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Nutritional Requirements and Actual Dietary Intake of Adult Burn Patients

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ABSTRACT

Introduction: Nutritional support of burn patients is essential to wound healing and improving their immune defense. Moreover, these patients have an increased need for the intake of calories and other nutrients, such as proteins, carbohydrates, and fats. The present study aimed to evaluate the levels of energy and macronutrient and micronutrient intake and compare them with the reference daily intake (RDI) in adult burn patients.

Methods: This cross-sectional study was conducted on 60 thermally burned patients who were admitted to the burn care at Imam Reza Hospital in Mashhad, Iran during October-December 2016. Data on the actual intake were collected using the nutrient intake analysis (NIA) through direct observation. In addition, the nutritional intakes of each individual were assessed using the Nutritionist IV software, and data analysis was performed in SPSS version 18.

Results: Mean levels of energy, carbohydrate, and protein intake were significantly lower compared to the mean total energy requirement and carbohydrate and protein RDA (P<0.001). On the other hand, the mean fat intake was within the RDI range (20.5±8.3%), and the mean levels of vitamin A, folate, and vitamin C intake were significantly lower compared to the RDI (P<0.001).

Conclusion: According to the results, total calorie, carbohydrate, and protein intakes in the patients with major burn injuries were lower than the standard recommended values, while the level of fat intake was normal based on the RDA. In addition, our findings indicated that vitamin and mineral intakes in the adults with major burn injuries were lower than the RDI limit, which may decelerate wound healing and increase the length of hospital stay.

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Introduction

Burn injuries are common traumatic injuries and a major cause of morbidity and mortality in developing countries (1). The mortality rate of burn injuries has been estimated at 265,000 cases per year across the world (2). Burns caused by fire are among the leading causes of death in various communities, and more than 90% of burn injuries occur in low- and middle-income countries (3).

Nutritional aids are considered essential to the treatment of burn patients. The hyper metabolic state resulting from burn injuries increases the risk of malnutrition in the patients (4). Adequate nutrition has been reported to reduce weight loss, facilitate wound healing, decrease mortality, and minimize the deleterious effects of burn injuries in the patients (5). Moreover, the composition of proteins, fats, and carbohydrates is critical in the dietary regimen of burn patients, while their

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calorie requirements are also higher compared to normal individuals (6).

Glucose is a preferred substrate for wound healing and should be considered the main source of energy intake in burn patients (7). In moderate-to-severe burn patients, providing the lipid levels of more than 15% of calories per day has been reported to impair the immune function (8). Proteins are important dietary components, which nutritionally support 20-25% of the calories received by burn patients and provide a balanced between the breakdown and synthesis of tissues (9).

Although vitamin requirements increase in burn patients, they have rarely been established. Several studies have denoted that vitamin A is involved in the immune function, epithelialization, and wound healing (8, 10-12). Furthermore, vitamin C is considered to be an essential nutrient for collagen synthesis and immune function, which might also be required at higher concentrations for wound healing (13). In this regard, Barbosa et al. conducted a randomized, double-blinded study and observed that vitamin C supplementation shortened the wound healing time due to the decreased level of oxidative stress (14). Moreover, micronutrient deficiencies were confirmed in the patients following tissue breakdown and increased urinary copper and zinc. However, wound exudates were considered to be the primary cause of the loss of these trace minerals (15, 16).

Some studies have demonstrated that burn injuries are associated with the impaired status of copper and zinc (17, 18). For instance, Voruganti et al. evaluated the wound exudate, plasma nutrient intake, and 24-hour urine samples in terms of copper and zinc concentrations. The findings of the mentioned study indicated that the reduced plasma levels of copper and zinc after the burn injuries were insufficiently balanced during the hospitalization of the patients (18).

To date, no studies have compared the energy level and macronutrient and micronutrient intakes with the reference daily intake (RDI) in adult burn patients. The present study aimed to investigate and compare the actual dietary intake of adult burn with the RDI.

Material and methods

Study Population

This cross-sectional study was conducted on 60 burn patients who were admitted to the burn center at Imam Reza Hospital in Mashhad, Iran during October-December 2016. The study protocol was approved by the local scientific Ethics Committee of Mashhad University of Medical Sciences, and informed consent was obtained from the selected patients or their legal guardians. The exclusion criteria of the study were pregnant or lactating women and patients with pre-existing pathologies (e.g., cancer and organ dysfunction).

Oral nutrition was initiated in all the patients within 24 hours after admission. Daily energy requirements were also calculated using the Curreri formula. In addition, the multivitamin and mineral intakes of the patients were recorded.

Dietary Assessment

Demographic data were collected using a questionnaire, and total body surface area (TBSA) was used to collect the data with nutrient intake analysis (NIA). Data on the actual intakes were also collected through the direct observation of consumed foods and the remainder of the meals in the patients. In several cases, photographs were taken using Smartphones in order to document the amount of the consumed food (19). Moreover, individual nutritional intakes were assessed using the Nutritionist IV software, which could identify and analyze the macronutrient and micronutrient intakes.

Statistical Analysis

Data analysis was performed in SPSS version 17 (SPSS Inc., Chicago, IL, USA) using the Kolmogorov-Smirnov test to evaluate the normality of the variables. In addition, student's independent t-test and Mann-Whitney U test were used to compare the differences in the data with normal and non-normal distribution between the groups, respectively. One-sample t-test was also applied for the comparison of the nutrient intakes with dietary recommendations. All the statistical analyses were two-sided, and the P-value of less than 0.05 was considered significant.

Results

During October-December 2016, 60 adult patients with thermal burn injuries were examined. The mean age of the patients was 40±19.1 years, and 45.6% of the subjects were male. The baseline characteristics of the patients are presented in Table 1.

Table 1. Baseline Characteristics of Patients

	Age (year)	Length of Hospital Stay (day)	Total Body Surface Area (%)	Baux-index
Male (n=26)	39.62±20.2	20.03±8.8	27.53±14.8	67.153±26.3
Female (n=31)	40.3±18.6	30.54±11.21	40.03±20.7	80.35±22.5
P-value	0.891	<0.001	0.013	0.046

Values expressed as mean±SD; P<0.05

According to the information in Table 2, there were no significant differences in the serum albumin level, total protein, urea, and creatinine between admission and discharge during the study period (P>0.05). However, a significant change was observed in the body weight of the patients (P<0.001) (Table 2).

Table 2. Comparison of Weight and Biochemical Parameters between Admission and Discharge

	Admission	Discharge	*P-value*
Weight (kg)	63.42±2.3	60.90±2.3	<0.001
Albumin (mg/dl)	3.16±0.76	3.04±0.6	0.145
Total Protein (mg/dl)	5.53±1.2	5.40±1.1	0.373
Urea (mg/dl)	27.90±10.7	27.74±21.5	0.959
Creatinine (mg/dl)	0.94±0.2	0.90±0.2	0.550

Values expressed as mean±SD; P<0.05

The mean energy intake was estimated at 1091± 454 kilocalories, which was lower compared to the mean total energy requirement (2955±803 kcal) (P<0.001). The RDI for carbohydrate and fat intakes is 60-70% and 15-20% of the total energy intake, respectively, and the RDI for protein is 1-2 g/kg/day. In the present study, the mean carbohydrate intake was estimated at 54.6±10%, which was significantly lower than the RDI limit (P<0.001). Moreover, the mean fat intake was within the recommended range of RDI (20.5±8.3%), and protein intake was 0.7 g/kg/day, which was significantly lower than the RDI limit (P<0.001) (Table 3).

Table 3. Comparison of Energy and Macronutrient Intake with RDI

	Mean±SD	RDI of Burn Patients	*P-value*
Calorie (kcal)	1091±454	2955±803	<0.001
Carbohydrates (% total energy)	54.6±10	60.0-70.0	<0.001
Protein (g/kg/day)	0.7	1-2	<0.001
Fat (% total energy)	20.5±8.3	15.0-20.0	<0.001

Values expressed as mean±SD; P<0.05

According to the information in Table 4, the RDI of vitamin A and folate was 10,000 IU and 1,000 mcg in the burn patients, respectively. The median (IQR) vitamin A and folate intake was calculated to be 697.6 IU (range: 511.5-994.3 IU) and 55 mcg (range: 42.9-111.1 mcg), which were significantly lower compared to the RDI limits (P<0.001).

Table 4. Comparison of Micronutrient Intake with RDI

	Mean±SD/Median (IQR)	RDI of Burn Patients	*P-value*
Vitamin A (IU)	697.6 (511.5-994.3)	10000	<0.001
Folate (mcg)	55 (42.9-111.1)	1000	<0.001
Vitamin C (mg)	174±141.3	1000	<0.001
Zinc (mg)	4.6±1.9	220	<0.001
Copper (mg)	0.5±0.2	4.5	<0.001
Selenium (mcg)	0.02±0.01	300-500	<0.001

Values expressed as mean±SD or median (interquartile range); P<0.05; RDI: reference daily intake

According to the results, the mean vitamin C intake (174±141.3 mg) was significantly lower than the RDI limit. The recommended daily intakes of zinc, copper, and selenium were estimated at 220 mg, 4.5 mg, and 300-500 mcg, respectively. However, the mean intakes of these minerals were determined to be 4.6±1.9 mg, 0.5±0.2 mg, and 0.02±0.01 mcg, respectively, which were significantly lower than the RDI limits (P<0.001).

Discussion

Insufficient food intake leads to malnutrition in the patients with burn injuries; therefore, dietary intake plays a pivotal role in the care procedure of these patients, and assessing their actual calorie requirements is of paramount importance.

The study by Frakes et al. was conducted in 20 hospital wards on 611 patients, and the food intake of the patients at breakfast, lunch, and dinner were recorded, and the mean food intake in all the served meals was reported to be 78.1% (20). In another study by Tabibi et al. (2011), 42.6% of the patient ate all their lunch, 30.5% ate 75% of the contents on their plate, 9.4% ate 50% of the food, 2.7% ate 25% of the contents, and 5.5% ate all their food (21). Consequently, the majority of the patients received inadequate energy compared to the RDI limit. Consistently, the results of the present study indicated that the mean energy intake was lower than the mean total energy requirement in the burn patients. On the other hand, carbohydrates were observed to be the most important source of energy for the patients. Consuming adequate carbohydrates prevents protein from being used as an energy source (9). In addition, previous studies have confirmed that carbohydrates effectively reduce catabolism, and high intakes of carbohydrates and protein and low intake of dietary fat could remarkably improve the conditions of burn patients (22). However, the dietary intake of macronutrients was lower than the RDI limit in the current research.

Vitamin C (ascorbic acid) is considered essential to healthy diets, while it is also a highly effective antioxidant, which lowers oxidative stress and inflammation and influences wound healing through the proliferation and synthesis of collagen (8). Furthermore, vitamin C causes neutrophils to migrate to the wound site through coagulation. According to the findings of Barbosa et al. and Sahib et al., patients with adequate dietary intake of vitamin C have better wound healing (23, 24). However, the results of the present study showed that the mean vitamin C intake was significantly lower than the RDI limit in the burn patients.

Vitamin A has long been associated with wound healing as it promotes epithelial cell differentiation, collagen synthesis, and immunity, thereby playing a key role in the control of wound healing (8). Moreover, vitamin A intake is particularly important in the prevention of wound infection and plays a major role in inflammatory responses through recalling macrophages to the site of the injury. In the form of beta-carotene, vitamin A disarms the free radicals, thereby stimulating the repair of burned tissues (25). In the current research, vitamin A intake was significantly lower than the recommended RDI limit in the burn patients.

Copper and zinc are the co-factors of the superoxide dismutase enzyme (26). In another study in this regard, Berger et al. stated that patients with adequate dietary intakes of zinc, copper, and selenium had better wound healing outcomes, and lower infection rates were reported in the patients with adequate zinc intake. The recommended daily intakes of zinc, copper, and selenium have been determined to be 220 mg, 4.5 mg, and 300-500 mcg, respectively. However, the mean intake of these minerals was significantly lower than the RDI limits in the present study (27).

Immediate initiation of nutritional monitoring is one of the most essential forms of support in burn patients. It is of utmost importance to determine the usual weight and height of these patients and perform clinical evaluations for the signs of nutritional deficiencies immediately upon admission. This could help identify the comorbidities and nutritional status of the patients with burn injuries (28). In the current research, no significant correlations were observed between food intake, age, and gender. On the other hand, the findings of Roberto et al. indicated that dietary intakes were relatively lower in the wards with elderly patients (29). Furthermore, Hamilton K et al. reported that food intake in males was higher in men compared to women regardless of the type of the diet (30). The

aforementioned studies confirm the importance of proper nutrient intake in burn patients. In the present study, the energy, protein, and carbohydrate intakes were observed to be lower than the recommended limits for the patients with burn injuries.

Conclusion

According to the results, the intakes of total calories, carbohydrates, and protein in the patients with major burn injuries were lower than the requirements for healthy adults without burn injuries, while the level of fat intake was within the recommended range of the RDA. Since energy and protein intake directly affect morbidity, adequate amounts of these nutrients are critical factors in the care of burn patients in order to avoid nutritional complications. Considering that adequate dietary intake is essential to the proper care of the patients with burn injuries, early provision of nutritional support and increasing the intakes of vitamins and minerals are crucial to mitigating the acute state of burn injuries; this issue should be properly addressed in further investigations in this regard.

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Conflict of interest

None declared.

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