Research Article / Araştırma Makalesi

Evaluation of Albumin and Ischemia Modified Albumin Levels in Children with Acute Malnutrition

Akut Malnütrisyonlu Çocuk Hastalarda Albumin ve İskemi Modifiye Albumin Düzeylerinin Değerlendirilmesi

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Abstract

Background: Children are significantly more likely to be malnourished due to their special nutritional needs for growth. Ischemia Modified Albumin (IMA) is a new marker of ischemia that occurs when serum albumin comes in contact with the heart's ischemic tissues. IMA has been used to measure several acute conditions but has never been used to measure acute malnutrition in children. This study aims to examine albumin and IMA in malnourished children to see if they can be used as markers of malnutrition in children.
Materials and Methods: 84 children were examined (41 boys and 43 girls, mean age (SD): 6.18 (3.89); range: 0.92-16.75 years) who were referred to the hospital from 20 October to May 20, 2020. A physician performed nutrition examinations on children. BMI of less than 18.5 was considered malnourished children. The hypothesis of the normality of variables was accepted with the Kolmogorov–Smirnov test. To study the difference in variables means at groups, the T-test and Phi-Correlation were used. The ANCOVA was used to study the relationship between variables and Albumin and IMA values at different levels.
Results: The amount of albumin in the study group ranged from 4.10 to 5.15 (mean ± SD 4.82± 0.17), and the IMA range in the study group was 0.56 to 1.25 (mean ± SD 0.74± 0.13). The amount of albumin in the control group ranged from 4.19 to 5.19 (mean ± SD 4.83± 0.18), and the IMA range in the control group was 0.44 to 1.11 (mean ± SD 0.67± 0.13). No significant difference was observed between the albumin values (p-value = 0.752) between malnourished and healthy children. However, the IMA level in malnourished children was significantly higher (p-value = 0.19) than in healthy children.
Conclusions: Although albumin was not significantly different between the two groups, the IMA of malnourished children was significantly higher than that of healthy children. This result means that IMA can be used as a marker for malnutrition in children. This study is a preliminary study showing that IMA can be used as a malnutrition marker in children with malnutrition and we believe that it will contribute to the literature.

Key Words: Albumin, Ischemia Modified Albumin, Malnutrition

Öz

Amaç: Çocukların büyümek için özel beslenme ihtiyaçları nedeniyle yetersiz beslenme olasılığı önemli ölçüde daha yüksektir. İskemi Değiştirilmiş Albümin (IMA), serum albümini kalbin iskemik dokularıyla temas ettiğinde ortaya çıkan yeni bir iskemi belirtecidir. IMA birkaç akut durumu ölçmek için kullanılmıştır. Ancak çocuklarda akut yetersiz beslenmeyi ölçmek için daha önce kullanılmamıştır. Bu çalışma, yetersiz beslenen çocuklarda albümin ve IMA'nın, çocuklarda yetersiz beslenme belirteçleri olarak kullanılıp kullanılamayacaklarını görmek için incelemeyi amaçlamaktadır.
Materyal ve Metod: 20 Ekim-20 Mayıs 2020 tarihleri arasında hastaneye sevk edilen 84 çocuk (41 erkek ve 43 kız, ortalama yaş (SD): 6.18 (3.89); yaş aralığı: 0.92-16.75 yıl) muayene edildi. Bir uzman çocukların beslenme muayenelerini yaptı. BMI'nin 18.5'in altında olması yetersiz beslenen çocuklar olarak kabul edildi. Değişkenlerin normalliği hipotezi Kolmogorov-Smirnov testi ile kabul edildi. Değişken ortalamalarındaki farkı gruplarda incelemek için T-testi ve Phi-Korelasyon kullanıldı. ANCOVA testi, değişkenler ile Albümin ve IMA değerleri arasındaki ilişkiyi farklı seviyelerde incelemek için kullanıldı.
Bulgular: Çalışma grubundaki albümin miktarı 4.10 ile 5.15 arasında (ortalama ± SD 4.82± 0.17) ve çalışma grubundaki IMA aralığı 0.56 ile 1.25 arasında (ortalama ± SD 0.74± 0.13) idi. Kontrol grubundaki albümin miktarı 4,19 ila 5,19 (ortalama ± SD 4,83±0,18) ve kontrol grubundaki IMA aralığı 0,44 ila 1,11 (ortalama ± SD 0,67± 0,13) arasında değişmektedir. Yetersiz beslenen ve sağlıklı çocuklar arasında albümin değerleri (p değeri = 0.752) arasında anlamlı bir fark gözlenmedi. Bununla birlikte, yetersiz beslenen çocuklarda IMA düzeyi sağlıklı çocuklara göre anlamlı olarak daha yüksekti (p-değeri = 0.19).
Sonuç: Albümin iki grup arasında anlamlı farklılık göstermemesine rağmen, malnütrisyonlu çocukların IMA'sı sağlıklı çocuklara göre anlamlı olarak daha yüksekti. Bu sonuç, IMA'nın çocuklarda yetersiz beslenme için bir belirteç olarak kullanılabileceği anlamına gelir. Bu çalışma, malnütrisyonlu çocuklarda IMA'nın malnütrisyon belirteci olarak kullanılabileceğini gösteren bir ön çalışmadır ve literatüre katkı sağlayacağına inanıyoruz.

Anahtar Kelimeler: Albümin, İskemi Modifiye Albümin, Malnütrisyon

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Introduction

Childhood is one of the most important life periods to achieve adequate growth and establish health later. Children are significantly more likely to be malnourished due to their special nutritional needs for growth. In children's development, nutrition plays a greater role than other factors such as genetics (1). The average weight ratio of children in developing societies' lower socioeconomic class to their peers in developed countries is 30% lower (2). According to UNICEF figures, the percentage of children under the age of five who suffered from moderate to severe malnutrition between 1991 and 1980 was 42 percent in less developed countries and 36 percent in developing countries. This rate has risen to 31% worldwide between 1995 and 1990 (3). Although good health and care is a basic right of children, 200 million children worldwide and 174 million in developing countries suffer from malnutrition (4). Several factors are involved in causing malnutrition, including inadequate food intake, both in terms of quantity, such as famine, extreme poverty, or ignorance (2). Also, in cases where the child cannot absorb and use food, it can cause child malnutrition, such as diarrhea, anorexia, severe vomiting, parasitic diseases, celiac disease, cleft lip, and cleft palate, and pyloric stenosis (5). Although there is a close relationship between malnutrition and poverty, in many societies, the main cause of malnutrition is not a lack of food at home but cultural poverty, inadequate use of food when the child grows up, and lack of access to health services (2).

Abnormal serum albumin levels can sign liver or kidney disease or poor diet (6). Albumin, one of the most important plasma proteins, is released from the liver during a natural process and prevents fluid from leaking out of the arteries by balancing body fluids (7). Albumin is involved in tissue growth and repair, the transport of hormones, nutrients, and some drugs (6, 7). The presence of open wounds, burns, and postoperative conditions increases a person's risk of developing abnormal albumin (8). Ischemia Modified Albumin (IMA) is a new marker of ischemia that occurs when serum albumin comes in contact with the heart's ischemic tissues (9). Cobalt binding assay is used to measure IMA because IMA is not capable of a bind with cobalt (10, 11). IMA has been used to measure acute conditions such as pancreatitis, coronary syndrome, ischemic stroke, myocardial ischemia, myocardial infarction, and abdominal pain (9-14). However, no studies have yet conducted on the relationship between child malnutrition and IMA. This study measured albumin levels and ischemia-modified albumin (IMA) in severely malnourished children to see if these markers could help diagnose acute malnutrition.

Materials and Methods

Population

In this study, 84 children were examined (41 boys and 43 girls, mean age (SD): 6.18 (3.89); range: 0.92-16.75 years) who were referred to the hospital from October 20 to May 20, 2020. A physician performed nutrition examinations on children. The informed consent was received from the children's parents, and all the examination steps were carried out based on the Declaration of Helsinki. Children were examined to identify any underlying conditions affecting the nutritional status and prevent any underlying diseases affecting the results. Children's BMI was calculated by measuring weight divided by children's height. Blood samples were then taken from the participants. Albumin and IMA samples were identified through automated analysis.

A nutritionist determined nutrition status through SGA. Nutritionists were unaware of children's albumin and IMA status. The SGA method applies a brief overview of a person's nutritional status, including weight loss status over the last six months, dietary changes, muscle mass, and fluid balance. A BMI below 20 usually indicates underweight for developed countries and 18.5 for other countries (11). Therefore, BMI of less than 18.5 was considered malnourished children. According to this classification, 43 participants were diagnosed with malnutrition and were included in the study group, and 41 participants were diagnosed without malnutrition and were included in the control group. Albumin and IMA were considered as biochemical markers of nutritional status in children.

Statical Analysis

The hypothesis of the normality of variables was accepted with the Kolmogorov–Smirnov test. Therefore, to study the difference in variables means at groups, the T-test and Phi-Correlation were used. The ANCOVA was used to study the relationship between variables and Albumin and IMA values at different levels. All p-values below 0.05 were considered significant. All data analyses have been performed with SPSS 26.1 software package (SPSS Inc., Chicago, USA).

Results

The descriptive statistics of participants, including weight, height, BMI, and age, are shown in Table 1.

As shown in the table above, the participants' age ranged from 0.92 to 16.75 years (mean ± SD 6.18± 3.89). The participants' weight ranged from 7 kg to 50 kg (mean ± SD 19.59± 11.00), and the height of the participants ranged from 66 cm to 160 cm (mean ± SD 109± 23.47).

The participants' BMI was obtained by measuring these parameters, ranging from 11.9 to 23.4 (mean ± SD 15.20± 2.31). In Table 1, the number of participants can be seen by gender, which is divided into two study and control groups.

As shown in the table above, the total number of participants in the study was 84, of which they were divided into two groups of study and control based on the BMI ≥ 18.5 kg/m^2. The study group consisted of 43 subjects, of whom 20 were male, and 23 were female. The control group consisted of 41 subjects, of whom 21 were male, and 20 were female.

Albumin and IMA levels were then measured in participants, the values of which are shown in Table 2.

Table 1. Descriptive statistics of demographic and genders

	Study		Control		
Variable	**min-max**	**mean(sd)**	**min-max**	**mean(sd)**	p-value
Weigh	7.0-35.0	15.04(6.37)	10.4-60.0	24.36(12.77)	.000
height	66-145	103.63(21.66)	80-160	116.10(23.85)	.014
BMI	11.9-16.9	13.56(1.07)	14.5-23.4	16.92(1.99)	.691
age	.92-13.58	6.02(3.71)	1.25-16.75	6.36(4.12)	.000
gender	n	%		%	.666
Male	20	46.5	21	51.2	
Female	23	53.5	20	48.8	

Table 2. ALBUMIN and IMA of Participants

	Study		Control		p-value
Variable	**min-max**	**mean(sd)**	**min-max**	**mean(sd)**	
ALBUMIN	4.100-5.150	4.82(.17)	4.190-5.190	4.83(.18)	.752
IMA	.56-1.25	.74(.13)	.44-1.11	.67(.13)	.019

IMA: Ischemia Modified Albumin

As shown in the table above, the amount of albumin in the study group ranged from 4.10 to 5.15 (mean ± SD 4.82± 0.17). The IMA range in the study group was 0.56 to 1.25 (mean ± SD 0.74± 0.13). The amount of albumin in the control group ranged from 4.19 to 5.19 (mean ± SD 4.83± 0.18). The IMA range in the control group was 0.44 to 1.11 (mean ± SD 0.67± 0.13). With a general look at the values, it can be seen that the amount of albumin in the control and study groups is not much different, but the IMA in the study group is slightly higher Table 2.

In the following, we compared the demographic statistics of the two groups with each other, the results of which are given in Table 1.

As expected, the study group's height, weight, and BMI were significantly lower than the healthy group. Albumin and IMA values were then compared separately with each of the demographic variables, the results of which are shown in Table 3. The albumin and IMA biomarkers have not found relationship with any demographic parameters.

No significant difference was observed between the albumin values (p-value = 0.752) between malnourished and healthy children. On the other hand, the IMA level in malnourished children was significantly higher (p-value = 0.019) than in healthy children (Table 2).

Table 3. Comparing albumin and IMA values with demographic data.

	Albumin		IMA	
Variables	(min-max) mean	*p*-value	(min-max) Mean	*p*-value
WEIGHT	(8-32)14.97	0.845	(8-39)14.88	0.841
HEIGHT	(74-154)101.2	0.649	(69-142)102.4	0.888
AGE	(1.2-16)7.97	0.866	(1.3-15.2)8.32	0.956
BMI	(13-22)16.84	0.443	(12-21)16.17	0.746
GENDER	(1-2)1.4	0.97	(1-2)1.3	0.050

Discussion

Malnutrition is a major cause of reduced life expectancy and morbidity in children, and malnourished children are at higher risk of disease and death than healthy children (2, 5). Sixty percent (more than 7 million) of deaths in children under five are attributed to malnutrition (4). Nutritional deficiencies in children are associated with reduced educability, decreased ability, and inability to acquire skills. These problems can also affect future generations and endanger society's national, social, cultural, and political development irreparably (1).

This is the first study to examine albumin and ischemia-modified albumin (IMA) in malnourished children. The results showed no significant relationship between albumin and the child's nutritional status. Slattery and Patchett (15), In their study of albumin in dialysis patients, concluded that albumin could not be used as an accurate marker to measure malnutrition. Another study assessed the malnutrition status of the elderly by examining their albumin levels. Their results also showed that albumin could not be considered a reliable marker for patients' nutritional status (16).

However, a significant difference was observed between the IMA of children with malnutrition and the control group. IMA is used as an oxidative stress marker (17). Studies have shown that IMA levels increase in conditions such as obesity, diabetes, or psoriasis, which cause oxidative stress (11,18,19). IMA has also been used as a biomarker of myocardial ischemia (20). The association between IMA and the conditions such as free radicals, acidosis, and hypoxia has also been suggested, but the exact mechanism of action of IMA is not yet fully understood (11, 20-22).

Studies have shown that in malnourished patients, the

production of reactive oxygen intermediates increases, which can lead to oxidative stress in patients (20). Since IMA has been used in previous studies as an oxidative stress marker (21, 22), and malnutrition is one of the causes of oxidative stress in the body (19), it seems that oxidative stress can affect IMA in children with malnutrition. Today, much research has been done on how free radicals affect the human body and antioxidants' protective role. Antioxidants in the diet play an important role in regulating inflammation and the immune system's response due to the control of oxygen free radicals. A healthy diet can provide many natural antioxidants (11, 20-22).

Oxidative stress refers to tissue damage caused by the overproduction of oxidizing compounds or the ineffectiveness of antioxidant defense mechanisms in removing them (23). Oxidative stress results from an imbalance between the production of oxygen free radicals and the body's antioxidant defense (24). Oxidative compounds can be produced naturally in the body, but improper activation of oxidative stress can cause vascular damage and atherosclerosis (25). Studies

have shown that malnutrition can increase oxidative stress in the body, which can be seen by increasing the level of oxidized lipids (24-26). In a study of Egyptian children, Aly, Shaalan (27) showed that malnourished children had higher oxidative stress levels than children with normal nutrition.

Another study has shown that IMA levels in patients with very high or low serum albumin levels (<20 or >55 g⁄L) may be unreliable as a marker and have little clinical information value (17). In our study, none of the patients had abnormal albumin levels, and therefore these conditions do not apply to the results of our study. Our results showed that malnourished children had significantly higher IMA levels than healthy children. Other studies have shown that IMA can be associated with systemic inflammation and oxidative stress in the body (17-22). Our results also showed that an increase in IMA in children could be a sign of malnutrition and abnormal nutritional status. Of course, IMA's mechanism as a biomarker is not yet fully understood, and our study is one of the first to examine IMA in the field of malnutrition. Therefore, in order to accurately assess the effects of malnutrition on IMA in children, more studies are needed.

Study Limitations

The study has several limitations. Firstly, The small number of patients. Second, the use of single hospital data in the study. It suggests that IMA can be used as a marker for malnutrition in children. However, the need for further studies to explain the exact mechanism of IMA and to evaluate its relationship with malnutrition can be counted among the limitations of the study.

Conclusion

In this study, albumin and IMA levels in malnourished children were assessed. Although albumin was not significantly different between the two groups, the IMA of malnourished children was significantly higher than that of healthy children. This result means that IMA can be used as a marker for malnutrition in children. Further studies are needed to assess the exact mechanism of IMA and its association with malnutrition.

Ethical Approval: *Ethical approval: The study was carried out with the approval of the Council of Ethics of the Faculty of Medicine of Harran University with the decision no 04 dated 10.12.2018.*

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