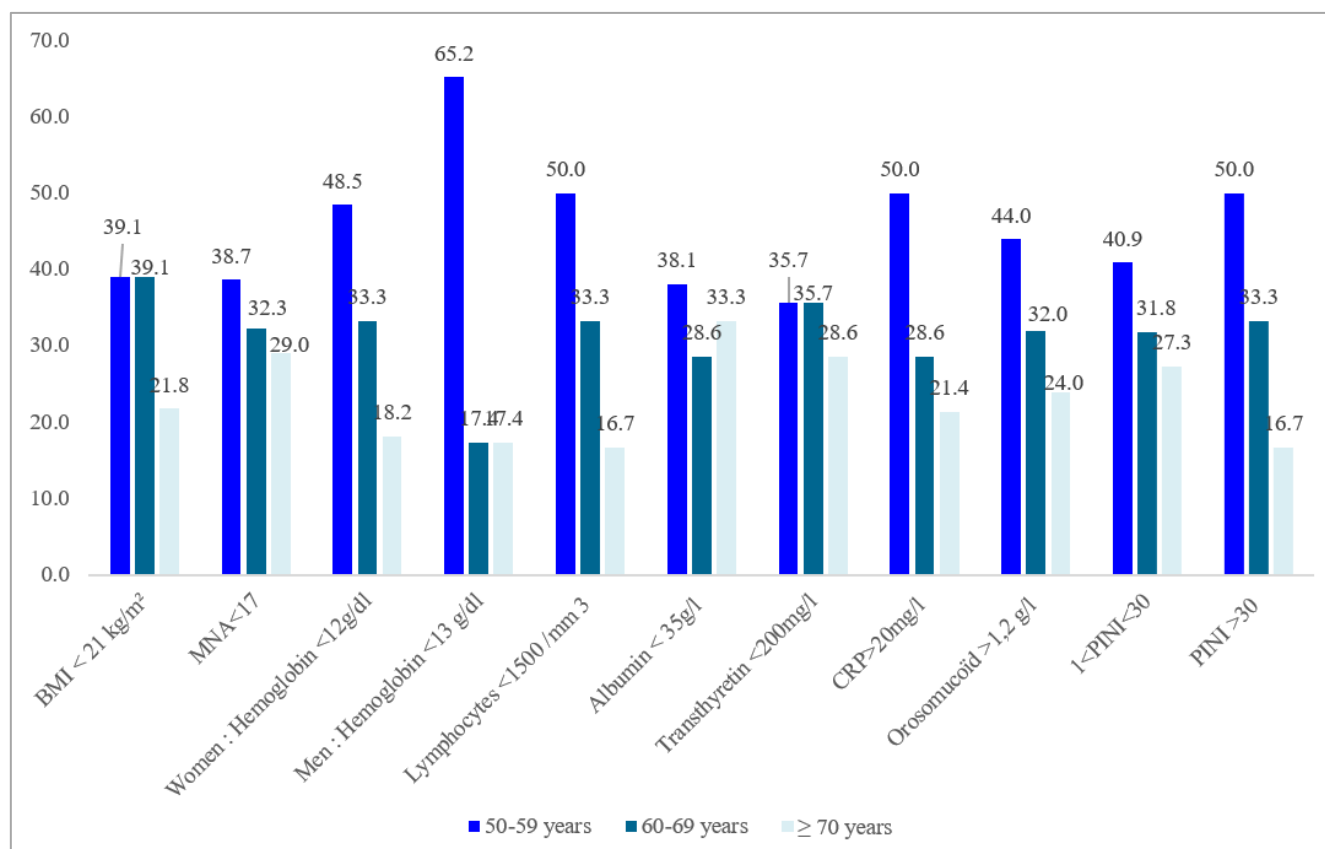
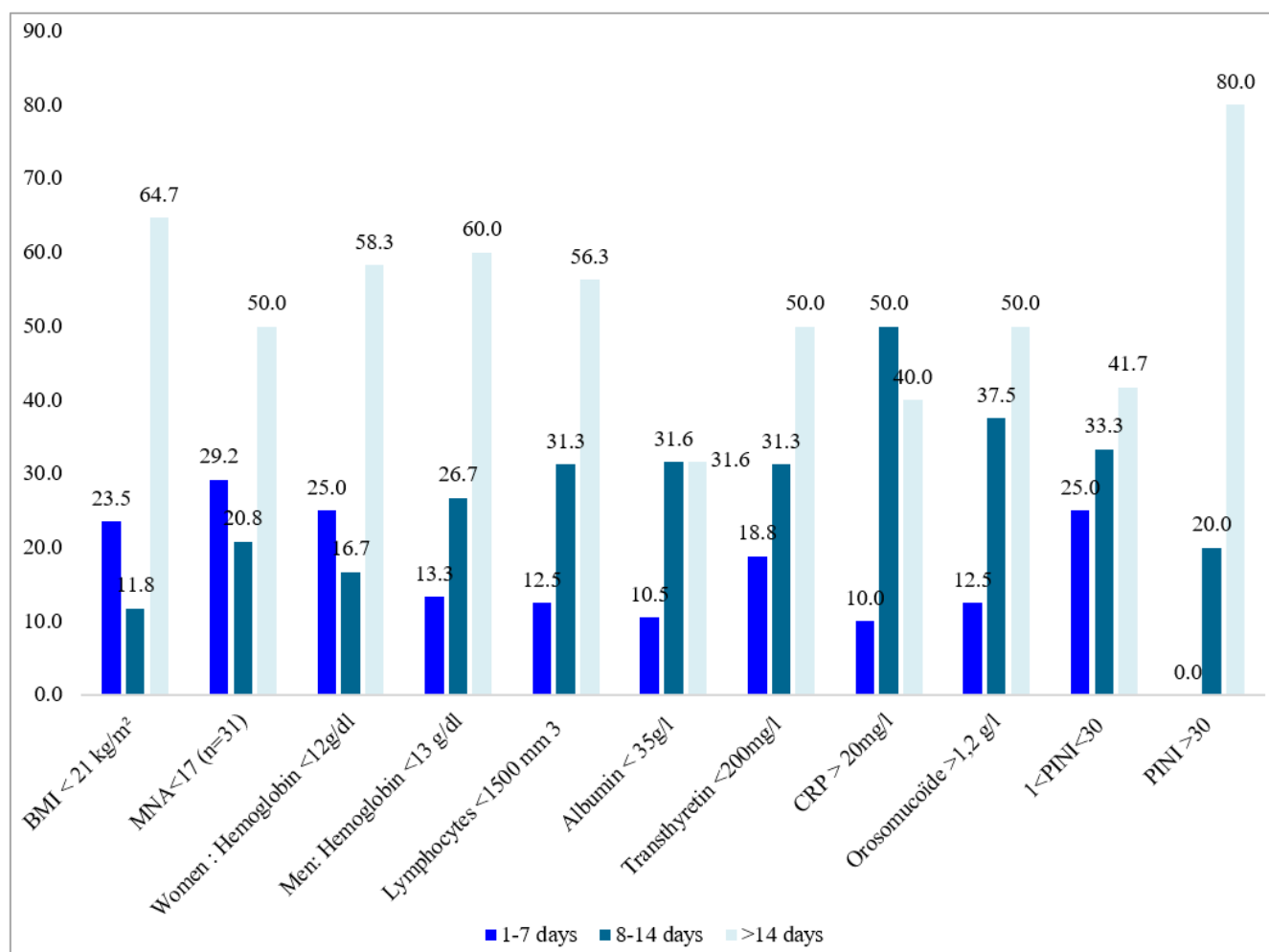


Figure 1. Frequency of disorders of parameters associated with protein-energy malnutrition according to age groups.



**Figure 2.** Frequency of disorders of parameters associated with protein-energy malnutrition in hospitalized patients according to the duration of hospitalization.

## 4. Discussion

The study population included more women than men, with an average age of  $63 \pm 9$  years. Depending on the place of residence, the majority of patients came from urban areas and lived with family. Indeed, our study took place in Ouagadougou the capital city and given the African sociocultural context, particularly Burkinabe, most elderly people live with their close relatives [14]. Of the 102 people identified in the internal medicine department, 66.67% came for an outpatient consultation and 33.33% were hospitalized patients with an average length of stay of  $17.47 \pm 13.73$  days. The absence of a geriatrics department at YO UHC means that hospitalized elderly people are distributed in different departments related to the pathology diagnosed.

The results presented in Table 2 showed that the mean values of anthropometric parameters and MNA score were significantly lower in hospitalized patients compared to outpatients, except for height. The mean values of brachial contour (BC) and calf contour (CC) were significantly lower in

hospitalized patients compared to outpatients ( $p=0.001$ ). In a cross-sectional study, Zayani found similar results in 2013 with a mean BC of  $27.24 \pm 4.19$  for hospitalized patients and  $29.52 \pm 5.26$  for outpatients ( $p=0.02$ ). The results were similar for the CC with  $32.68 \pm 4.47$  and  $35.27 \pm 5.14$  for hospitalized patients and outpatients respectively ( $p=0.01$ ). This result reflects a much greater loss of muscle mass in hospitalized patients. Two phenomena are thought to be at the origin of this state, namely the reduction of physical activities and the reduction of food intake as well as a general physical weakness involving a reduction in the muscular strength of the elderly person [15].

In the study population, 22.50% had a BMI  $<21 \text{ kg/m}^2$ , including 50.0% among hospitalized patients and 8.80% among outpatients, with a significant difference ( $p < 10^{-5}$ ) (table 3). These results showed that half of the hospitalized patients had nutritional problems. This could be explained by the fact that in hospitalization, patients are subject to sometimes unsuitable catering, overly rigid meal times, perfusions without food and the loss of autonomy of these patients associated with a stressful situation [16].

Regarding the MNA score, 30.40% of the total sample had



poor nutritional status (MNA<17) including 70.60% among hospitalized patients and 10.30% among outpatients with a significant difference ( $p < 10^{-4}$ ) (Table 3). In several studies, the MNA was correlated with anthropometric data, particularly BMI, weight loss and BC in the elderly [17-19]. This would justify the higher prevalence of malnutrition in the hospitalized population.

Indeed, the majority of patients during the administration of the questionnaire for calculating the MNA score revealed that they did not respect the main meals of the day and did not frequently consume foods rich in protein and/or micronutrients, even when financial means allowed it. Thus, elderly people in outpatient care would be faced with an increased risk of insufficient nutritional intake, given socio-economic factors, ignorance of nutritional needs by the elderly person themselves or by those around them (their family), difficulty in shopping, preparing and eating as well as eating meals alone and a non-varied diet and taking more than three medications per day [20]. However, the MNA may not reflect the nutritional realities of Burkina Faso because the questionnaire was developed based on the realities of the European population.

Mean values of nutritional and inflammatory proteins showed a statistically significant difference between hospitalized and outpatients (Table 2). Mean values of hemoglobin levels in both women and men showed a significant decrease compared to normal values, and much more marked in hospitalized compared to outpatients. This reflects the presence of frequent anemia in both sexes in hospitalized compared to outpatients. This anemia could be due to an unbalanced diet or the presence of much higher inflammation in the hospital environment [15, 21].

For a lymphocyte count  $\leq 1500/\text{mm}^3$ , our results showed a significant difference ( $p = 0.02$ ) between hospitalized patients (50.0%) and outpatients (27.9%) (Table 2). This result reflects an immune deficiency that could be explained by the more marked inflammation in hospitalized patients, inflammation being a factor in protein-energy malnutrition. Indeed, physiological aging results in a dysregulation of the immune system, which is itself clearly aggravated by states of malnutrition and is proportional to the intensity of protein-energy malnutrition. Protein-energy malnutrition therefore aggravates the physiological immune deficiency due to aging and promotes infections. If an infection occurs, it worsens malnutrition through the anorexia it causes and through changes in protein metabolism linked to hypercatabolism, making the elderly person susceptible to developing a new infection, thus creating a real vicious circle of infection-malnutrition [22, 23].

Albumin is the oldest nutritional marker used. Its decrease is a good indicator of chronic malnutrition because of its long half-life. In contrast, transthyretin reflects rapid fluctuations in nutritional status and allows early detection of protein-energy malnutrition. As the concentration of these proteins is modified during the inflammatory syndrome [23, 24],

the level of inflammatory proteins such as CRP and orosomucoid are determined in parallel with their dosages, as well as the calculation of the PINI index for the interpretation of the results. Many publications highlight malnutrition in hospitalized elderly people [15, 25, 26].

The comparison between the hospitalized and outpatient population shows a significant decrease in nutritional proteins (albumin:  $p < 10^{-6}$ , and transthyretin:  $p = 0.001$ ) and a statistically significant increase in inflammatory proteins (CRP:  $p = 0.001$  and Orosomucoid:  $p = 0.0001$ ) in hospitalized patients (Table 3). These results suggest a much more pronounced malnutrition in hospitalized patients. The PINI index is a tool for detecting malnutrition of catabolic origin. In our study population, the frequency of patients with  $\text{PINI} > 1$  was 50.00% in hospitalized patients versus 16.20% in outpatient patients ( $p = 0.003$ ) (Table 3). This result thus reflects more risks in terms of severity of the condition and vital prognosis for hospitalized patients. These data are in agreement with several works [15, 27].

The frequency of protein-energy malnutrition was higher in patients with a hospital stay of more than 14 days (Figure 2). As well as those who had a length of stay of between 8 and 14 days. This confirms the work of experts from the American Society for Parenteral and Enteral nutrition [28] showing that malnutrition sets in within the first 2 weeks after hospitalization [29].

These results show that elderly people living in hospital seem to be significantly more exposed than outpatients, combining chronic malnutrition (simultaneous decrease in albumin and transthyretin) with an inflammatory state that further aggravates their endogenous malnutrition. The high proportion of elderly people at risk of malnutrition is probably linked to many factors such as the accumulation of pathologies, depression and polymedication [20, 30]. With the hospital stay, nutritional status deteriorates further, particularly in elderly people with motor dependence [15, 30]. According to Kamel and colleagues, hospitalization is a high-risk factor for deterioration in the nutritional status of elderly people [31]. According to the same author, elderly people defined as "poorly nourished" (Albumin  $< 35\text{g/L}$ ) compared to the "well-nourished" group have a hospital stay that can be twice as long with 2 to 20 times more complications. Depression would be the main factor responsible for weight loss during long stays because of the increased feeling of dependence and the stubborn refusal to be placed in an institution. The prescribed therapies could also be incriminated [30].

## 5. Conclusions

The results show a high frequency of protein-energy malnutrition accompanied by inflammatory syndrome in hospitalized people. Therefore, it is important to monitor the nutritional status of hospitalized people for better management in order to avoid complications and an increase in the length of hospitalization.

## Abbreviations

BC	Brachial Contour Index
BMI	Body Mass Index
CC	Calf Contour
CRP	C reactive Protein
MNA	Mini Nutritional Assessment
PINI	Prognostic Inflammatory and Nutritional Index
YO UHC	Yalgado Ouédraogo University Hospital Center

## Author Contributions

**Alice Kiba-Koumaré** Conceptualization, Data curation, Formal Analysis, Funding acquisition, Investigation, Methodology, Resources, Writing - original draft

**Claude Kocola**: Conceptualization, Formal Analysis, Investigation, Methodology, Writing - original draft

**Fabienne Soudré** Writing - review & editing

**Raoul Karfo**: Writing - review & editing

**Arnaud Kouraogo**: Data curation, Formal Analysis

**Elié Kabré** Supervision, Writing - review & editing

**Jean Sakandé** Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Resources, Writing - original draft, Supervision

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## Data Availability Statement

The data is available from the corresponding author upon reasonable request.

## Conflicts of Interest

The authors declare no conflicts of interest.

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