Original Article

Impact of nutritional status on length of stay and hospital costs among patients admitted to a tertiary care hospital in Thailand

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Background and Objectives: Malnutrition has high prevalence among hospitalized patients but goes unrecognized in many patients. Early detection of malnutrition using an effective screening tool is required. This study aimed to examine the effects of nutritional status determined by the Nutrition Alert Form (NAF) and its individual sections on length of stay (LOS) and hospital costs in hospitalized patients, to investigate their associated factors, and to determine hospital malnutrition prevalence. **Methods and Study Design:** This retrospective cohort study enrolled 2,906 hospitalized patients aged ≥15 years in Ramathibodi Hospital between January and September 2016. At admission, nutritional status was screened using NAF. Nutrition status was defined as: NAF-A (normal/mild malnutrition; scores of 0–5), NAF-B (moderate malnutrition; 6–10), and NAF-C (severe malnutrition; ≥11). Information regarding LOS and hospital costs during patients' hospitalization was also collected. **Results:** The prevalence of malnutrition was 15.3%. After adjusting for age, sex and primary diagnosis, we found significantly longer LOS and higher hospital costs among those with NAF-B and NAF-C, in comparison with patients having NAF-A. The highest increase in LOS was in male patients aged ≥60 years with NAF-C. The highest increase in LOS and hospital costs was associated with higher scores for functional capacity. **Conclusions:** Higher levels of malnutrition screened using the NAF were significantly associated with longer LOS and higher hospital costs. Older adult patients had the highest risk of being malnourished and developing negative consequences. A prospective study of nutritional support by a nutrition care team is underway.

Key Words: malnutrition, length of stay, hospital costs, nutrition status, Nutrition Alert Form

INTRODUCTION

The prevalence of malnutrition in hospitalized patients is higher than that of the general population. Almost half of hospitalized patients are identified as malnourished.[1-3] During hospitalization, decreased energy intake (due to loss of appetite, inappropriate oral diet restriction, and disease-related dysphagia and malabsorption) leads to starvation-related malnutrition. Furthermore, infections, inflammatory processes, stress and metabolic disturbance play a major role in disease-related malnutrition.[4] Lack of awareness about this condition and its consequences results in worsening nutritional status among hospitalized patients. Previous studies[5-8] have showed that malnutrition in the hospital is related to many adverse outcomes, such as longer length of hospital stay (LOS), higher hospital costs, greater medical complications, morbidity and mortality; however, the effects of malnutrition during hospitalization vary across different populations.

Early detection of malnourishment in patients using highly precise and practical screening tools is required for early prevention and treatment of malnutrition and its consequences.[8-10] The Nutrition Alert Form (NAF)[11] is a validated and simplified nutritional screening tool modified from the original version of the Subjective Global Assessment (SGA).[12] The Society of Parenteral and Enteral Nutrition of Thailand (SPENT) recommends using the NAF to determine malnutrition.[13] Even so, the impacts of nutritional status screening using NAF and individual NAF sections on LOS and hospital costs have not been determined and this information is essential for confirming the efficacy of this screening tool and encourage medical professionals and stakeholders to be aware of their patients' nutrition. High-risk patient groups with the

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same nutritional status should be identified because they have limited health resources. Practice guidelines should also define more intensive nutritional management in these groups. Moreover, few studies presented the prevalence of malnutrition using NAF in Tertiary Care Hospital and most studies in Thailand focused only on specific settings, such as internal medicine ward and post-operative unit.[3,10,11]

The aims of the present study were to: 1) examine the effects of nutritional status screened using NAF on LOS and hospital costs among hospitalized patients; 2) evaluate the same outcomes using individual NAF sections; 3) investigate the impacts of potential factors on these outcomes; and 4) determine the prevalence of malnutrition screened using NAF in a tertiary care hospital.

METHODS

Participants and study design

This retrospective cohort study enrolled 3,519 hospitalized patients aged 15 years or older in Somdech Phra Debaratana Medical Center (SDMC), Ramathibodi Hospital in Bangkok, Thailand, between January 2016 and September 2016. Of these, 2,906 patients with complete nutritional assessment data were analysed. We excluded patients with obstetric conditions. Baseline demographic data including age, sex, and medical history were collected, and a physical examination and nutritional evaluation performed on the admission date. Information on LOS and hospital costs during patients' hospitalization was also collected. Hospital costs and estimated reimbursement data were obtained from the hospital database, in Thai baht (THB) (1 THB=0.03019 USD). All expenses related to the current hospital admission (e.g., laboratory tests, medications, therapies, nursing services, and procedures) were included in the hospital cost analysis.

The study protocol was approved by the Institutional Review Board, Faculty of Medicine, Ramathibodi Hospital, Mahidol University (Approval number ID 05-60-33).

Measurements

Anthropometric measurements, including weight and height, were taken by nurses using standardized techniques. The primary diseases or conditions recorded by physicians were obtained from online medical records, using International Classification of Diseases, 10th edition (ICD-10) codes. Body mass index (BMI) was calculated as body weight in kilograms divided by height in meters squared.

NAF scores are calculated using the total score from eight sections: height, weight and BMI, body build, weight change, dietary intake change, gastrointestinal symptoms, functional capacity, and the patient's disease.[13] Serum albumin and total lymphocyte counts were added for patients whose weight could not be measured. The NAF scores were categorized into three groups of nutritional status: NAF A or normal to mild malnutrition (scores of 0 to 5), NAF B or moderate malnutrition (6 to 10), and NAF C or severe malnutrition (≥11). The cut points of NAF have been previously validated in a hospitalized Thai population.[11] The nutritional status of all patients included in this study was evaluated using the NAF, and all assessments were performed by well-trained nurses within 24 hours of admission. All nutrition status information was entered into the database system.

Statistical analysis

Baseline data of patients are presented as mean ±standard deviation (SD) or median (interquartile range, IQR) for continuous variables and as frequency (%) for binary or categorical variables. ANOVA and Kruskal–Wallis tests were used to compare means across the nutritional status group, depending on the data distribution. Chi-square tests were used to analyze categorical variables. Linear regression analysis was used to assess the relationship of nutritional status with LOS and hospital costs, which were reported as beta coefficients with 95% confidence intervals (CI). Each section on the NAF was analyzed using multivariable linear regression models adjusted for the following potential covariates: age (in years), sex and primary diagnosis (cancer, rheumatologic disease, genitourinary tract disease, gastrointestinal tract disease, respiratory tract disease, cardiovascular disease and others). We used a multivariable linear regression model to test for interactions between NAF and age or sex, in relation to LOS and hospital costs. Subgroup analysis stratified by age (15–59 years and ≥60 years) and sex were also used to assess the association of nutritional status and of individual NAF sections with LOS and hospital costs for both age and sex groups; associations were illustrated using forest plots. Statistical significance was defined as p-value <0.05 and all reported probability tests were two-sided. The data were analyzed using IBM SPSS Statistics for Windows, Version 24.0 (IBM Corp., Armonk, NY, USA).

RESULTS

A total of 2,906 patients meeting the study criteria were included in this study. The mean age was 57.17±17.28 years and 48.8% of patients were aged 60 years or older. A total 63.6% of the sample was female. The most common primary cause of hospitalization was cancer (40.1%), followed by rheumatologic disease (13.4%) and genitourinary tract disease (10.2%). Regarding the prevalence of malnutrition, the number of patients with NAF A, NAF B, and NAF C were 2,461 (85%), 331 (11.4%), and 114 (3.9%), respectively. The mean age, median LOS, and median hospital costs increased with higher levels of malnutrition. The number of patients aged 60 years or older also increased with higher levels of malnutrition (Table 1).

Both LOS and hospital costs were significantly higher with increased malnutrition. LOS and hospital costs significantly increased in older patients, but decreased in female patients. After adjusting for age, sex and primary diagnosis, LOS in patients with NAF B and NAF C was longer than those in patients with NAF A by 3.74 (95% CI 3.13–4.36) days and 11.57 (95% CI 10.57–12.56) days, respectively. Moreover, hospital costs for patients with NAF B and NAF C were also higher at 42,939.32 (95% CI 25,159.95–60,718.70) THB and at 187,031.08 (95% CI 157,114–216,948) THB than those for patients with NAF A (Table 2). Significant interactions were found between NAF and age or sex when associated with LOS and hospital costs (p<0.001).

Table 1. Baseline characteristics of participants

Characteristics	All participants N=2906	Nutrition Alert Form (NAF)			*p* value
		A (score 0–5) n=2461	B (score 6–10) n=331	C (score >10) n=114	
Age (years), mean±SD	57.2±17.3	55.1±16.7	67.0±14.6	73.9±17.3	<0.001
Age group, n (%)					<0.001
15–59 years	1489 (51.2)	1390 (56.5)	83 (25.1)	16 (14.0)	
≥60 years	1417 (48.8)	1071 (43.5)	248 (74.9)	98 (86.0)	
Sex, female, n (%)	1849 (63.6)	1619 (65.8)	164 (49.5)	66 (57.9)	<0.001
Primary diagnosis, n (%)					<0.001
Cancer	1192 (41.0)	964 (39.2)	201 (60.7)	27 (23.7)	
Rheumatologic disease	388 (13.4)	375 (15.2)	10 (3.0)	3 (2.6)	
GU tract disease	295 (10.2)	281 (11.4)	6 (1.8)	8 (7.0)	
GI tract disease	287 (9.9)	257 (10.4)	28 (8.5)	2 (1.8)	
Respiratory tract disease	172 (5.9)	130 (5.3)	19 (5.7)	23 (20.2)	
Cardiovascular disease	155 (5.3)	107 (4.3)	23 (6.9)	25 (21.9)	
Others	417 (14.4)	347 (14.1)	44 (13.3)	26 (22.8)	
Length of stay (days), median (IQR)	2 (2–4)	2 (2–3)	3 (2–7)	9 (4-18)	<0.001
Hospital costs (THB), median (IQR)	84607.00 (52540.50-133512.75)	84932.00 (53444.00-123714.00)	68889.00 (43900.00-184636.00)	146528.50 (63402.00-297141.25)	<0.001

GU: Genitourinary; GI: gastrointestinal; IQR: interquartile range; SD: standard deviation; THB: Thai baht.
NAF A: normal to mild malnutrition; NAF B: moderate malnutrition; NAF C: severe malnutrition.

Table 2. Association of potential factors with length of stay and hospital costs

	Length of stay (days)			Hospital cost (THB)		
	β-coefficient (95% CI)	*p* value	*p* for trend	β-coefficient (95% CI)	*p* value	*p* for trend
Age (per 10 years)	0.83 (0.69 to 0.97)	<0.001		18,962.80 (15,140.95 to 22,784.66)	<0.001	
Sex (female)	-0.92 (-1.43 to -0.41)	<0.001		−15,961.15 (−29,899.41 to 20,22.88)	<0.001	
NAF			<0.001			<0.001
A (Ref.)	0.00			0.00		
B	4.33 (3.74 to 4.93)	<0.001		50,758.15 (33,527.63 to 67,988.67)	<0.001	
C	11.6 (10.6 to 12.6)	<0.001		211,982.86 (182,540.88 to 241,424.84)	<0.001	
NAF†			<0.001			<0.001
A (Ref.)	0.00			0.00		
B	3.74 (3.13 to 4.4)	<0.001		42,939.32 (25,159.95 to 60,718.70)	<0.001	
C	10.8 (9.80 to 11.8)	<0.001		193,809.59 (163,896.76 to 223,722.42)	<0.001	

CI: confidence interval; NAF: Nutrition Alert Form; Ref: reference; THB: Thai baht.
NAF A: normal to mild malnutrition; NAF B: moderate malnutrition; NAF C: severe malnutrition.
All analyses were performed using linear regression analysis.
†Multiple variable-adjusted model, adjusted for age (in years), sex and primary diagnosis.

After adjusting for age, sex and primary diagnosis, higher scores on all individual sections of the NAF were significantly associated with an increase in both LOS and hospital costs, except the section of weight change during the past 4 weeks, in which higher scores were associated only with increasing LOS. Higher scores in the section of functional capacity were associated with the highest increase in LOS (6.95 (95% CI 6.19–7.70) days per each 1-point score increase) and the highest increase in hospital costs (133,710.84 (95% CI 113,635.44–153,786.24) THB per each 1-point score increase) (Table 3).

The subgroup analysis was stratified by age group and sex, and adjusted for primary diagnosis. Higher levels of malnutrition significantly increased the LOS among all age groups and sexes. Compared with NAF A, the highest increase in LOS was found in male patients aged 60 years or older with NAF C (12.46 (95% CI 9.89–15.03) days), followed by female patients aged 60 years or older with NAF C (11.81 (95% CI 10.23–13.39) days) (Figure 1). Hospital costs increased with higher levels of malnutrition in both male patients in all age groups and female patients aged 60 years or older, but not in female patients aged 15–59 years. The highest increase in hospital costs was found among male patients aged 60 years or older with NAF C (230,635.73 (95% CI 162,043.07–299,228.39) THB), compared with male patients in the same age group with NAF A (Figure 2).

Higher scores on all sections of the NAF were significantly associated with an increase in LOS in patients aged 60 years or older. In all age and sex groups, higher scores on weight change in past 4 weeks, persistent gastrointestinal symptoms in past 2 weeks, functional capacity and patients' disease were significantly associated with an increase in LOS, whereas functional capacity and patients' disease were significantly associated with an increase in hospital costs. Moreover, higher functional capacity scores were the best predictor of LOS in male patients and amount of dietary intake scores were the best for female patients (Figure 3). Higher functional capacity scores were the best predictor of hospital costs for all

Table 3. Association of Nutrition Alert Form sections with length of stay and hospital costs

Nutrition Alert Form sections	Length of stay (days)		Hospital costs (THB)	
	β-coefficient (95% CI)	*p* value	β-coefficient (95% CI)	*p* value
Weight and body mass index	1.73 (1.17 to 2.28)	<0.001	23,591.05 (9,243.72 to 37,938.37)	0.001
Body build	2.75 (1.92 to 3.57)	<0.001	62,624.46 (41,261.63 to 83,987.29)	<0.001
Weight change in past 4 weeks	1.62 (0.81 to 2.42)	<0.001	10,974.25 (-9,916.43 to 31,864.94)	0.303
Dietary intake in the past 2 weeks				
Type of diet	5.58 (4.89 to 6.27)	<0.001	77,678.42 (59,224.09 to 96,132.75)	<0.001
Quantity of diet	6.94 (5.76 to 8.12)	<0.001	56,144.55 (24,931.38 to 87,357.73)	<0.001
Persistent gastrointestinal symptoms in past 2 weeks	3.27 (2.81 to 3.72)	<0.001	45,132.08 (33,147.97 to 57,116.18)	<0.001
Functional capacity	6.95 (6.19 to 7.70)	<0.001	133,710.84 (113,635.44 to 153,786.24)	<0.001
Patient's disease[†]	2.19 (1.86 to 2.53)	<0.001	24,790.99 (15,811.63 to 33,770.35)	<0.001

CI: confidence interval; THB: Thai baht.
All analyses performed using linear regression analysis adjusted for age (in years), sex and primary diagnosis.
B-coefficients are per each 1-point score increase in each section of the Nutrition Alert Form.
[†]B-coefficients are per each 3-point score increase in patient's disease. Scores in this section increase at least 3 points for each additional disease

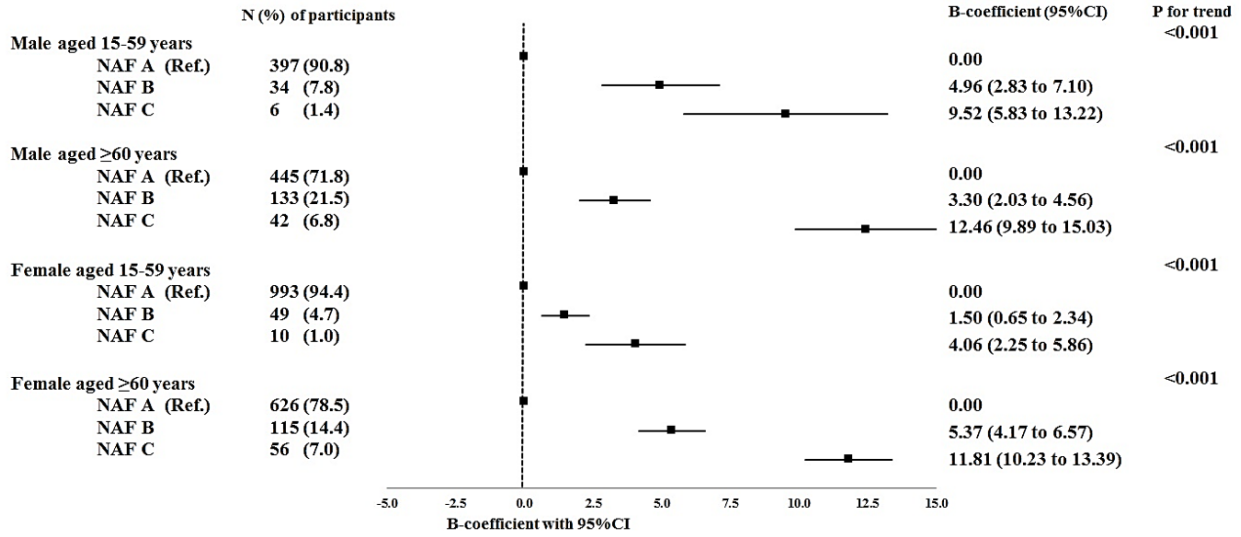

Figure 1. Forest plot of association between Nutrition Alert Form and length of stay (days), stratified by age and sex. Ref: reference. NAF A: normal to mild malnutrition; NAF B: moderate malnutrition; NAF C: severe malnutrition. All analyses performed using linear regression analysis, adjusted for primary diagnosis.

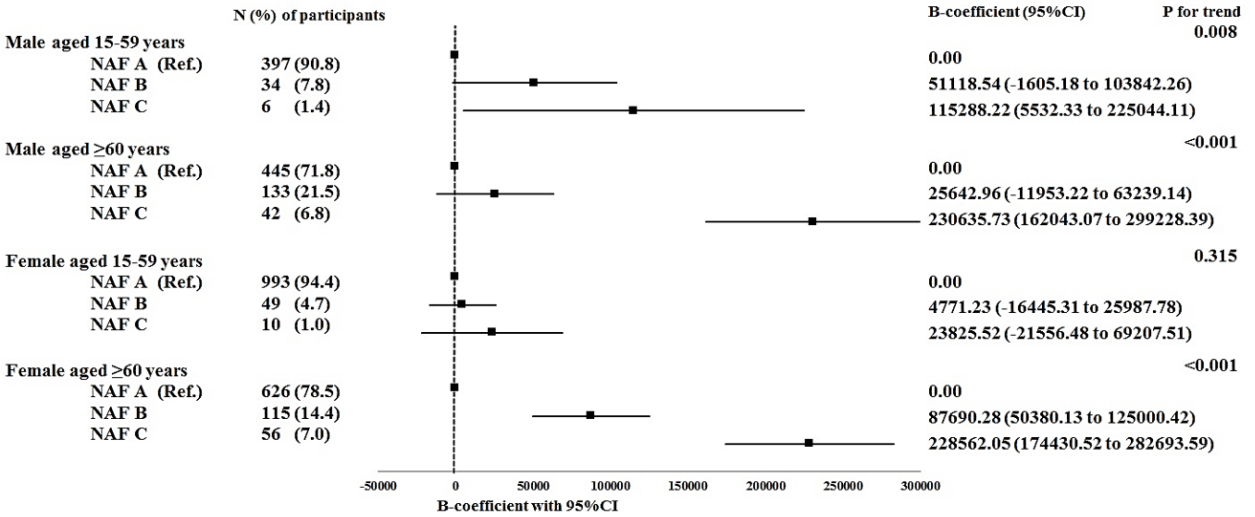

Figure 2. Forest plot of association between Nutrition Alert Form and hospital costs (Thai baht), stratified by age and sex. Ref: reference. NAF A: normal to mild malnutrition; NAF B: moderate malnutrition; NAF C: severe malnutrition. All analyses performed using linear regression analysis adjusted for primary diagnosis.

patients (Figure 4).

DISCUSSION

This study included a large number of patients admitted to SDMC, Faculty of Medicine Ramathibodi Hospital, a tertiary hospital in Thailand. The NAF is a nutritional screening tool that has been validated in a Thai population. The NAF is easy to use and does not require nutrition expertise to use it. We found that for hospitalized patients in a tertiary care setting, higher levels of malnutrition (assessed by NAF) were associated with longer LOS and higher hospital costs. This association remained after adjusting for age, sex and primary diagnosis. However, there were differences among sex and age groups. In patients aged 60 years or older, all individual NAF sections were associated with an increase in LOS and most sections (7/8 in male and 6/8 in female) were also associated with an increase in hospital costs.

The prevalence of malnutrition in the present study was 15.4%, which is slightly less than the rates of malnutrition reported in previous studies done in hospital settings. This could be because many patients in our study were surgical patients, some of whom were hospitalized for an elective surgery or intervention, and the survey was performed among more patients with upper to middle income levels than those with low income levels, as a difference to previous studies;[3,4] however, the prevalence in the present study was higher than the community.[14]

The present study revealed that severely malnourished patients remained hospitalized 10.8 days longer and had

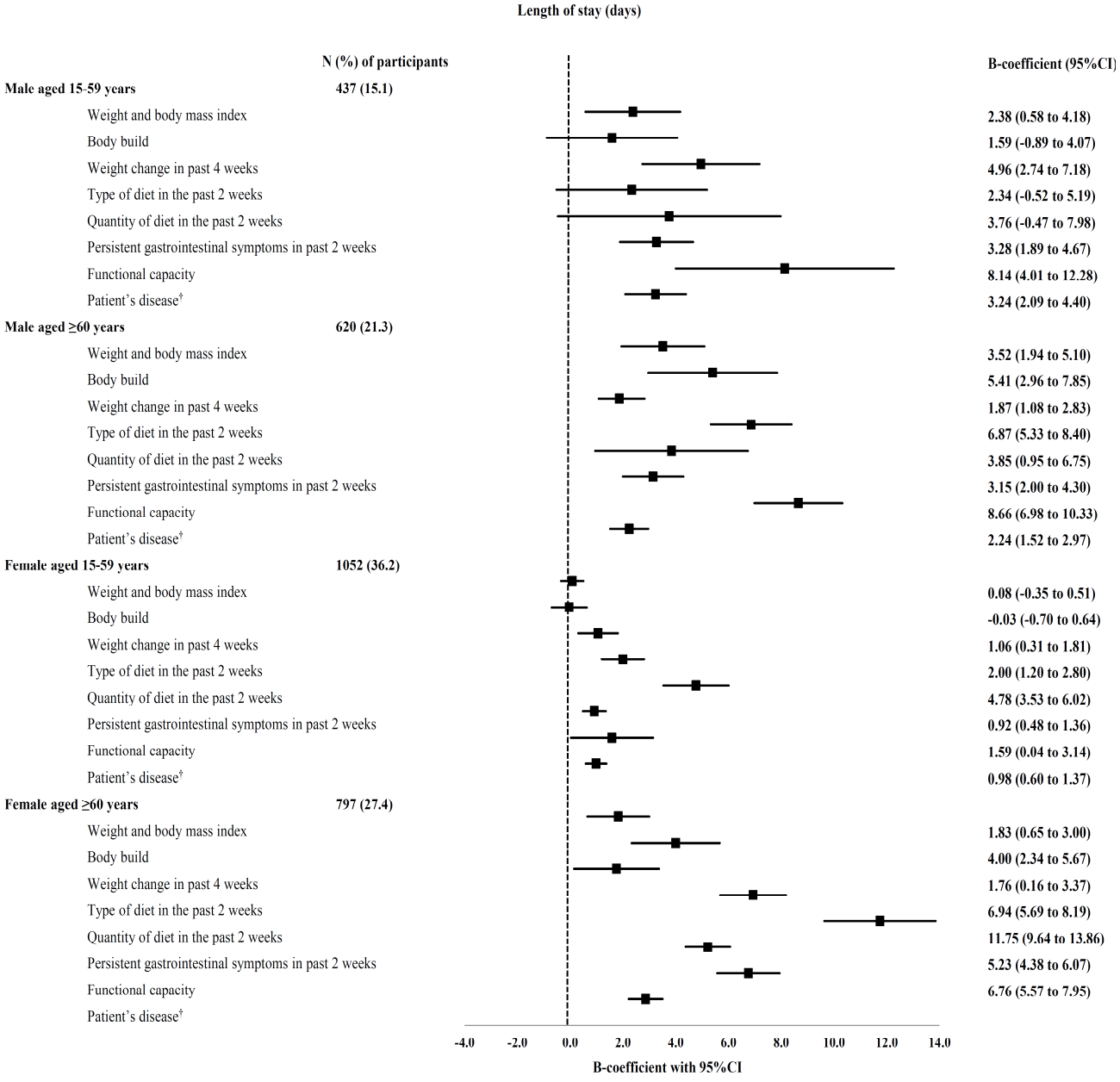

Figure 3. Forest plot of association of Nutrition Alert Form sections with length of stay (days) and hospital costs (Thai baht), stratified by age and sex. CI: confidence interval; THB: Thai baht. All analyses performed using linear regression analysis adjusted for primary diagnosis. B-coefficients are per each 1-point score increase in each section of the Nutrition Alert Form. †B-coefficients are per each 3-point score increase in patient's disease. Scores in this section increase at least 3 points for each additional disease.

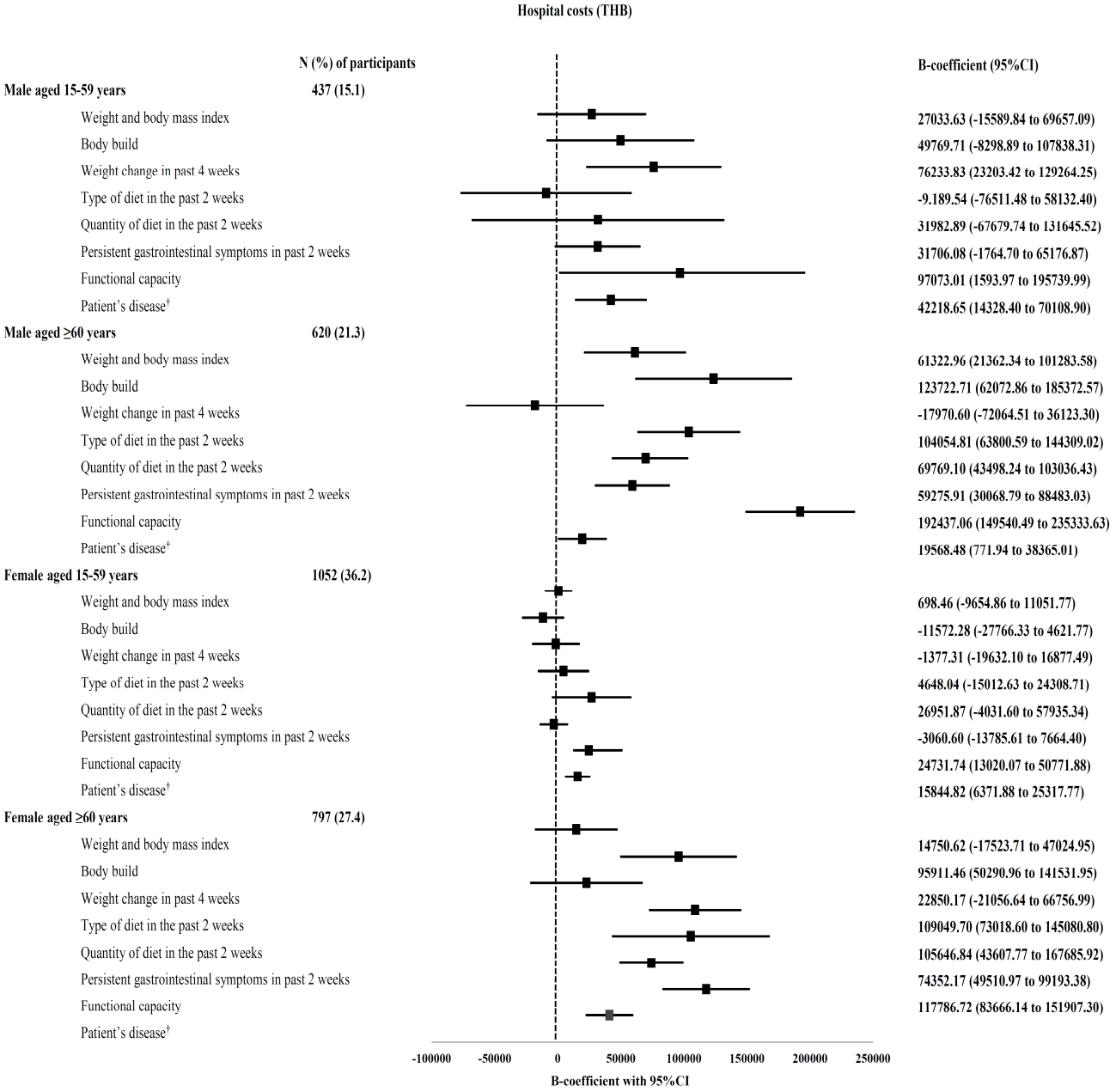

Figure 4. Forest plot of association of Nutrition Alert Form sections with length of stay (days) and hospital costs (Thai baht), stratified by age and sex (cont.). CI: confidence interval; THB: Thai baht. All analyses performed using linear regression analysis adjusted for primary diagnosis. B-coefficients are per each 1-point score increase in each section of the Nutrition Alert Form. †B-coefficients are per each 3-point score increase in patient's disease. Scores in this section increase at least 3 points for each additional disease.

hospital costs that were 193,809.59 THB higher than patients with normal to mild risk of malnutrition, after adjusting for age, sex and primary diagnosis. These findings are similar to those of previous studies.[15,16]

We found a higher prevalence of malnutrition among older individuals. Compared with patients with normal to mild risk of malnutrition, those aged 60 years or older were at higher risk for increased LOS (men: 12.46 days and women: 11.81 days) and hospital costs (men: 228,562.05 THB and women: 230,635.73 THB) when they were malnourished. Moreover, older age (≥60 years) and male sex were independently related factors of longer LOS and higher hospital costs. These results are in line with those of previous studies.17-20 Ageing is an important risk factor in nutritional alteration owing to physical, cognitive, and physiological limitations.[21] Our study suggests that older hospitalized patients with malnutrition, especially those aged 60 years or older, should be a priority care group.[22] Upon subgroup analysis, however, the effect of malnutrition on hospital costs was not sustained. This may be a result of including hospital costs in the expenses for advanced procedures, such as non-invasive operations and elective interventions.

Our study showed that functional capacity was a strong predictor of both LOS and hospital costs among all age and sex groups. Poor physical performance is closely related to sarcopenia (loss of skeletal muscle mass and impaired function) which can arise from malnutrition and a sedentary lifestyle.[23] Additionally, the deterioration of functional capacity impacts the quality and quantity of food intake.[24] We also found that the type and amount of dietary intake in the past 2 weeks were robust predictors

of both LOS and hospital costs for elderly patients (age ≥60 years). A decrease in food consumption directly influences energy and nutrient deficiencies. Prolonged inadequate ingestion also negatively affects weight loss and functional capacity, particularly in elderly people.[24] These findings suggest that, at the very least, functional capacity should be included in nutritional screening tools for adults, and dietary intake evaluation should be included in nutritional screening tools for elderly individuals.

This study had some limitations. Some patients with incomplete data in the database might have been excluded owing to the study's retrospective design. It is possible for outcomes to be influenced by a change in nutritional status during the hospitalization, but the likelihood of this occurring is small; previous research has found that less than 5% of patients significantly change their nutritional status during hospitalization.[25] Furthermore, LOS can be confounded by a missing discharge status (e.g. clinical improvement, transference and death). Primary diagnosis was accounted for in our regression models, but disease severity was not. For example, the stage of cancer could affect the LOS and hospital costs. In addition, some patients were admitted for a short period of time, depending on their intervention, so our findings might not reflect the true LOS and hospital costs.

Conclusion

The prevalence of malnutrition is high among hospitalized patients, with older male patients having the greatest risk of being malnourished. Malnutrition in hospitalized patients screened using the NAF was significantly associated with longer LOS and higher hospital costs. Higher scores on each section of the NAF were associated with longer LOS, and higher scores in nearly all sections were correlated with higher hospital costs. Functional capacity is a good predictor of LOS and hospital costs, as well as dietary intake history in elderly individuals. Early detection of malnutrition and aggressive treatment may lead to decreased length of stay and costs among hospitalized patients. A prospective study on nutritional management by a nutrition care team is ongoing, to support this hypothesis.

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AUTHOR DISCLOSURES

All authors declare that they have no potential competing interests to report.

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