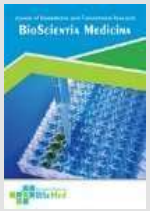
eISSN (Online): 2598-0580



Bioscientia Medicina: Journal of Biomedicine & Translational Research

Journal Homepage: www.bioscmed.com

Analysis of Risk Factors Related to Malnutrition on Length of Stay Hospitalization: A Single-Center Observational Study at Klungkung General Hospital, Indonesia

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ARTICLE INFO

Keywords:
Hospital
Indonesia
Length of stay
Malnutrition
Risk factors

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All authors have reviewed and approved the final version of the manuscript.

https://doi.org/10.37275/bsm.v8i11.1107

A B S T R A C T

Background: Malnutrition is a prevalent issue in hospital settings, significantly impacting patient outcomes and healthcare costs. This study aimed to identify and analyze risk factors associated with malnutrition and its influence on the length of stay (LOS) among hospitalized patients at Klungkung General Hospital, Indonesia. **Methods:** A retrospective observational study was conducted, including adult patients admitted to Klungkung General Hospital between January 1, 2023, and December 31, 2023. Malnutrition was assessed using the Subjective Global Assessment (SGA) tool. Patient demographics, medical history, nutritional status, laboratory parameters, and LOS were collected. Univariate and multivariate analyses were performed to identify risk factors associated with malnutrition and its impact on LOS. **Results:** A total of 43,949 patients were included in the study, with 1,084 (2.46%) identified as malnutrition. The mean LOS for malnutrition patients was significantly longer than for well-nutrition patients (7.8 days vs. 4.2 days, $p < 0.001$). Multivariate analysis revealed that age ≥ 60 years (OR 2.31, 95% CI 1.85-2.89), presence of comorbidities (OR 1.75, 95% CI 1.42-2.16), low albumin levels (OR 2.05, 95% CI 1.68-2.50), and inadequate dietary intake (OR 1.98, 95% CI 1.61-2.43) were independent risk factors for malnutrition. Malnutrition was also an independent predictor of prolonged LOS (OR 1.68, 95% CI 1.36-2.07). **Conclusion:** Malnutrition is a significant problem at Klungkung General Hospital, associated with increased LOS. Early identification of risk factors and implementation of targeted nutritional interventions are crucial to improve patient outcomes and reduce healthcare costs.

1. Introduction

Malnutrition, a state of impaired nutritional status, is a pervasive and often underestimated problem in hospital settings worldwide. It encompasses both undernutrition, characterized by inadequate nutrient intake or absorption, and overnutrition, marked by excessive nutrient intake. While both forms of malnutrition have detrimental health effects, undernutrition is more commonly observed in hospitalized patients and is associated with a wide range of adverse outcomes. These outcomes include increased susceptibility to infections, impaired wound healing, muscle wasting, prolonged hospital stays, increased readmission rates, and even elevated mortality rates. The prevalence of malnutrition in hospitals varies considerably depending on the patient population, assessment tools, and healthcare setting. Studies have reported malnutrition rates ranging from 20% to 50% in hospitalized patients globally. In developing countries like Indonesia, the prevalence of malnutrition among hospitalized adults has been reported to be as high as 60.5%. This alarmingly high

prevalence underscores the urgent need for healthcare providers and policymakers to address malnutrition as a critical public health issue in Indonesian hospitals. Several risk factors contribute to the development of malnutrition in hospitalized patients. These factors can be broadly categorized into patient-related, disease-related, and healthcare-related factors. Patient-related factors encompass a wide range of individual characteristics that predispose individuals to malnutrition. Advanced age is a significant risk factor, as physiological changes associated with aging can impair nutrient absorption and utilization. Additionally, low body mass index (BMI), a measure of body fat based on height and weight, is often indicative of undernutrition. Poor dietary intake, whether due to lack of appetite, difficulty swallowing, or other factors, is a direct cause of malnutrition. Underlying chronic diseases, such as diabetes mellitus, cardiovascular disease, and chronic kidney disease, can also increase nutrient requirements and impair nutrient absorption, further contributing to malnutrition.[1,2]

Disease-related factors play a crucial role in the development of malnutrition in hospitalized patients. Certain medical conditions can significantly increase nutrient requirements or impair nutrient absorption, leading to a state of malnutrition. For instance, cancer patients often experience increased energy and protein needs due to the metabolic demands of the tumor and the side effects of cancer treatments. Infections can also lead to malnutrition by increasing metabolic rate, impairing nutrient absorption, and suppressing appetite. Gastrointestinal disorders, such as inflammatory bowel disease and malabsorption syndromes, can directly affect nutrient absorption, leading to deficiencies in essential vitamins and minerals. Healthcare-related factors are also important contributors to malnutrition in hospital settings. Delayed or inadequate nutritional screening and intervention can result in missed opportunities to identify and address malnutrition early in the hospital stay. Prolonged fasting periods, often required for medical procedures or tests, can exacerbate malnutrition by depriving patients of essential nutrients. Additionally, certain medications can have side effects that interfere with nutrient absorption or utilization, further contributing to malnutrition. The economic impact of malnutrition on healthcare systems is substantial. Malnutrition patients often require more intensive medical care, longer hospital stays, and have higher readmission rates compared to well-nutrition patients. Studies have shown that malnutrition patients have a 1.5 to 5 times longer length of stay (LOS) than well-nutrition patients. This prolonged LOS translates to increased healthcare costs, including costs associated with additional diagnostic tests, treatments, and hospital resources. The financial burden of malnutrition extends beyond the hospital setting, as malnutrition patients are also more likely to require long-term care and rehabilitation services.[3,4]

In Indonesia, where healthcare resources are often limited, the economic burden of malnutrition is particularly significant. The high prevalence of malnutrition in Indonesian hospitals, coupled with its associated increase in healthcare utilization and costs, poses a significant challenge to the healthcare system. Addressing malnutrition is not only crucial for improving patient outcomes but also for ensuring the sustainability of healthcare services in the country. To effectively address malnutrition in hospitals, it is essential to identify and understand the risk factors associated with its development. This knowledge can guide the implementation of targeted nutritional interventions to prevent and manage malnutrition, ultimately improving patient outcomes and reducing healthcare costs. Early identification of malnutrition patients through comprehensive nutritional screening and assessment is crucial. Once identified, malnutrition patients should receive individualized nutritional care plans that address their specific needs and underlying medical conditions. This may involve providing oral nutritional supplements, enteral nutrition (tube feeding), or parenteral nutrition (intravenous feeding), depending on the severity of malnutrition and the patient's ability to consume food orally. In addition to individualized nutritional care,

healthcare providers should also focus on addressing the underlying causes of malnutrition. This may involve managing chronic diseases, optimizing medication regimens to minimize side effects that interfere with nutrient absorption, and providing education to patients and their families about the importance of good nutrition and how to maintain a healthy diet.[5-7] This study aimed to investigate the risk factors associated with malnutrition and its impact on LOS among hospitalized patients at Klungkung General Hospital, Indonesia. By identifying these risk factors, we hope to provide valuable insights for healthcare providers to develop and implement effective nutritional interventions to mitigate the adverse effects of malnutrition in this setting.

2. Methods

A retrospective, single-center observational study was conducted at Klungkung General Hospital, a 200-bed public tertiary care hospital located in Klungkung Regency, Bali, Indonesia. The hospital serves a diverse population and provides a wide range of medical services, including internal medicine, surgery, pediatrics, obstetrics and gynecology, and other specialties. The study population included all adult patients (aged ≥18 years) admitted to Klungkung Regional General Hospital between January 1st, 2023, and December 31st, 2023. Patients were identified through the hospital's electronic medical record (EMR) system. Inclusion criteria were: Age ≥18 years at the time of admission; Admission to the hospital for at least 24 hours; Availability of complete medical records, including nutritional assessment data. Exclusion criteria were: Patients admitted for elective procedures; Patients with a primary diagnosis of eating disorders; Patients with missing or incomplete nutritional assessment data. Data were collected retrospectively from the EMR system and included the following variables: Demographic data: Age, sex, ethnicity, educational level, occupation, and socioeconomic status; Medical history: Comorbidities (hypertension, diabetes mellitus, cardiovascular disease, chronic kidney disease, chronic obstructive pulmonary disease, cancer, etc.), previous hospitalizations, and current medications; Anthropometric measurements: Height, weight, body mass index (BMI), and mid-upper arm circumference (MUAC); Nutritional assessment: Subjective global assessment (SGA) score, dietary intake (estimated energy and protein intake), and laboratory parameters (albumin, prealbumin, hemoglobin, total lymphocyte count); Length of stay (LOS): Calculated as the number of days between admission and discharge. Malnutrition was assessed using the SGA tool, a validated and widely used method for identifying malnutrition in hospitalized patients. The SGA assesses nutritional status based on a combination of subjective and objective criteria, including: Weight history: Weight loss over time, current weight compared to usual weight; Dietary intake changes: Changes in appetite, food intake, and ability to eat; Gastrointestinal symptoms: Nausea, vomiting, diarrhea, constipation; Functional capacity: Ability to perform activities of daily living; Physical examination findings: Loss of subcutaneous fat, muscle wasting, edema, ascites. Based on the SGA assessment, patients were classified into three categories: SGA A: Well-nutrition; SGA B: Moderately malnutrition; SGA C: Severely malnutrition. Dietary intake was assessed using a 24-hour dietary recall method. Patients were interviewed by a trained dietitian to obtain information about their food and fluid intake over the past 24 hours. The estimated energy and protein intake were calculated using a standardized nutrient database. Laboratory parameters, including albumin, prealbumin, hemoglobin, and total lymphocyte count, were obtained from the EMR system. These parameters were used as objective indicators of nutritional status. LOS was calculated as the number of days between admission and discharge. Patients who died during hospitalization were excluded from the LOS analysis.

Data were analyzed using SPSS software (version 26.0). Descriptive statistics were used to summarize patient characteristics and nutritional status. Categorical variables were presented as frequencies and percentages, while continuous variables were

presented as means and standard deviations. Univariate analysis was performed to compare the characteristics of malnutrition and well-nutrition patients using chi-square tests for categorical variables and independent t-tests for continuous variables. Multivariate logistic regression analysis was used to identify independent risk factors for malnutrition. Variables with a p-value < 0.20 in the univariate analysis were included in the multivariate model. Linear regression analysis was performed to assess the impact of malnutrition on LOS, adjusting for potential confounders such as age, sex, comorbidities, and severity of illness. The adjusted regression coefficient (β) and its 95% confidence interval (CI) were reported. A p-value < 0.05 was considered statistically significant. The study was conducted in accordance with the Declaration of Helsinki and Good Clinical Practice guidelines. All patient data were anonymized and de-identified to protect patient confidentiality.

3. Results

Table 1 provides a summary of the characteristics of malnutrition patients within a larger study population of 43,949 individuals. Malnutrition was present in 2.46% of the total patient population, which translates to 1084 individuals. Among the malnutrition patients, 71.03% (769 patients) were classified as moderately malnutrition (SGA B), while 28.97% (315 patients) were severely malnutrition (SGA C). The mean age of malnutrition patients was 52.3 years, with a standard deviation of 16.8 years. This indicates a wide range of ages among this group. The majority of malnutrition patients were female (54.2%). The most common comorbidities among malnutrition patients were hypertension (32.1%), diabetes mellitus (21.5%), and cardiovascular disease (18.3%). These proportions are similar to those observed in the overall patient population, suggesting that malnutrition risk is not significantly associated with these specific comorbidities in this dataset.

Table 1. Characteristic patients.

Characteristic	Value	Standard deviation (SD)
Prevalence of malnutrition	2.46% (1084/43949)	
SGA B (moderate malnutrition)	71.03% (769/1084)	
SGA C (severe malnutrition)	28.97% (315/1084)	
Mean age malnutrition patients(years)	52.3	16.8
Female malnutrition patients	54.2% (596/1084)	
Hypertension of malnutrition patients	32.1% (349/1084)	
Diabetes mellitus	21.5% (233/1084)	
Cardiovascular disease	18.3% (198/1084)	

Table 2 presents the results of a statistical analysis examining risk factors associated with malnutrition. The odds ratio (OR) indicates the likelihood of malnutrition in individuals with the specified risk factor compared to those without. Patients aged 60 years or older are 2.31 times more likely to be malnutrition compared to younger patients. This association is statistically significant (p < 0.001). Patients with comorbidities (e.g., diabetes, hypertension, cardiovascular disease) are 1.75 times more likely to be malnutrition than those without comorbidities. This association is also statistically significant (p < 0.001). Patients with low albumin levels, a marker of nutritional status, are 2.05 times more likely to be malnutrition compared to those with normal levels. This association is statistically significant (p < 0.001). Patients with inadequate dietary intake are 1.98 times more likely to be

malnutrition than those with adequate intake. This association is statistically significant ($p < 0.001$). Table 2 identifies four key risk factors for malnutrition: advanced age, presence of comorbidities, low albumin levels, and inadequate dietary intake. These findings suggest that older individuals, those with underlying health conditions, and those with poor nutritional intake are at higher risk for malnutrition.

Table 2. Risk factors for malnutrition.

Risk factor	Odds ratio (95% CI)	p-value
Age ≥ 60 years	2.31 (1.85-2.89)	<0.001
Presence of comorbidities	1.75 (1.42-2.16)	<0.001
Low albumin levels	2.05 (1.68-2.50)	<0.001
Inadequate dietary intake	1.98 (1.61-2.43)	<0.001

Table 3 provides a comprehensive look at the relationship between malnutrition and length of hospital stay (LOS). The first two rows show a clear difference in average LOS between malnutrition and well-nutrition patients. Malnutrition individuals have a mean LOS of 7.8 days, significantly higher than the 4.2 days for well-nutrition individuals. The p-value of <0.001 indicates this difference is highly statistically significant, meaning it's very unlikely to be due to chance. The bottom row presents the results of a linear regression analysis, which is a statistical model that examines the relationship between multiple variables. In this case, the model was used to determine if malnutrition independently predicts a longer LOS, even when considering other factors that might also affect LOS (these other factors are not explicitly listed in the table but are mentioned in the text as "age, sex, comorbidities, and severity of illness"). The results show that malnutrition is indeed a significant predictor ($p < 0.001$). The beta coefficient ($\beta = 1.68$) quantifies the impact of malnutrition on LOS. It suggests that, on average, being malnutrition is associated with a 1.68-day increase in hospital stay compared to being well-nutrition, assuming all other factors in the model are held constant. The 95% confidence interval (1.36-2.07) provides a range within which the true beta coefficient is likely to fall. Table 3 provides strong evidence that malnutrition significantly increases the length of hospital stays, even when accounting for other potential contributing factors.

Table 3. Length of stay (LOS) and malnutrition.

Characteristic	Mean LOS (days)	Standard deviation (SD)	p-value	Beta coefficient (β)	95% confidence interval (CI)
Malnutrition	7.8	5.2	<0.001		
Well-nutrition	4.2	3.1			
Linear regression analysis (malnutrition)			<0.001	1.68	1.36-2.07

4. Discussion

The intricate relationship between malnutrition and prolonged length of stay (LOS) in hospital settings necessitates a nuanced understanding that extends beyond the simplistic view of malnutrition as merely a consequence of insufficient nutrient intake. Malnutrition, in its complexity, emerges as a multi-faceted syndrome, its roots entrenched in a web of diverse etiologies and its tendrils reaching far and wide, wreaking havoc on the intricate physiological mechanisms that underpin recovery and convalescence. Malnutrition is not a singular entity

but a spectrum of conditions characterized by an imbalance in nutrient intake, utilization, or excretion. This imbalance can stem from a multitude of factors, both intrinsic and extrinsic to the individual. Intrinsic factors encompass a myriad of physiological and pathological conditions that interfere with nutrient absorption, metabolism, or utilization. These may include gastrointestinal disorders such as inflammatory bowel disease, malabsorption syndromes, and short bowel syndrome, which impair the absorption of essential nutrients from the diet. Chronic illnesses like cancer, kidney disease, and liver disease can also disrupt nutrient metabolism and lead to malnutrition. Moreover, genetic predispositions and metabolic disorders can further contribute to the development of malnutrition by altering nutrient requirements or impairing nutrient utilization pathways. Extrinsic factors, on the other hand, encompass environmental and behavioral influences that shape an individual's nutritional status. Socioeconomic disparities, limited access to nutritious food, and food insecurity are major contributors to malnutrition, particularly in vulnerable populations. Dietary restrictions, fad diets, and disordered eating patterns can also lead to nutrient deficiencies and imbalances. Additionally, certain medications and medical treatments can interfere with nutrient absorption or utilization, further increasing the risk of malnutrition.[8-10]

The physiological consequences of malnutrition are not confined to the immediate nutritional deficits. They extend to multiple organ systems, impairing physiological processes that are essential for maintaining homeostasis, fighting infection, and promoting tissue repair. These far-reaching effects can significantly delay recovery and prolong hospitalization. One of the most profound effects of malnutrition is its impact on the immune system. Malnutrition weakens both innate and adaptive immunity, impairing the body's ability to fight infection and increasing the risk of sepsis and other life-threatening complications. This is partly due to the depletion of essential nutrients such as vitamins A, C, D, E, and zinc, which are crucial for immune cell function and proliferation. Malnutrition also disrupts the gut microbiome, leading to dysbiosis and further compromising immune function. These immunological perturbations can lead to prolonged hospital stays due to increased susceptibility to infections and slower recovery from illnesses. Malnutrition also has a profound impact on muscle mass and function. The body, deprived of essential nutrients, catabolizes muscle protein to meet its energy needs, leading to muscle wasting and weakness. This can result in impaired mobility, increased risk of falls, and difficulty participating in rehabilitation programs, all of which can delay hospital discharge. Furthermore, malnutrition can impair respiratory muscle function, leading to pneumonia and other respiratory complications that can prolong hospitalization. Another critical consequence of malnutrition is its impact on wound healing. Malnutrition impairs collagen synthesis, angiogenesis, and immune cell function, all of which are essential for wound repair. This can lead to delayed wound healing, wound dehiscence, and increased risk of infection, significantly prolonging hospital stays, especially in surgical patients. Malnutrition also affects the cardiovascular system. Nutrient deficiencies can lead to cardiac dysfunction, arrhythmias, and hypotension, which can further complicate underlying medical conditions and delay recovery. Moreover, malnutrition can increase the risk of thromboembolic events, such as deep vein thrombosis and pulmonary embolism, which can be life-threatening and significantly prolong hospitalization. The gastrointestinal system is also profoundly affected by malnutrition. Nutrient deficiencies can lead to atrophy of the intestinal mucosa, impairing nutrient absorption and perpetuating the cycle of malnutrition. Malnutrition can also lead to diarrhea, constipation, and other gastrointestinal complications that can further impede recovery and delay discharge. The neurological system is not immune to the effects of malnutrition. Nutrient deficiencies, particularly of thiamine and vitamin B12, can lead to peripheral neuropathy, encephalopathy,

and other neurological complications. These complications can impair cognitive function, motor function, and sensory perception, leading to prolonged hospitalization and increased risk of falls and other adverse events.[11-13]

The multifaceted nature of malnutrition and its diverse etiologies highlight the need for a comprehensive approach to its management. Addressing only one aspect of malnutrition, such as inadequate nutrient intake, is unlikely to be sufficient in reversing its deleterious effects. A multidisciplinary approach that involves physicians, nurses, dietitians, pharmacists, and social workers is essential to identify and address the underlying causes of malnutrition and to implement tailored interventions that meet the individual needs of each patient. The complex interplay of biological, psychological, and social factors in malnutrition underscores the importance of a holistic approach to patient care. Addressing the nutritional needs of patients is not merely a medical issue; it is a fundamental aspect of patient well-being that can significantly impact their recovery and quality of life. By recognizing the multifaceted nature of malnutrition and its far-reaching consequences, healthcare providers can develop comprehensive strategies to prevent, identify, and treat this debilitating condition, ultimately leading to improved patient outcomes and reduced healthcare costs.[13,14]

Malnutrition, often perceived as a simple lack of nutrients, instigates a cascade of detrimental effects at the cellular level, ultimately impacting an individual's overall health and recovery. This intricate interplay between malnutrition and cellular dysfunction elucidates the mechanisms underlying the increased susceptibility to complications, infections, and prolonged hospital stays observed in malnourished patients. Protein synthesis is the cornerstone of cellular function, facilitating the production of enzymes, structural proteins, and signaling molecules essential for growth, repair, and homeostasis. Malnutrition, characterized by inadequate protein intake or impaired protein utilization, disrupts this fundamental process. Amino acids, the building blocks of proteins, become scarce, hindering the assembly of new proteins and impeding the replacement of damaged cellular components. The consequences of impaired protein synthesis are far-reaching. In the context of wound healing, the synthesis of collagen, a crucial structural protein for tissue repair, is compromised. This results in delayed wound closure, increased risk of infection, and the formation of fragile scar tissue. Similarly, in the immune system, the synthesis of antibodies and immune cells is hampered, compromising the body's ability to fight off pathogens. This heightened susceptibility to infections further prolongs recovery and increases the likelihood of complications.[15,16]

Energy metabolism encompasses the intricate pathways through which cells generate adenosine triphosphate (ATP), the primary energy currency of the body. Malnutrition, particularly inadequate intake of carbohydrates and fats, disrupts these pathways, leading to energy deficits at the cellular level. Mitochondria, the powerhouses of cells, play a central role in energy production. Malnutrition impairs mitochondrial function, reducing ATP generation and compromising cellular processes that rely on energy. For instance, the active transport of nutrients across cell membranes, the maintenance of ion gradients, and the synthesis of macromolecules all require ATP. When energy is limited, these processes become inefficient, leading to cellular dysfunction and ultimately, organ failure. In the immune system, energy deficits impair the activation and proliferation of immune cells, hindering the body's ability to mount an effective immune response. This energy deprivation leaves the body vulnerable to infections, further complicating recovery and prolonging hospital stays.[15,17]

The immune system is a complex network of cells, tissues, and organs that work in concert to defend the body against pathogens. Malnutrition weakens this intricate defense system at multiple levels, increasing the risk of infections and impairing the healing process. Protein-calorie malnutrition, the most common form of malnutrition, leads to atrophy of

lymphoid organs, such as the thymus and spleen, which are crucial for the development and maturation of immune cells. Additionally, malnutrition reduces the production of cytokines, signaling molecules that orchestrate the immune response. This weakens the communication between immune cells, impairing their ability to coordinate an effective defense against pathogens. Micronutrient deficiencies, particularly deficiencies in vitamins A, C, D, E, and zinc, further compromise immune function. These micronutrients play essential roles in immune cell development, activation, and proliferation. For example, vitamin A is crucial for the maintenance of mucosal barriers, the first line of defense against pathogens, while zinc is essential for the function of T cells, a type of white blood cell that plays a key role in adaptive immunity. The gut microbiome, a complex community of trillions of microorganisms residing in the digestive tract, plays a pivotal role in immune function. Malnutrition disrupts this delicate ecosystem, leading to dysbiosis, an imbalance in the composition of the gut microbiota. Dysbiosis impairs the gut barrier function, allowing harmful bacteria and toxins to leak into the bloodstream. This triggers an inflammatory response, further weakening the immune system and increasing susceptibility to infections. Moreover, dysbiosis alters the production of short-chain fatty acids, metabolites produced by gut bacteria that have anti-inflammatory and immunomodulatory properties.[16-18]

The cellular and molecular changes induced by malnutrition manifest clinically as a vicious cycle of increased complications, readmissions, and prolonged hospital stays. Impaired wound healing increases the risk of infection, which in turn prolongs recovery and necessitates additional medical interventions. Compromised immune function renders patients vulnerable to opportunistic infections, further complicating their clinical course. Malnutrition also contributes to the development of other complications, such as pressure ulcers, falls, and delirium. These complications not only prolong hospital stays but also increase healthcare costs and place a significant burden on patients and their families. Malnutrition is a complex syndrome with far-reaching consequences that extend beyond the immediate nutritional deficits. At the cellular level, malnutrition disrupts protein synthesis, energy metabolism, and immune function, leading to impaired wound healing, increased susceptibility to infections, and prolonged recovery. The gut microbiome, a key player in immune health, is also affected by malnutrition, further compromising the body's defense mechanisms. These cellular and molecular changes manifest clinically as a vicious cycle of increased complications, readmissions, and prolonged hospital stays. Therefore, early identification and aggressive management of malnutrition are crucial for improving patient outcomes, reducing healthcare costs, and breaking the cycle of malnutrition-related complications. Understanding the intricate interplay between malnutrition and cellular dysfunction is essential for developing effective interventions that address the root causes of malnutrition and promote optimal recovery.[17-19]

Malnutrition is not a standalone condition; it interacts with and exacerbates existing comorbidities, creating a vicious cycle that can significantly prolong hospitalization and worsen patient outcomes. This section delves into the intricate relationship between malnutrition and various complications, highlighting the physiological mechanisms involved and the clinical implications. Malnutrition patients are at a heightened risk of developing pressure ulcers, also known as bedsores. These painful wounds result from sustained pressure on the skin, often occurring in patients with limited mobility. Malnutrition contributes to pressure ulcer development through several mechanisms. Protein is essential for collagen synthesis, a key component of the skin's structure and integrity. Inadequate protein intake impairs collagen production, making the skin more fragile and prone to breakdown under pressure. Vitamins such as vitamin C and zinc play crucial roles in wound healing and tissue repair. Malnutrition often leads to deficiencies in these micronutrients, delaying wound healing and increasing the risk of pressure ulcer formation.

Malnutrition can lead to anemia and decreased blood flow to the skin, further compromising its ability to withstand pressure and heal wounds. The development of pressure ulcers can have serious consequences for hospitalized patients. These wounds are often painful and can become infected, requiring additional treatments and prolonged hospitalization. In severe cases, pressure ulcers can lead to sepsis, a life-threatening condition.[18,19]

Falls are a common complication in hospitalized patients, particularly among the elderly and those with underlying medical conditions. Malnutrition is a significant risk factor for falls due to its impact on muscle strength, balance, and cognitive function. Malnutrition leads to muscle wasting, reducing muscle strength and making it difficult for patients to maintain balance and prevent falls. Vitamin D plays a crucial role in muscle function and bone health. Malnutrition often leads to vitamin D deficiency, further contributing to muscle weakness and increasing the risk of falls. Malnutrition can impair cognitive function, leading to confusion and disorientation, which can increase the risk of falls. Falls can result in fractures, head injuries, and other serious injuries, necessitating additional medical interventions and extending hospital stays. Furthermore, the fear of falling can lead to decreased mobility and further deconditioning, creating a downward spiral of functional decline.[17-19]

Delirium is a serious neuropsychiatric syndrome characterized by acute disturbances in attention, awareness, and cognition. It is a common complication in hospitalized patients, particularly among the elderly and those with underlying medical conditions. Malnutrition is a risk factor for delirium due to its impact on brain function and neurotransmitter metabolism. Malnutrition can lead to electrolyte imbalances, such as hyponatremia (low sodium) and hypokalemia (low potassium), which can disrupt neuronal function and contribute to delirium. Deficiencies in thiamine (vitamin B1), niacin (vitamin B3), and other B vitamins are associated with delirium, as these vitamins are essential for energy metabolism and neurotransmitter synthesis. Malnutrition can trigger systemic inflammation, which can affect brain function and contribute to delirium. Delirium can have devastating consequences for hospitalized patients. It can lead to prolonged hospitalization, increased risk of complications, functional decline, and even death. Preventing and managing delirium is a critical aspect of patient care, and addressing malnutrition is an essential component of this approach. Malnutrition can impair respiratory function through several mechanisms, increasing the risk of pneumonia and other respiratory complications. Malnutrition weakens the respiratory muscles, making it difficult for patients to cough effectively and clear secretions from the lungs. This can lead to the accumulation of mucus and bacteria, increasing the risk of pneumonia. Malnutrition impairs immune function, making patients more susceptible to respiratory infections. Vitamin D plays a role in immune function and lung health. Malnutrition-related vitamin D deficiency can further compromise respiratory function. Respiratory complications, particularly pneumonia, are a leading cause of morbidity and mortality in hospitalized patients. Malnourished patients are at a higher risk of developing pneumonia, which can lead to prolonged hospitalization, intensive care unit admission, and even death.[18,19]

The impact of malnutrition extends beyond the aforementioned complications. It affects virtually every organ system in the body, leading to a wide range of adverse effects. Malnutrition can lead to cardiac arrhythmias, heart failure, and orthostatic hypotension (a drop in blood pressure upon standing). Malnutrition can impair gut function, leading to diarrhea, constipation, and malabsorption. Malnutrition can disrupt hormonal balance, leading to insulin resistance, glucose intolerance, and thyroid dysfunction. Malnutrition can impair kidney function, leading to fluid and electrolyte imbalances. These systemic effects of malnutrition can further complicate the course of illness, delay recovery, and increase the risk of mortality. Addressing malnutrition is therefore

essential for optimizing patient outcomes and minimizing healthcare costs. The intricate relationship between malnutrition and comorbidities highlights the need for a comprehensive approach to patient care. Malnutrition is not simply a side effect of illness; it is a dynamic and complex condition that can significantly impact patient outcomes. Early identification and aggressive management of malnutrition are critical for preventing complications, improving recovery, and reducing healthcare costs. Healthcare professionals must adopt a proactive approach to malnutrition screening and intervention. This involves utilizing validated screening tools, developing individualized nutritional care plans, and addressing the underlying causes of malnutrition. Furthermore, healthcare providers should be vigilant in monitoring for complications associated with malnutrition and implementing preventive measures where possible.[19,20]

5. Conclusion

Malnutrition is a prevalent and often overlooked problem in hospitalized patients. Our study provides compelling evidence that malnutrition is an independent predictor of prolonged LOS. These findings underscore the importance of early identification and aggressive management of malnutrition to improve patient outcomes and reduce healthcare costs. Future research should focus on developing and evaluating comprehensive malnutrition management programs that address the complex interplay of biological, psychological, and social factors contributing to this debilitating condition.

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