Journal of Fasting and Health
http://jfh.mums.ac.ir
JFH

# Nutritional status and oxidative stress on admission and discharge of myocardial infarction patients

Mohsen Nematy[1,2], Seyed Mostafa Parizadeh[1], Mohammad Safarian[1,2], Abdolreza Norouzy[2], Seyed Mohammad Reza Parizadeh[1,3], Mohsen Mouhebati[1], Maryam Ghandehari[1], Shima Tavalaie[1], Majid Ghayour-Mobarhan[1,4,*], Gordon A. Ferns[5]

1. Metabolic Syndrome Research Center, Mashhad University of Medical Sciences, Mashhad, Iran
2. Department of Nutritional Sciences, Faculty of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran
3. Department of Medical Biochemistry, Faculty of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran
4. Department of Modern Sciences and Technologies, Faculty of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran
5. Brighton & Sussex Medical School, Division of Medical Education, Falmer, Brighton, Sussex BN1 9PH, UK

ARTICLEINFO

*Article type:*
Original article

*Article History:*
Received: 19 May 2018
Accepted: 29 Jul 2018
Published: 27 Sep 2018

*Keywords:*
Myocardial infarction
Nutritional risk screening (NRS-2002)
Prooxidant-antioxidant balance
Suboptimal nutrition

ABSTRACT

**Introduction:** The present study aimed to evaluate the effects of hospitalization on the nutritional status and prooxidant-antioxidant balance (PAB) of the patients with myocardial infarction (MI).
**Methods:** This study was conducted on 57 patients diagnosed with MI with the mean age of 58.44±12.80 years. The patients were admitted to the cardiac care unit (CCU) of Ghaem Hospital in Mashhad, Iran. Nutritional status of the patients was assessed using the nutritional risk screening (NRS-2002) questionnaire. In addition, anthropometric and biochemical parameters and their changes were evaluated. PAB was also assessed as an oxidative stress marker. In total, 15 patients stayed in the hospital for more than one week. The measurements were performed upon admission and discharge.
**Results:** Upon admission, 49.1% of the patients were well-nourished, and 50.9% were at nutritional risk. As expected, the patients were overweight (36.8%) or obese (19.2%), and all the measures of adiposity were high. Well-nourished patients had lower serum PAB comparatively, while the difference was not statistically significant. The prevalence of the suboptimal nutrition index increased from 46.7% upon admission to 53.3% upon discharge. However, the increase was not considered significant due to the small sample size. Serum PAB increased within one week after admission, while the change was not significant (P=0.249).
**Conclusion:** According to the results, the prevalence of suboptimal nutrition was high in the MI patients in Iran and increases during hospitalization.

► *Please cite this paper as*:
Nematy M, Parizadeh SM, Safarian M, Norouzy A, Parizadeh SMR, Mouhebati M, Ghandehari M, Tavalaie Sh, Ghayour-Mobarhan M, Ferns GA. Effects of Nutritional Status and Oxidative Stress on the Admission and Discharge of Myocardial Infarction Patients. 2017; 5(4): 184-192. Doi: 10.22038/jnfh.2018.32026.1113

## Introduction

Malnutrition or suboptimal nutrition has been described variably. Some scholars have addressed this issue as an intake imbalance, which leads to metabolism impairment and loss of the body mass (1). Others have defined it as nutritional deficiency or imbalance in energy, protein, and other nutrients, exerting adverse effects on various organs and the body form (2). In high-income countries, diseases are considered to be the main cause of suboptimal nutrition (3). Chronic and acute disorders may induce or deteriorate suboptimal nutrition through infections, trauma, and inflammation by changing the appetite, and nutrient absorption and metabolism (3).

The prevalence of nutritional risks upon

* *Corresponding author:* Majid Ghayour-Mobarhan, Department of Modern Sciences and Technologies, School of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran. Tel: +985138828573; Email: ghayourm@mums.ac.ir

admission to the hospital appears to be high in most countries (4, 5). Suboptimal nutrition imposes a burden on the patients and healthcare systems due to increased length of hospital stay, healthcare costs, and morbidity and mortality (6-8). Furthermore, suboptimal nutrition is likely to deteriorate during hospitalization (9). It has been reported that the length of hospital stay increases by approximately 40-70% in the patients with suboptimal nutrition (3).

In a study in this regard, Norman et al. reviewed 20 studies about suboptimal nutrition in hospitals (3). Moreover, a systematic review evaluated 66 studies that were performed in South America, and the prevalence of malnutrition was estimated at 40-60% upon hospital admission, which gradually increased during hospitalization (10). Overall, studies across the world have indicated that the prevalence of hospital suboptimal nutrition is within the range of 20-50% (3). There are significant differences in the reported prevalence rates, which could be due to various patient populations, medical and geographic settings, and screening tools. Occurrence or increase of malnutrition during hospitalization may lead to impaired absorption, insufficient nutrient intake, and loss of nutrients due to illness (11).

Disease-related malnutrition is a critical issue in hospitalized patients globally (12). Suboptimal nutrition screening upon hospital admission and early therapeutic management could improve the clinical outcomes in these patients (6). Although the body of knowledge regarding suboptimal nutrition has been promoted recently, evidence is suggestive of insufficient nutritional evaluations in hospitals (4).

Considering that myocardial infarction (MI) is a significant cause of mortality and morbidity across the world (13). Data are scarce regarding the prevalence of hospital malnutrition or suboptimal nutrition, especially in the MI patients in Iran. Dietary changes during hospitalization could influence nutritional status and oxidative stress in these patients.

The present study aimed to investigate the prevalence of suboptimal nutrition in the patients admitted to the cardiac ward upon admission and discharge in Ghaem Hospital in Mashhad, Iran. In addition, we assessed prooxidant-antioxidant balance (PAB) as an oxidative stress marker involved in MI.

## Material and methods

### *Subjects*

This cross-sectional study was conducted on the MI patients admitted to the cardiac care unit (CCU) of Ghaem Hospital in Mashhad, Iran. In total, 57 patients (39 males and 18 females) with the mean age of 58.44±12.80 years were enrolled in the study. Exclusion criteria of the study were the presence of known HIV and hepatitis B infections, unconsciousness, and acute edema in the patients.

Written informed consent was obtained from the patients prior to the study. The study protocol was approved by the Ethics Committee of Mashhad University of Medical Sciences.

### *Diagnosis of MI*

Diagnosis of MI was confirmed by a cardiologist (14) based on the increased levels of cardiac biomarkers (particularly troponin) in combination with the evidence of myocardial ischemia (presence of the symptoms of ischemia, new ischemic electrocardiographic alterations or new myocardial motion abnormalities in cardiac imaging).

### *Assessment of Nutritional Status*

Nutritional evaluation was performed on the first day of hospitalization and one week after admission using the nutritional risk screening questionnaire. Anthropometric and biochemical measurements were also carried out on each patient. The research team consisted of a researcher for the mentioned measurements, a healthcare officer, a physician, and a nurse.

### *Nutritional Risk Screening (NRS)*

Malnutrition risk screening is essential to the accurate identification of malnourished hospitalized patients (15). NRS-2002 is a simple nutritional screening tool (16), which was used to evaluate the nutritional status of the patients in the present study. Assessments were performed upon admission and discharge. NRS-2002 yields a nutritional score (range: 0-3), a disease severity score (range: 0-3), and an additional score for the patients aged more than 69 years. The maximum score in this scale is seven. Total score of ≥3 are indicative of severely undernourished or high-risk patients.

### *Anthropometric Measurements*

Weight, height, triceps skin fold thickness (TSF), mid-arm circumference (MAC), mid-calf circumference, waist, and hip circumference of the patients were measured based on a standard protocol. A portable stadiometer (OTM, Tehran, Iran) was used to measure the maximum height to the nearest 0.5 centimeter when the patients were without shoes, and their head was positioned in the Frankfort plane. Height was measured using the demi-span protocol in the patients unable to stand (17).

Waist circumference was determined as the distance around the smallest area below the thorax and above the umbilicus without using a stretchable tape measure (18). The waist-to-hip ratio (WHR) was evaluated by dividing the wais-to-hip circumference. WHR of ≥1 and 0.8 indicated the risk of suboptimal nutrition in men and women, respectively.

Hip circumference was measured by recording the widest circumference. TSF was measured on the right side of the body based on the recommendations of Parnell (19) using the Harpenden caliper. The skin was stretched for separating fat from the muscle, and subcutaneous fat was evaluated nearest to 0.1 millimeters. Body mass index (BMI) was calculated based on the following equation: Weight (kg)/Height (m)2 (20)

### *Bioelectrical Impedance Analysis (BIA)*

Body composition analysis was performed using a portable bioelectrical impedance analyzer (Bodystat 1500 MDD, England) upon admission and before discharge. The validity of BIA has been confirmed in previous studies (21, 22). Total body water, body fat, metabolic rates, lean body mass, and WHR were assessed through BIA.

### *Biochemical Assessments*

Blood samples (10 ml) were collected from the patients after fasting on admission and before discharge from the hospital. After clot formation, the tubes containing the blood samples were centrifuged at 2500 rpm for 15 minutes in order to obtain serum. Hemolyzed samples were excluded from further analysis. Prior to the analysis, the serum was stored at the temperature of -80 °C. The serum levels of albumin, pre-albumin, total protein, and high-sensitivity C-reactive protein (HS-CRP) were determined by standard techniques using Cobas autoanalyzer (ABX Diagnostics, Montpellier, France).

PAB evaluation was performed based on the described method (23, 24). PAB values were expressed in the arbitrary unit as the percentage of hydrogen peroxide in the standard solution, and the values for the unknown samples were calculated according to the values of the standard curve. The precision of the modified PAB method was evaluated based on the intra- and inter-assay coefficients of variation (CV%). The intra-assay CV% of 28 samples that were analyzed in triplicate was estimated at 1.4-3.5% (mean: 2.1%). The inter-assay CV% of 20 samples that were analyzed over three days was estimated at 4.1-8.5% (mean: 6.1%). Serum PAB was not affected by the one-day, one-week, and three-month storage at the temperatures of 4°C, -20°C, and -80 °C, respectively.

### *Food Intake*

One-day food intake of the patients was determined based on the food record charts after completion by instructed nurses on a ward level. The recorded data were analyzed using the Food Analyzer software (Selak Teb Co., 2008, Iran). The amount of the consumed macro- and micro-nutrients was calculated using the same software. Upon admission, we relied on the self-report of the patients regarding their dietary intakes, which might have affected the accuracy of the results. The reports are more likely to be accurate upon discharge as the patient still consumes hospital food.

### *Statistical Analysis*

Data analysis was performed in SPSS version 11.5 (SPSS Inc, Chicago, IL, USA) using descriptive statistics (mean, standard deviation, median, and interquartile range). Moreover, Chi-square was used for the qualitative data (e.g., smoking habits and marital status). Independent samples t-test was performed to compare the variables between the patients with suboptimal nutrition and those with proper nutrition, and paired t-test was applied to compare the baseline and discharge variables.

## Results

### *Demographic Data*

Demographic characteristics of the patients are presented in Table 1. In total, the sample population (n=57) included 38 men (68.4%) and 19 women (31.6%) with the mean age of 58.44±12.80 years. Less than 5% of the patients were unwilling to participate in the study. Among the subjects, 36.8% were overweight (19.3% males, 17.5% females) and 19.2% were obese (14% males and 5.2% females); adiposity was high in all these cases.

TSF values were higher than the normal range in the male and female patients (Table 1). Mean energy intake in the patients was 800 and 600 kcal less than the mean estimated energy requirement upon admission and discharge, respectively (Table 1).

### *Biochemical and PAB Measurements*

Serum HS-CRP was approximately four times higher than the normal range in the patients, which is a typical feature in MI (Table 1). On the other hand, the well-nourished patients had lower PAB values compared to the subjects with suboptimal nutrition. However, the differences in this regard were not considered statistically significant.

### *Prevalence of Malnutrition*

According to NRS-2002, the prevalence of suboptimal nutrition was 50.9%, which was significantly higher in men (65.5%) compared to women (34.5%) (P<0.05) (Figure 2).

**Table 1.** Clinical Characteristics of Patients upon Admission (n=57)

| | | Male | Female | Male+Female |
|---|---|---|---|---|
| Number | | 39 | 18 | 57 |
| Age (year) | | 55.49±11.58 | 64.83±13.29 | 58.44±12.80 |
| Weight (kg) | | 74.07±13.24 | 64.11±10.39 | 70.93±13.17 |
| Height (cm ) | | 167.53±10.74 | 156.16±4.81 | 163.94±10.66 |
| BMI (kg/m$^2$) | | 26.56±5.34 | 26.63±3.73 | 26.58±4.86 |
| Waist Circumference (cm) | | 94.76±10.36 | 97.66±12.25 | 95.68±10.96 |
| Hip Circumference (cm) | | 96.28±6.28 | 98.00±9.75 | 96.82±7.43 |
| WHR | | 1.01±0.20 | 0.98±0.10 | 1.01±0.18 |
| Mid-arm Circumference (cm) | | 27.61±2.90 | 26.61±3.17 | 27.29±3.00 |
| TSF (mm) | | 17.94±4.84 | 24.61±8.84 | 20.25±7.17 |
| Mid-calf Circumference (cm) | | 33.20±3.20 | 31.27±3.33 | 32.51±3.35 |
| Fat Percentage | | 28.95±12.92 | 44.17±15.43 | 32.75±14.94 |
| Fat Mass (kg) | | 22.55±13.54 | 28.81±12.20 | 24.12±13.33 |
| Lean Mass (kg) | | 53.83±15.89 | 41.34±13.75 | 50.45±16.16 |
| Fat Mass and Lean Mass (kg) | | 74.22±12.93 | 67.66±12.75 | 72.53±13.03 |
| Water Percentage | | 53.95±14.46 | 46.83±17.14 | 52.03±15.32 |
| BMR (kcal) | | 1598.15±342.20 | 1201.10±295.70 | 1490.84±372.00 |
| Energy Requirement (kcal) | | 2233.88±501.26 | 1750.90±497.36 | 2091.82±540.82 |
| Protein (g) | | 67.95±46.13 | 60.72±52.76 | 65.67±47.96 |
| Carbohydrates (g) | | 134.69±91.28 | 119.89±104.20 | 130.02±94.86 |
| Fats (g) | | 53.03±37.97 | 46.78±40.06 | 51.05±38.40 |
| Energy Intake (kcal) | | 1295.44±831.20 | 1141.61±939.07 | 1246.86±861.24 |
| Protein (%) | | 21.76±10.52 | 20.05±11.99 | 21.22±10.93 |
| Carbohydrates (%) | | 39.71±15.11 | 38.61±18.44 | 39.36±16.07 |
| Fats (%) | | 33.48±12.14 | 30.22±16.21 | 32.45±13.49 |
| Pre-albumin (mg/dl) | | 25.07±8.60 | 35.23±21.61 | 28.01±14.14 |
| Albumin (g/dl) | | 4.14±0.47 | 4.08±0.75 | 4.12±0.55 |
| Total Protein (g/dl) | | 6.17±0.82 | 6.36±1.08 | 6.22±0.88 |
| HS-CRP (mg/l) | | 23.52±18.13 | 12.23±10.35 | 20.25±16.94 |
| Medication Hisotry N (%) | ASA | 31 (54.3) | 15 (26.3) | 46 (80.7) |
| | Captopril | 31 (54.3) | 12 (21) | 43 (75.3) |
| | Simvastatin | 23 (40.3) | 9 (15.7) | 31 (54.3) |
| | Metoral | 29 (50.8) | 9 (15.7) | 38 (66.6) |
| | Osvix | 19 (33.3) | 7 (12.2) | 26 (45.6) |
| | Heparin | 12 (21) | 11 (19.2) | 23 (40.3) |
| | Oxazepam | 14 (24.5) | 9 (15.7) | 23 (40.3) |
| | Syrup milk of Magnesia | 24 (42.1) | 10 (17.5) | 34 (59.6) |

Values expressed as mean±standard deviation.

BMI: body mass index; TSF: triceps skin fold; BMR: basal metabolic rate; WHR: waist circumference divided by hip circumference; HS-CRP: high sensitivity C-reactive protein

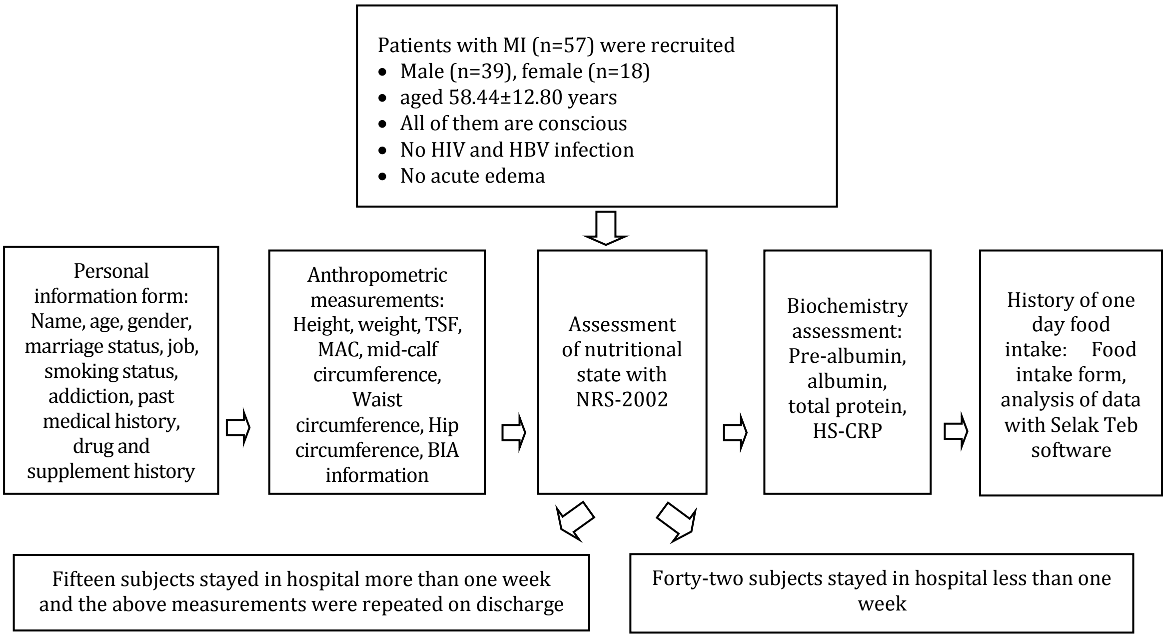


**Figure 1.** Nutritional Evaluation of Patients with Myocardial Infarction

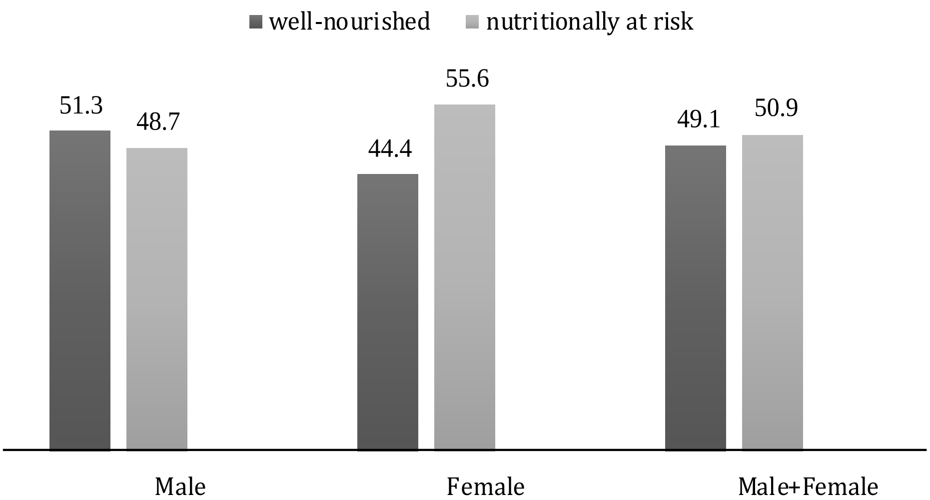


**Figure 2.** Prevalence of Suboptimal Nutrition and Proper Nutrition in Patients upon Admission (n=57)

***Comparison of Clinical and Paraclinical Features between Patients with Proper and Suboptimal Nutrition***

The patients with suboptimal nutrition had significantly lower body fat percentage and dietary intake of total energy, fats, carbohydrates, and protein compared to the other patients (P<0.05) (Table 2). However, no significant differences were observed in the micronutrient intake and anthropometric indices of the patients with proper nutrition and suboptimal nutrition (P>0.05) (Table 2).

***Comparison of Nutritional Parameters at Baseline and Discharge (n=15)***

BMI significantly decreased (0.5 kg/m$^2$) within one week of admission to the cardiac department (P<0.05) (Table 3). Anthropometric parameters, including TSF, MAC, mid-calf circumference, waist circumference, and hip

**Table 2.** Comparison of Clinical Characteristics in Patients with Proper Nutrition and Suboptimal Nutritional

| | | Nutritional Status | | P-value |
|---|---|---|---|---|
| | | Suboptimal Nutrition | Proper Nutrition | |
| Age (year) | | 61.34 ± 13.86 | 55.43 ± 11.06 | 0.081 |
| Gender | Male | 19(65.5%) | 20(71.4%) | 0.777 |
| | Female | 10(34.5%) | 8(28.6%) | |
| Marriage Status | Married | 24(82.8%) | 24(85.7%) | 0.476 |
| | Single | 5(17.2%) | 4(14.3%) | |
| Smoking Habits | Smoker | 11(37.9%) | 7(25%) | 0.395 |
| | Non-smoker | 18(62.1%) | 21(75%) | |
| SBP (mmHg) | | 11.07 ± 1.85 | 10.84 ± 1.75 | 0.647 |
| DBP (mmHg) | | 6.53 ± 1.27 | 6.80 ± 1.32 | 0.475 |
| Weight (kg) | | 71.25±14.78 | 70.58±11.53 | 0.850 |
| Height (cm ) | | 164.37±9.91 | 163.50±11.55 | 0.759 |
| BMI (kg/m$^2$) | | 26.26±4.70 | 26.92±5.08 | 0.609 |
| Waist Circumference (cm) | | 96.27±12.72 | 95.07±8.98 | 0.682 |
| Hip Circumference (cm) | | 97.17±9.69 | 96.46±4.11 | 0.723 |
| WHR | | 0.98±0.07 | 1.00±0.06 | 0.331 |
| Mid arm circumference (cm) | | 27.13±3.53 | 27.46±2.39 | 0.686 |
| TSF (mm) | | 20.12±6.24 | 20.37±8.06 | 0.901 |
| Mid-calf Circumference (cm) | | 32.25±4.02 | 32.79±2.47 | 0.573 |
| Fat Percentage | | 32.03±15.46 | 34.03±14.50 | 0.707 |
| Fat Mass (kg) | | 24.65±14.78 | 23.17±10.79 | 0.754 |
| Lean Mass (kg) | | 52.45±18.91 | 47.17±10.00 | 0.342 |
| Fat Mass and Lean Mass (kg) | | 73.39±14.46 | 71.25±10.91 | 0.640 |
| Water Percentage | | 51.93±14.85 | 52.19±16.65 | 0.961 |
| BMR (kcal) | | 1535.17±434.10 | 1418.00±234.78 | 0.360 |
| Energy Requirement (kcal) | | 2152.91±621.60 | 1979.83±344.49 | 0.381 |
| Protein (g) | | 26.14±22.19 | 106.61±29.07 | <0.001 |
| Carbohydrates (g) | | 60.59±51.24 | 201.93±73.49 | <0.001 |
| Fats (g) | | 18.93±17.23 | 84.32±22.23 | <0.001 |
| Energy Intake (kcal) | | 520.55±407.21 | 1999.11±461.54 | <0.001 |
| Protein (%) | | 20.41±14.49 | 22.07±5.35 | 0.572 |
| Carbohydrates (%) | | 39.10±21.54 | 39.64±7.38 | 0.901 |
| Fats (%) | | 26.69±15.81 | 38.42±6.75 | 0.001 |
| Pre-albumin (mg/dl) | | 30.15±16.77 | 25.87±10.96 | 0.357 |
| Albumin (g/dl) | | 4.00±0.54 | 4.25±0.55 | 0.166 |
| Total Protein (g/dl) | | 6.08±1.07 | 6.37±0.63 | 0.327 |
| HS-CRP (mg/l) | | 17.58±17.19 | 22.92±16.71 | 0.338 |
| PAB | | 65.37 (30.53-122.62) | 32.63 (19.21-113.31) | 0.314 |

Values expressed as mean±standard deviation.
SBP: systolic blood pressure; DBP: diastolic blood pressure; PAB: prooxidant-antioxidant balance

**Table 3.** Changes in Clinical Characteristics of Patients during Study Period (n=15)

| Parameter | Admission | Discharge | P-value |
|---|---|---|---|
| Weight (kg) | 71.33±15.07 | 70.50±14.85 | 0.060 |
| BMI (kg/m$^2$) | 28.16±6.52 | 27.78±6.48 | 0.032 |
| Waist Circumference (cm) | 98.46±11.77 | 97.26±10.34 | 0.244 |
| Hip Circumference (cm) | 99.26±9.28 | 97.20±12.54 | 0.093 |
| WHR | 1.06±0.31 | 1.00±0.062 | 0.500 |
| Mid-arm Circumference (cm) | 28.20±3.70 | 27.80±3.90 | 0.636 |
| TSF (mm) | 19.84±6.17 | 19.38±6.07 | 0.610 |
| Mid-calf Circumference (cm) | 33.86±3.91 | 33.50±3.83 | 0.416 |
| Fat Percentage | 37.03±11.91 | 33.06±7.41 | 0.200 |
| Fat Mass (kg) | 24.08±8.24 | 22.60±7.36 | 0.485 |
| Lean Mass (kg) | 50.21±20.32 | 46.70±11.62 | 0.280 |
| Fat Mass and Lean Mass (kg) | 67.00±10.03 | 66.88±10.52 | 0.834 |
| Water Percentage | 53.67±12.54 | 53.68±5.30 | 0.998 |
| BMR (kcal) | 1425.45±341.99 | 1389.09±335.88 | 0.241 |
| Energy Requirement (kcal) | 1981.50±558.78 | 1866.50±547.48 | 0.475 |
| Protein (g) | 62.93±45.09 | 61.33±39.16 | 0.878 |
| Carbohydrates (g) | 119.80±79.01 | 141.93±81.87 | 0.347 |
| Fats (g) | 58.33±44.22 | 49.87±27.56 | 0.414 |

| Continuous of table 3. | | | |
|---|---|---|---|
| Energy Intake (kcal) | 1265.07±833.86 | 1275.73±631.48 | 0.954 |
| Protein (%) | 20.73±12.03 | 19.06±8.50 | 0.571 |
| Carbohydrates (%) | 36.60±15.19 | 46.93±14.14 | 0.095 |
| Fats (%) | 36.00±14.79 | 34.00±10.27 | 0.676 |
| Pre-albumin (mg/dl) | 17.79±8.03 | 23.73±4.37 | 0.124 |
| Albumin (gr/dl) | 4.21±0.62 | 4.03±0.87 | 0.357 |
| Total Protein (gr/dl) | 6.47±1.48 | 6.63±1.54 | 0.758 |
| HS-CRP (mg/l) | 28.13±17.27 | 16.44±10.44 | 0.369 |
| PAB | 27.78 (18.60-169.32) | 108.79 (66.54-159.47) | 0.249 |

Values expressed as mean±standard deviation; Paired t-test, P-value of <0.05 considered significant

circumference, also reduced during this period although the differences were not statistically significant (P>0.05) (Table 3).

### *Comparison of Biochemical Parameters and PAB at Baseline and Discharge (n=15)*

Biochemical parameters, including total protein, serum albumin, pre-albumin, and HS-CRP, showed no significant differences after one week of admission to the cardiac department (P>0.05) (Table 3). On the other hand, the PAB values increased after this period although the difference was not statistically significant.

## Discussion

This was the first reported investigation regarding the prevalence of suboptimal nutrition and effect of hospitalization on the nutritional status of MI patients in Iran. According to the findings, suboptimal nutrition was highly prevalent among the MI patients, and their weight and BMI reduced by 0.5 kg/m$^2$ within one week after admission.

### *Prevalence of Suboptimal Nutrition in CCU*

Several studies have evaluated the prevalence of suboptimal nutrition in hospitals (3). Some of these studies have been conducted based on NRS-2002. In two studies that were performed in the hospitals in Denmark, the findings denoted that on the day of hospital admission, approximately 20% and 39.9% of the patients were at risk nutritionally (25, 26). Furthermore, the prevalence of nutritional risks has been investigated in two hospitals in Beijing (China) and Baltimore (U.S.A), and the risk was reported to be 39% and 51%, respectively (27).

In a multinational study conducted in 12 countries in Europe and the Middle East, it was reported that 32.6% of the patients were at nutritional risk (28). Overall, worldwide studies have indicated that the prevalence of suboptimal nutrition in the hospital is 20-50%. Several reasons have been proposed in this regard, including various patient populations, medical and geographical settings, and screening tools.

In the present study, the prevalence of suboptimal nutrition was 50.9% upon admission, which is in line with the previous studies in this regard. However, the prevalence of suboptimal nutrition in the MI patients in Iran has been shown to be significantly higher, especially in men (65.5%) compared to women (34.5%).

### *Effect of Hospitalization on Nutritional Status*

Among 15 patients who were hospitalized for more than one week, they lost 800 grams of weight since their mean energy intake was approximately 800 kcal less than the mean energy requirement in the male and female subjects. Moreover, BMI decreased significantly, and the prevalence of nutritional risk increased from 46.7% upon admission to 53.3% upon discharge; the prevalence was similar in men (50%) and (50%) women, which could be due to acute phase response and its effect on the serum protein level.

### *Causes of Suboptimal Nutrition*

In high-income countries, diseases are the main cause of suboptimal nutrition (3). As mentioned earlier, chronic and acute disorder may induce or deteriorate suboptimal nutrition through infections, trauma, and inflammation by changing the appetite, reducing nutrient intake and absorption, and increasing the energy and protein requirements (3, 29). Additionally, socioeconomic factors, living alone, and hospital food quality may play a key role in the development of suboptimal nutrition (30, 31), which may explain the high rate of suboptimal nutrition in the MI patients in Iran.

Several studies have indicated that poor awareness and training of hospital personnel leads to the inadequate nutritional care of hospitalized patients (25), which is consist with the findings of the current research. Correspondingly, MI patients in Iran have a daily energy intake of 800 kcal less than their energy requirements. The absence of feeding assistance and presence of dementia and depression may further reduce nutrient intakes in these patients (32, 33).

With regard to the underestimation of suboptimal nutrition in hospitalized patients (34), the prevalence of suboptimal nutrition in the MI patients in Iran seems to be higher than the current report. Due to the considerable medical and economic impact of suboptimal nutrition on the patients and healthcare systems, special attention must be paid to raising the awareness of medical staff regarding the nutritional care of hospitalized patients and improvement of nutritional screening.

### *Limitations of the Study*

The main limitations of the study were the small sample size and short follow-up, which might explain the lack of statistically significant differences in variables such as PAB.

## Conclusion

According to the results, the prevalence of suboptimal nutrition is high in the patients with MI in Iran and it increases along with the rise in oxidative stress during hospitalization. Therefore, special attention must be paid to the nutritional support of the patients admitted to cardiac care units, especially the high intake of natural antioxidants, in Iran. The findings of the current research should be reconfirmed in further investigations on larger sample sizes with longer follow-ups.

## Acknowledgments

Hereby, we extend our gratitude to the Research Council of Mashhad University of Medical Sciences, Iran for the financial support of this study.

## Conflict of interest

None declared.

## References

1. Kinosian B, Jeejeebhoy KN. What is malnutrition? Does it matter? Nutrition (Burbank, Los Angeles County, Calif). 1995;11(2 Suppl):196-7.
2. Lochs H, Allison S, Meier R, Pirlich M, Kondrup J, van den Berghe G, et al. Introductory to the ESPEN guidelines on enteral nutrition: terminology, definitions and general topics. Clinical nutrition. 2006;25(2):180-6.
3. Norman K, Pichard C, Lochs H, Pirlich M. Prognostic impact of disease-related malnutrition. Clinical nutrition. 2008;27(1):5-15.
4. Lucchin L, D'Amicis A, Gentile MG, Battistini NC, Fusco MA, Palmo A, et al. An Italian investigation on nutritional risk at hospital admission: The PIMAI (Project: Iatrogenic MAlnutrition in Italy) study. European e-Journal of Clinical Nutrition and Metabolism. 2009;4(4):e199-e202.
5. Rinninella E, Cintoni M, De Lorenzo A, Addolorato G, Vassallo G, Moroni R, et al. Risk, prevalence, and impact of hospital malnutrition in a Tertiary Care Referral University Hospital: a cross-sectional study. Internal and emergency medicine. 2018:1-9.
6. Kruizenga HM, Van Tulder MW, Seidell JC, Thijs A, Ader HJ, Van Bokhorst-de van der Schueren MA. Effectiveness and cost-effectiveness of early screening and treatment of malnourished patients–. The American journal of clinical nutrition. 2005;82(5):1082-9.
7. Correia MIT, Waitzberg DL. The impact of malnutrition on morbidity, mortality, length of hospital stay and costs evaluated through a multivariate model analysis. Clinical nutrition. 2003;22(3):235-9.
8. Allard JP, Keller H, Jeejeebhoy KN, Laporte M, Duerksen DR, Gramlich L, et al. Malnutrition at hospital admission-contributors and effect on length of stay. Journal of Parenteral and Enteral Nutrition. 2016;40(4):487-97.
9. McWhirter JP, Pennington CR. Incidence and recognition of malnutrition in hospital. Bmj. 1994;308(6934):945-8.
10. Correia MIT, Perman MI, Waitzberg DL. Hospital malnutrition in Latin America: A systematic review. Clinical Nutrition. 2017;36(4):958-67.
11. Soeters P, Reijven P, Allison S, Konig W, Sobotka L. Diagnosis of malnutrition-Screening and assessment. Basics in clinical nutrition. 2011:21-32.
12. Ruiz ÁJ, Buitrago G, Rodríguez N, Gómez G, Sulo S, Gómez C, et al. Clinical and economic outcomes associated with malnutrition in hospitalized patients. Clinical Nutrition. 2018.
13. Parizadeh SM, Ferns GA, Ghandehari M, Hassanian SM, Ghayour-Mobarhan M, Parizadeh SMR, et al. The diagnostic and prognostic value of circulating microRNAs in coronary artery disease: A novel approach to disease diagnosis of stable CAD and acute coronary syndrome. Journal of cellular physiology. 2018;233(9):6418-24.

14. Thygesen K, Alpert JS, White HD, Jaffe AS, Apple FS, Galvani M, et al. Universal definition of myocardial infarction: Kristian Thygesen, Joseph S. Alpert and Harvey D. White on behalf of the Joint ESC/ACCF/AHA/WHF Task Force for the Redefinition of Myocardial Infarction. European heart journal. 2007;28(20):2525-38.
15. Eglseer D, Halfens RJG, Lohrmann C. Use of an electronic malnutrition screening tool in a hospital setting: effects on knowledge, attitudes and perceived practices of healthcare staff. Br J Nutr. 2018;120(2):150-7.
16. Kondrup J, Allison SP, Elia M, Vellas B, Plauth M. ESPEN guidelines for nutrition screening 2002. Clinical nutrition. 2003;22(4):415-21.
17. Bassey EJ. Demi-span as a measure of skeletal size. Annals of human biology. 1986;13(5): 499-502.
18. Komlos J. Anthropometric history: an overview of a quarter century of research. Anthropologischer Anzeiger. 2009:341-56.
19. Tzotzas T, Krassas GE, Doumas A. Body composition analysis in obesity: radionuclide and non radionuclide methods. Hellenic journal of nuclear medicine. 2008;11(1):63-71.
20. Keys A, Fidanza F, Karvonen MJ, Kimura N, Taylor HL. Indices of relative weight and obesity. Journal of Clinical Epidemiology. 1972;25(6):329-43.
21. Gudivaka R, Schoeller D, Kushner RF. Effect of skin temperature on multifrequency bioelectrical impedance analysis. Journal of Applied Physiology. 1996;81(2):838-45.
22. Kyle UG, Genton L, Karsegard L, Slosman DO, Pichard C. Single prediction equation for bioelectrical impedance analysis in adults aged 20–94 years. Nutrition. 2001;17(3):248-53.
23. Alamdari DH, Ghayour-Mobarhan M, Tavallaie S, Parizadeh MR, Moohebati M, Ghafoori F, et al. Prooxidant–antioxidant balance as a new risk factor in patients with angiographically defined coronary artery disease. Clinical biochemistry. 2008;41(6):375-80.
24. Alamdari DH, Paletas K, Pegiou T, Sarigianni M, Befani C, Koliakos G. A novel assay for the evaluation of the prooxidant–antioxidant balance, before and after antioxidant vitamin administration in type II diabetes patients. Clinical biochemistry. 2007;40(3-4):248-54.
25. Kondrup J, Johansen N, Plum L, Bak L, Larsen IH, Martinsen A, et al. Incidence of nutritional risk and causes of inadequate nutritional care in hospitals. Clinical nutrition. 2002;21(6):461-8.
26. Rasmussen HH, Kondrup J, Staun M, Ladefoged K, Kristensen H, Wengler A. Prevalence of patients at nutritional risk in Danish hospitals. Clinical nutrition. 2004;23(5):1009-15.
27. Liang X, Jiang Z-M, Nolan MT, Efron DT, Kondrup J. Comparative survey on nutritional risk and nutritional support between Beijing and Baltimore teaching hospitals. Nutrition. 2008; 24(10):969-76.
28. Sorensen J, Kondrup J, Prokopowicz J, Schiesser M, Krähenbühl L, Meier R, et al. EuroOOPS: an international, multicentre study to implement nutritional risk screening and evaluate clinical outcome. Clinical nutrition. 2008;27(3):340-9.
29. Campbell I. Limitations of nutrient intake. The effect of stressors: trauma, sepsis and multiple organ failure. European journal of clinical nutrition. 1999;53(s1):s143.
30. Pirlich M, Schütz T, Kemps M, Luhman N, Minko N, Lübke HJ, et al. Social risk factors for hospital malnutrition. Nutrition. 2005;21(3):295-300.
31. Dupertuis Y, Kossovsky M, Kyle U, Raguso C, Genton L, Pichard C. Food intake in 1707 hospitalised patients: a prospective comprehensive hospital survey. Clinical Nutrition. 2003;22(2): 115-23.
32. Incalzi RA, Gemma A, Capparella O, Cipriani L, Landi F, Carbonin P. Energy intake and in-hospital starvation: a clinically relevant relationship. Archives of internal medicine. 1996;156(4):425-9.
33. Sullivan DH, Sun S, Walls RC. Protein-energy undernutrition among elderly hospitalized patients: a prospective study. Jama. 1999; 281(21):2013-9.
34. Pirlich M, Schütz T, Norman K, Gastell S, Lübke HJ, Bischoff SC, et al. The German hospital malnutrition study. Clinical nutrition. 2006;25(4):563-72.