Malnutrition prevalence in adrenal insufficiency among hospitalized elderly patients: limitations of the body mass index in the assessment of malnutrition

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ABSTRACT

Background and Objectives: This study aimed to evaluate malnutrition prevalence and usefulness of the body mass index (BMI) in the assessment of malnutrition in hospitalized elderly patients with adrenal insufficiency (AI). **Methods and Study Design:** 318 hospitalized AI patients were diagnosed by a rapid ACTH stimulation test with a history of steroid treatment and compared with 374 control patients. Nutrition was assessed using the Malnutrition Universal Screening Tool (MUST). Nutritional status was evaluated using the Mini Nutritional Assessment short form (MNA-SF) and BMI. **Results:** There was no difference in nutritional screening between the AI and control groups. Nutritional assessments indicated that 31.2% of all elderly patients suffered from malnutrition and 33.8% of patients were at risk of malnutrition. Less than half of the patients (34.9%) were identified as well nourished. In this study, 33.6% vs 29.1% of patients were malnourished in the AI and control group, respectively. Overall, prevalence of malnutrition was higher in the AI group than the control group. In the AI group, patients with low basal cortisol had a higher incidence of malnutrition than those with high basal cortisol. The BMI of patients in the AI group was higher than in the control group. According to BMI criteria, 64.3% of malnourished patients were overweight or obese in the AI group. **Conclusions:** Elderly AI patients are prone to develop malnutrition despite being overweight or obese. Therefore, more extensive nutritional assessment of elderly patients with AI is required regardless of BMI.

Key Words: malnutrition, nutritional status, nutritional assessment, adrenal insufficiency, elderly

INTRODUCTION

Adrenal insufficiency (AI) is a serious endocrine disorder which occurs due to insufficient production of cortisol by the adrenal cortex and impairment of the hypothalamic-pituitary-adrenal (HPA) axis.[1] Adrenal insufficiency can be primary or secondary, based on the underlying pathophysiology. Secondary AI is more common. The most common cause of AI is chronic administration of exogenous glucocorticoids, which leads to prolonged suppression of the HPA axis resulting in insufficient corticotrophin releasing hormone production.[2] Glucocorticoid therapy is widely prescribed for the management of various disorders because of its anti-inflammatory effect and immunosuppressive action.[3] Therefore, elderly patients who often receive glucocorticoids for medical treatment, are at a higher risk of AI. Joseph et al[4] reported that the median percentage of patients found to have AI was 37.4%. Chen et al[5] showed that the incidence of AI in the general population was 15.5/105 but 92.4/105 in the elderly population (>60 years). Clinical manifestations of AI are nonspecific such as lassitude and fatiguability in the early stage. The clinical diagnosis of AI is not easy to identify unless there is clinical awareness of the disease.[6]

Malnutrition is a major clinical problem among elderly patients. The overall prevalence of malnutrition was 23% with the highest prevalence observed in a rehabilitation setting (50.5%), followed by hospitals (38.7%), nursing homes (13.8%), and communities (5.8%).[7] Malnutrition in the elderly can lead to serious complications, including : an impaired immune system, which increases the risk of infections, poor wound healing, muscle weakness and decreased bone mass, which can lead to frequent falls and fractures, increased complications, increased length of stay and mortality.[8-10] Despite being a common and long-standing clinical problem among the elderly, malnutrition and its associated negative outcomes are often unrecognized .

Nausea, vomiting, anorexia and abdominal pain are common clinical symptoms in AI. These can lead to poor oral intake and weight loss, which may subsequently play a role in the development of malnutrition in older patients.[11] Chronic excess glucocorticoid leads to changes in body composition, with fat redistribution resulting in accumulation of central adipose tissue and weight gain.[12] BMI is an objective method for assessment of malnutrition.. Nutritional risk and low BMI are both associated with poor health-related outcomes and mortality among older adults.[13] Yet BMI may not reflect the nutritional status of the hospitalized patients.[14,15]

Studies of nutritional status in elderly patients with AI are few. We sought to evaluate the prevalence of malnutrition and the usefulness of body mass index in the recognition of malnutrition in hospitalized elderly patients with adrenal insufficiency.

MATERIALS AND METHODS

Hospitalized elderly patients over 65 years were studied: 318 patients with AI and a history of steroid use and 374 control subjects who were diagnosed by a rapid ACTH (corticotrophin) stimulation test.

Assessment of adrenal cortex function

Adrenal cortex function was assessed using the rapid ACTH (250 μg of cosyntropin) stimulation test. The rapid ACTH stimulation test was performed in the following manner. Basal cortisol was sampled prior to administration of 250 μg of cosyntropin (ACTH) intravenously. Blood samples for cortisol were then collected at 30 and 60 min respectively. A normal response was a peak serum cortisol of ≥18 μg/dL at 30 or 60 min. AI was confirmed when the 250 μg ACTH stimulated cortisol was less than 18 μg/dL.[16] Subsequent measurement of plasma ACTH, determined whether AI was primary or secondary.

Anthropometric assessment

All anthropometric data including body weight, height, body mass index and calf circumference were recorded using standard techniques.

Nutritional screening and nutritional assessment

The nutritional screening was conducted on all patients admitted to the Chungbuk National University Hospital within 24 hours to identify risk of malnutrition. The nutritional screening test and nutritional assessment were provided by the NST (nutritional support team) of Chungbuk National University hospital. Nutritional screening was assessed using the Malnutrition Universal Screening Tool (MUST).[17] The MUST score system consists of three parameters: BMI, weight loss and acute disease effect. The overall risk for malnutrition is reported as low (score=0), medium (score=1) or high (score ≥2). Nutritional status was also evaluated using the Mini Nutritional Assessment short form (MNA-SF).[18] The maximum MNA-SF score is 14 points. It categorized patients as malnourished (scores ≤7), at risk for malnutrition (scores from 8 to 11) or normal (scores ≥12)

Biochemical parameters

We obtained nutritional haematology and biochemistry information, including hemoglobin, total lymphocyte count, serum total protein, albumin, glucose, total cholesterol and calcium.

Statistical analysis

Statistical analyses were performed with the SPSS statistical package version 21.0 (SPSS, Chicago, IL, USA). Continuous data are expressed as means and standard deviations. Categorical variables are presented as frequencies and percentages. Categorical variables were evaluated by the Chi-square test and continuous variables by the t-test. Analysis of variance (ANOVA) was used for continuous variables.

Ethics statement

The study was approved by the Institutional Review Board of the Chungbuk National University Hospital (IRB No. 2017-11-003). The requirement for informed consent was waived by the IRB.

RESULTS

Clinical characteristics

Clinical characteristics of the patients are shown in Table 1. A total of 692 hospitalized elderly patients were enrolled in this study. The study group consisted of 423 (61.1%) women and 269 (38.9%) men. The mean age was 76.1±6.3 years, ranging between 65 and 91 years. Among the study population, 318 patients had a positive rapid ACTH stimulating test and were categorized as the AI group and 374 patients had a negative rapid ACTH stimulating test and were categorized as the control group. There was no age difference between the two groups. The proportion of women in the AI group was lower than the control group. The most common cause of AI was an underlying pneumonia in both groups (18.6% vs 22.5%, AI group vs Control group). Oncological disorders were the second most common cause of underlying disease in both groups. Endocrine disorders were more prevalent in the AI group than the control group.

Laboratory findings are summarized in Table 2. Serum albumin, total protein, glucose, total lymphocyte count, electrolyte (sodium, potassium chloride) were significantly lower in the AI group than in the control group. There was no difference in cholesterol, creatinine and uric acid between two groups. Plasma C-reactive protein was higher in the AI group than in the control group.

Anthropometric parameters

The BMI of patients in the AI group was significant higher than the control group (Table 3). According to patient BMIs, 61.0% vs 42.3% of patients were categorized as either overweight or obese in the AI group vs. control group, respectively. In the AI group, 64.3% of malnourished patients were overweight or obese (Figure 1).

When we analyzed the BMIs according to basal cortisol (Table 4), AI patients with a low basal cortisol (below 5 μg/dL) had higher BMIs than AI patients with a high basal cortisol (above ≥10 μg/dL). In the control group, those with an intermediate basal cortisol had the highest BMI.

Nutritional screening test

The baseline nutritional screening test (MUST) showed that 19.1% of patients were at minimal risk of malnutrition and more than three quarters of patients were at medium and high risk of malnutrition, 33.1% and 45.8% respectively. There was no difference in nutritional screening by MUST between the AI and control groups (Table 5). The nutritional screening test results were as follows in both group (AI group vs. control group): 30.8% vs. 19.8%, were at low risk, 18.2% vs. 35.0% were at a medium risk and 50.9% vs. 45.2% were at a high risk, respectively. Also, nutritional screening results were analyzed according to basal cortisol in both groups (Table 6). In the AI group, patients with low basal cortisol had a higher incidence of high risk of MUST than those with high basal cortisol. In the control group, patients with an intermediate basal cortisol showed highest risk for malnutrition according the MUST screening test.

Nutritional assessment

The nutritional assessment suggested that 31.2% of all elderly patients suffered from malnutrition and 33.8% of patients were at risk of malnutrition. Less than half of the patients (34.9%) were identified as well nourished.

Malnourished patients were 33.6% vs. 29.1% in the AI vs. control groups, respectively (Table 5). Patients at risk of malnutrition were 45.6% vs. 23.8% in the AI vs. control group. Overall, the prevalence of malnutrition was higher in the AI group than in the control group.

We analyzed nutritional status according to basal cortisol in both groups. In AI group, patients with a low basal cortisol had a higher incidence of malnutrition than those with high basal cortisol. Nutritional status correlated with basal cortisol in the AI group (Table 6). In the control group, patients with an intermediate basal cortisol showed the highest incidence of malnutrition (Table 7).

DISCUSSION

The present study demonstrated that the nutritional status in AI was worse than in controls in this study. The prevalence and the risk of malnutrition in AI patients appear to be higher than previous studies that used the MNA scale for nutritional assessment. Liu et al reported that 18.5% and 33.1% of hospitalized elderly patients were malnourished or at risk of malnutrition, respectively. Sanz et al[19] studied 1090 elderly diabetic patients in 35 Spanish hospitals utilizing the MNA and found that 21.2% of patients had malnutrition and 39.1% of the patients were at risk of malnutrition. Guigoz Y et al[20] identified 36 studies of hospitalized elderly patients (n=8,596) and reported that the mean prevalence of malnutrition and the risk of malnutrition was 23% and 46%, respectively. Nevertheless, no previous studies have focused on elderly patients with AI.

In the present study, we analyzed the nutritional status of all participants regardless of adrenal function. Nutritional assessment showed that 31.2% of all elderly patients suffered from malnutrition and 33.8% of patients were at risk of malnutrition. Less than half of the patients (34.9%) were identified as well nourished. Compared to previous studies, our study demonstrated a high prevalence of malnutrition and those risk of malnutrition. In general, an adrenal function test was performed when patients complained of nausea, vomiting, unknown origin of abdominal pain or hypotension, weakness and electrolyte imbalance. These non-specific symptoms may induce poor oral intake in elderly patients. Therefore, the rate of malnourished patients was high in this study. We analyzed the nutritional status of patients according to basal cortisol and in the AI group, nutritional status had showed an inverse correlation with basal cortisol.

In the control group, patients with intermediate basal cortisol showed highest incidence of malnutrition. The conflicting result between the AI group and control group might be explained by the high percentage of patients with oncological disorders with intermediate basal cortisol.

We also evaluated nutritional screening test using MUST and analyzed how these results correlated with basal cortisol. In the AI group, patients with low basal cortisol showed higher incidence of high risk of MUST than those with high basal cortisol. In control group, patients with intermediate basal cortisol showed highest incidence of high risk of MUST. The result of nutritional screening test was similar to the nutritional assessment.

Anthropometric parameters, such as body weight, BMI, mid-arm circumference (MAMC) and triceps skinfold thickness (TST), are good predictors of malnutrition. Detection of anthropometric parameters for malnutrition requires simple, non-invasive technique and inexpensive tools such as the MAMC and TST. The accuracy and reproducibility of these anthropometric measurements may be affected by the equipment calibration and examiner. Therefore, BMI is preferred to access malnutrition in general. However, BMI alone is insufficient to evaluate nutritional status in elderly patients due to various causes.[21] Baccro et al[15] reported similar results that malnutrition prevalence using the Subjective Global Assessment (SGA, 48.7%) is high against the low prevalence using the BMI (9.9%). They suggested that BMI was not a suitable method to assess the impact of malnutrition in hospitalized patients compared with the SGA.

Our study showed a similar result. The mean BMI in AI group was higher than in controls. For the AI group, 61.0% were classified as overweight or obese. In the AI group, 64.3% of malnourished patients were overweight or obese. Our findings show that elderly AI patients may have an unfavorable nutritional status even if overweight or obese. If only BMI is available an indicator of malnutrition, malnutrition in elderly patients with AI may not be recognized. Measurement combination increases sensitivity and specificity.

Malnutrition is associated with adverse clinical outcomes such as longer hospital day and mortality.[8] It t is also associated with increased healthcare-related costs.[22] Therefore, various subjective tools have been developed and are currently used for the detection of malnutrition, including SGA, PG-SGA, MUST, MNA and its short form (SF-MNA). The MNA was developed and validated on large representative studies of elderly persons worldwide. It evaluates nutritional status based on features of the history and physical examination and scores patients on a scale ranging from well-nourished to severely malnourished.[23] However, it may be too long for a examiner in a primary care setting.[24] Thus, a simple nutritional screening tools was needed that would be accurate in the clinical setting. The MNA-SF has 6 questions instead of 18, removes time-consuming and subjective factors, and can be examined in approximately within 3 minutes.[23] The MNA-SF was highly correlated with the total MNA score and has high diagnostic accuracy (98.7%) for predicting malnutrition. Objective tools, such as laboratory and anthropometric parameters, are convenient and reproducible for nutritional assessment. Unfortunately, many studies have shown that the inadequacy of any tool used alone in accurately predicting the nutritional status of patients.[25] The diagnosis of malnutrition depends upon multi factorial clinical determination such as physical findings, presence of risk factors, biochemical markers and recent body weight changes. Therefore, attempts to develop new tools, trials or new combinations of nutritional factors are necessary to evaluate the malnutrition in patients.

In this study, we evaluated anthropometric parameters according to basal cortisol. The low basal cortisol (below 5 μg/dL) group had a higher BMI than the high basal cortisol (above ≥10 μg/dL) group. This may be associated with long term glucocorticoid exposure. Chronic glucocorticoid excess can lead to marked changes in body composition, such as reducing lean body mass, bone mass and redistribution of fat. The aging process is also linked to various changes in body composition, such as reducing lean body mass and accumulating body fat simultaneously like glucocorticoid.[26] Taken together, loss of muscle mass and fat accumulation may be accelerated in elderly patients with AI.

AI patients usually present with nonspecific symptoms such as weakness, fatigue, nausea, anorexia, vomiting, fever, and abdominal discomfort. Due to its vague symptomatology, delay diagnosis is common. In a cross-sectional study of 216 patients with AI, 47% had symptoms for more than 1 year before diagnosis and 20% had symptoms for more than 5 years before diagnosis.[27] Only 15% of patients were given the correct diagnosis at the initial medical encounter.

Because of multiple comorbidities along with vague symptoms, the diagnosis of AI in the elderly is often difficult and can be mistaken for the aging process. Epidemiological data of AI in the elderly population were uncommon.

Based on nationwide hospitalized datasets in Taiwan, the prevalence of AI was 15.5/105 in the whole population. The prevalence of AI was 92.4/105 in the elderly population. Incidence of AI was six-fold higher in elderly population than young people.

Chronic administration of glucocorticoid is the most common cause of adrenal insufficiency.[2] As a result, local forms of glucocorticoid, including topical, intra-articular, or aerosol therapy have been used instead of systemic therapy to minimize adverse effects. Synthetic glucocorticoids have a higher affinity for the glucocorticoid receptor and lower affinity for the binding protein, so even with short half-lives, lower-potency agents can potentially cause adverse effects if given in adequate amounts with frequent delivery.[28] Theoretically local forms of glucocorticoid have a less systemic adverse effect; however, all available forms of glucocorticoid are capable of inducing AI. Therefore, patients who take any form of glucocorticoid have the potential to develop AI. While there is limited published data regarding the clinical impact, Smans et al[29] suggests that 6% of patients presenting in the hospital with AI may have glucocorticoid-induced AI.

In the present study, we evaluated adrenal function using a rapid ACTH stimulation test. The insulin hypoglycemia test is considered the gold standard for the diagnosis of AI. However, it requires medical supervision and can be harmful in patients with a history of seizure, cardiac disease, or the elderly.[30] It has potential significant side effects compared to the rapid ACTH stimulation test.

The most common co-morbidity experienced by patients in the AI group was an infectious disease (18.6%, n=59), followed by oncological disorders (17.0%, n=54), endocrine disorders (13.2%, n=42), and musculoskeletal disorders (12.6%, n=40). Pneumonia was the most common outcome of the infectious disorders, followed by urinary tract infection, abscess and sepsis. Chen et al[5] reported that the most common co-morbidity in hospitalized elderly patients with AI was pneumonia (8.6%), followed by urinary tract infection (6.9%), electrolyte imbalance (6.6%), and septicemia (5.7%). Our study showed similar results.

Biochemical parameters have been used as markers of malnutrition due to objective and quantitative results. However, they should only be used a complement to findings from a through physical examination. Biochemical parameters can be easily influenced by various factors that are independent from the nutritional condition of the patient.[31] The present study showed that serum of albumin, total protein, glucose, total lymphocyte count, electrolyte (sodium, potassium chloride) were significantly lower in the AI group than in the control group. The plasma of C-reactive protein was higher in the AI group compared to the controls. However, there was no difference in serum cholesterol, creatinine and uric acid. Cholesterol is one of the biochemical parameters of malnutrition, but in patients who take statin or have liver cirrhosis, caution should be taken when determining malnutrition.

Several studies reported that prevalence of chronic disorders, including COPD, asthma, diabetes and chronic renal failure are higher in elderly patients.[32-35] To date, no studies have been conducted to assess nutritional status among elderly patients with AI. This is the first study to evaluate the nutritional status of hospitalized elderly patient with AI. The current study has a few limitations. Food intake has not been assessed in its own right; without it a nutritional assessment is incomplete. We have not t utilized anthropometric parameters such as arm and calf circumference, triceps skin fold thickness. Further research should focus on nutritional assessment in elderly patients with adrenal insufficiency by documentation of diet[22] and the utilization of anthropometric parameters which provide more specific information on body composition, especially that which allows an assessment of sarcopenia.[36]

Symptoms of AI are associated with poor oral intake which plays a potential role in developing malnutrition subsequently. Elderly AI patients have an unfavorable nutritional status even if they are overweight or obese, in part because this may mask problems in food intake and the presence of sarcopenia. . Therefore, we should evaluate nutritional assessment of elderly patients with AI, regardless of BMI. A nutritional assessment is not complete unless it is known what is eaten.

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AUTHOR DISCLOSURE

The authors have no conflicts of interest to disclose.

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Table 1. Baseline clinical characteristics of patients

	Adrenal insufficiency group (N=318)	Control group (N=374)
Age (Years)	75.57±6.43	76.01±6.28
Sex (F : M), n	170 : 148	253 : 121
Co-morbidities, n (%)		
Cardiologic disorder	32 (10.1)	35 (9.4)
Drug intoxication	1 (0.3)	3 (0.8)
Electrolyte disorder	14 (4.4)	33 (8.8)
Endocrine disorder	42 (13.2)	27 (7.2)
Gastroenterologic disorder	15 (4.7)	19 (5.1)
Hematologic disorder	8 (2.5)	9 (2.4)
Infectious disorder	59 (18.6)	84 (22.5)
Musculoskeletal disorder	40 (12.6)	36 (9.6)
Nephrologic disorder	24 (7.5)	31 (8.3)
Neurologic disorder	8 (2.5)	28 (7.5)
Oncological disorder	54 (17.0)	43 (11.5)
Pulmonary disorder	20 (6.3)	24 (6.4)
Rheumatologic disorder	1 (0.3)	2 (0.5)

Table 2. Laboratory findings by adrenal insufficiency

	Adrenal insufficiency group (N=318)	Control group (N=374)	*p* value
Hb (g/dL)	11.10±1.94	11.59±1.46	0.456
Total Lymphocyte count (/mm^3)	1247.75±821.54	1407.07±859.75	0.014
Total protein (g/dL)	6.02±0.85	6.23±0.92	0.041
Albumin (g/dL)	3.37±0.77	3.53±0.69	0.004
Glucose (mg/dL)	132.83±54.98	148.17±60.32	0.001
Total cholesterol (mg/dL)	146.02±49.54	144.96±44.75	0.786
AST (IU/L)	21.28±15.68	25.91±32.76	0.024
ALT (IU/L)	27.05±16.27	35.61±39.05	0.002
ALP (IU/L)	83.11±42.51	84.81±43.7	0.631
Uric acid (mg/dL)	4.43±2.16	4.68±6.22	0.527
BUN (mg/dL)	18.51±12.79	21.12±19.88	0.004
Creatinine (mg/dL)	1.12±1.18	1.07±1.18	0.596
CRP (mg/L)	6.29±8.08	5.04±6.25	0.033
Sodium (mEq/L)	131.25±10.68	133.97±7.98	0.001
Potassium (mEq/L)	4.01±0.75	4.24±1.62	0.015
Chloride (mEq/L)	97.53±11.95	101.23±7.63	0.001
ACTH (pg/mL)	14.83±15.67	23.38±24.78	0.001
Basal cortisol (μg/dL)	5.86±3.97	20.04±3.56	0.012
30 minute cortisol (μg/dL)	10.71±4.34	22.99±8.16	0.006
60 minute cortisol (μg/dL)	12.23±4.49	26.03±8.55	0.001

AST: aspartic acid transaminase; ALT: alanine aminotransferase; CRP: C-reactive protein; ALP: alkaline phosphatase.

Table 3. Anthropometrics parameters measured in the patients

	Adrenal insufficiency group (N=318)	Control group (N=374)	*p* value
BMI (kg/m^2)	24.52±4.96	22.55±4.29	0.001
Underweight (<18.5 kg/m^2)	40 (12.6%)	64 (17.1%)	
Normal weight (18.5 - 22.9 kg/m^2)	84 (26.4%)	152 (40.6%)	
Overweight (23.0 - 24.9 kg/m^2)	64 (20.1%)	74 (19.8%)	
Obesity (≥ 25 kg/m^2)	130 (40.9%)	84 (22.5%)	0.001

Table 4. BMI according to basal cortisol

	Basal cortisol (μg/dL)	BMI (kg/m^2)	*P* - value
Adrenal insufficiency group (N=318)	1 ≤ cortisol < 5	24.90±4.78	
	5 ≤ cortisol < 10	24.82±5.29	0.009
	10 ≤ cortisol	22.84±4.46	
Control group (N=374)	1 ≤ cortisol < 5	22.84±3.91	
	5 ≤ cortisol < 10	24.02±4.53	0.006
	10 ≤ cortisol	22.19±4.21	

Table 5. Nutritional screening test and Nutritional assessment of patients

	Adrenal insufficiency group (N=318)	Control group (N=374)	*p* value
MUST			
Low risk	58 (30.8%)	74 (19.8%)	
Medium risk	98 (18.2%)	131 (35.0%)	0.312
High risk	162 (50.9%)	169 (45.2%)	
MNA-SF			
Normal nutritional status	66 (20.8%)	176 (47.1%)	
At risk of malnutrition	145 (45.6%)	89 (23.8%)	0.001
Malnourished	107 (33.6%)	109 (29.1%)	

MUST: Malnutrition Universal Screening Tool; MNA-SF: Mini Nutritional Assessment short form

Table 6. Nutritional screening test according to basal cortisol

	Basal cortisol (μg/dL)	MUST (Number)			*p* value
		Low risk	Medium risk	High risk	
Adrenal insufficiency group	1 ≤ cortisol < 5	10	46	120	
(N=318)	5 ≤ cortisol < 10	47	48	38	0.008
	10 ≤ cortisol	1	4	4	
Control group (N=374)	1 ≤ cortisol < 5	5	4	5	
	5 ≤ cortisol < 10	24	60	147	0.009
	10 ≤ cortisol	45	67	17	

MUST: Malnutrition Universal Screening Tool

Table 7. Nutritional assessment according to basal cortisol

	Basal cortisol (μg/dL)	MNA-SF (Number)			*p* value
		Normal nutritional status	At risk of malnutrition	Malnourished	
Adrenal insufficiency group	1 ≤ cortisol < 5	26	60	90	0.032
(N=318)	5 ≤ cortisol < 10	33	84	16	
	10 ≤ cortisol	7	1	1	
Control group	1 ≤ cortisol < 5	5	4	5	0.003
(N=374)	5 ≤ cortisol < 10	86	60	85	
	10 ≤ cortisol	85	25	19	

MNA-SF: Mini Nutritional Assessment short form

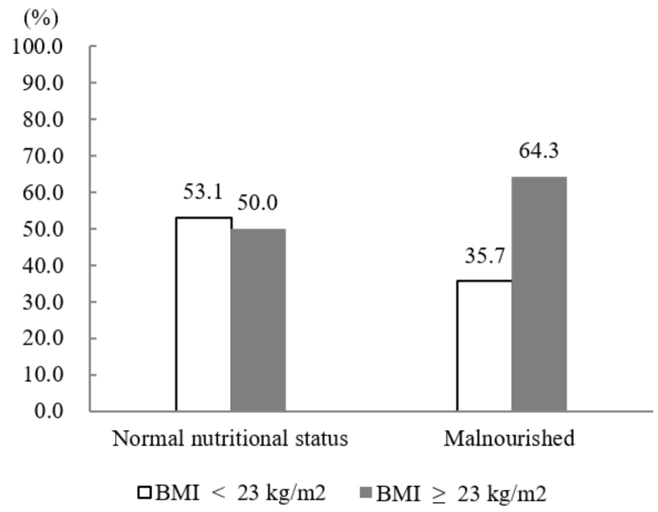

Figure 1. Relation between MNA-SF (Mini Nutritional Assessment short form) and BMI in the AI group.