NUTRITIONAL ASSESSMENT OF CHILDREN WITH CHRONIC LIVER DISEASES: THE ROLE OF ANTHROPOMETRY AND BIOELECTRICAL IMPEDANCE.

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ABSTRACT:

Background*: Malnutrition is considered one of the most serious complications of CLD.*

Aim Of the Work: *The aim of this study was to assess the nutritional status of children with chronic liver diseases (CLD) using bioelectrical impending analysis (BIA) and anthropometric measurements.*

Patients and methods: *This work was conducted as a cross sectional study and included 103 children with CLD. The included children were classified into 2 groups; group (1) which included 62 patients with mid upper arm circumference >5th percentile and group (2): included 41 patients with mid upper arm circumference ≤5th percentile. Each child underwent: full history taking, thorough clinical examination, and anthropometry measuring and bio electrical impedance analysis.*

Results*: There were statistically significant differences between group 1 and group 2 as regard the median of Egyptian Z score of weight, height and body mass index (P-value= 0.006, 0.001 and 0.019, respectively). There were statistically significant differences between group 1 than group 2 as regard the median values of fat range percent, fat mass, fat free mass, body water percent, bone mass and phase angle which were higher in group 1 than group 2 (P-value= 0.001, 0.001, 0.001, 0.001, 0.001 and 0.001, respectively).*

Conclusion*: Anthropometric parameters can be used for assessment of nutritional status in children with CLD .Bioelectrical impedance analysis is an effective tool for evaluation of nutritional state of CLD children.*

Keywords: *Anthropometry; Bioelectrical impedance analysis; chronic Liver diseases; Malnutrition.*

INTRODUCTION:

Childhood period is well known by its vulnerability as it is characterized by continuous variations in nutritional needs. Moreover, underlying medical conditions such as CLD can increase this vulnerability. Malnutrition not only affects the quality of life but also may increase the morbidity and mortality of patients with CLD [1].

Growth failure in CLD is due to increased energy expenditure, anorexia, reduced intake malabsorption, impaired hepatic protein synthesis, pubertal delay, adrenal insufficiency, and euthyroid syndrome [2]**.** Despite distinct advancements in nutritional therapy, malnutrition and growth retardation remain inevitable consequences of CLD. The global prevalence of CLD in children is about 3%, with a quarter undernourished. Malnutrition itself is a negative prognostic indicator of survival [3].

AIM OF THE WORK:

The aim of this study was to assess the nutritional status of children with CLD using bioelectrical impending analysis (BIA) and anthropometric measurements.

PATIENTS AND METHODS:

This cross sectional study was carried out on 103 children with CLD attending the outpatient clinic of Pediatric Hepatology, Gastroenterology and Nutrition Department, National Liver Institute, Menoufia University from March 2018 to August 2020. Written informed consent was obtained from the children's legal guardian.

To allow a meaningful comparison with the criterion measures, the included children were classified into 2 groups; group (1) which included 62 patients with mid upper arm circumference (MUAC) >5th percentile and group (2): included 41 patients with MUAC ≤5th percentile. Measurements <5th percentile for MUAC was taken as an indicator of malnutrition. Inclusion criteria were patients with CLD, height more than 90 cm and age more than 5 years and less than 18 years. Exclusion criteria were comatose children, children with ascites, children with cardiac or renal impairment, diabetic children, children suffering from malignancy and children on corticosteroid therapy.

Anthropometric measurements included; height, weight, body mass index, head circumference, neck circumference, mid upper arm circumference and differential body component composition including total body water, muscle mass, Fat free mass (equal to the muscle mass), fat mass (total body fat), bone mass, and phase angle were calculated using Tanita MC-780 MA Bioelectrical Impending Analysis (BIA device) which is an eight electrodes, multi-frequancy segmental body composition analyzer. We plotted height, weight and body mass index on both WHO and Egyptian z score.

Dietetic recall was recorded for 3 consecutive days (*breakfast, lunch, dinner and snacks*) and average caloric intake was calculated. also history of vitamins intake, especially fat soluble vitamins recommended in cholestatic liver diseases, was taken.

Statistical analysis:

Data were collected and entered to the computer using SPSS (Statistical Package for Social Science) program for statistical analysis (version 21) (IBM Corp., Released 2012). The results were considered significant when the probability of error is less than 5% (P value ≤ 0.05).

Data were described using minimum, maximum, median and inter-quartile range. Comparisons were carried out between two studied independent not-normally distributed subgroups using Mann-Whitney U test. Z-test for independent proportions is used to compare two independent proportions. Chi-square test was used to test association between qualitative variables.

Ethical Consideration:

The study protocol conforms to the ethical guidelines of the 1975 Declaration of Helsinki and approved by the institutional review board of the National Liver Institute (NLI-IRB 00003413 FWA0000227) Menoufia University (Approval number: 00143**).**

RESULTS:

There was no statistically significant difference between children with MUAC>5th and children with MUAC ≤5th percentile regarding age and sex distribution (Table 1).

As regard etiologies observed in the studied patients, metabolic liver diseases (Wilson, Glycogen storage disease, α1 antitrypsin deficiency, galactosemia) were the most frequent causes of CLD representing 29.13% followed by viral hepatitis (hepatitis C and B) which represents 23.30%, children and there was a statistically significant difference between the two groups (p= 0.007) (Table 2).

The average caloric intake and caloric deficit (Which is the difference between actual caloric intake and standard intake) were higher in MUAC>5th percentile group than MUAC≤5th percentile group with a statistically significant difference regarding the average caloric intake (p=0.007) and there was no statistically significant difference between both groups regarding vitamins intake and food allergy (Table 3).

There were statistically significant differences between group 1 and group 2 as regard the median of Egyptian Z score of weight, height and body mass index (P-value= 0.006, 0.001 and 0.019, respectively) (Table 4). There were statistically significant differences between group 1 and group 2 as regard the median values of fat range percent, fat mass, fat free mass, body water percent, bone mass and angle alpha which were higher in group 1 than group 2 (P-value= 0.001, 0.001, 0.001, 0.001, 0.001 and 0.001, respectively) (Table 5).

The median values of neck circumference and waist circumference were higher in children with MUAC>5th percentile than children with MUAC≤5th percentile with a statistically significant difference (P-value= 0.001 and 0.001, respectively) (Table 6).

The majority of patients (80.49%) of patients with MUAC≤5thpercentile had thigh circumference <10th percentile while (41.9%) of patients with MUAC>5thpercentile had thigh circumference percentile between 10-25th with a statistically significant difference between both groups as regard thigh circumference (p=0.00001) (Table 6).

The phase angle is a statistically acceptable significant discriminator of malnutrition with Area under the ROC curve (AUC) = 0.706. At the level of ≤4.3, sensitivity and specificity were 51.22% and 83.87%, respectively (*P-value*=0.0001). Neck circumference is a statistically acceptable significant discriminator of malnutrition with (AUC) = 0.721. At the level of ≤ 0.3690, sensitivity and specificity were 75.61% and 61.29 %, respectively (*P-value*=0.0001). Thigh circumference is a statistically acceptable significant discriminator of malnutrition with AUC= 0.821. At the level of ≤ 36 with a sensitivity and specificity were of 87.80% and 69.35% (*P-value*=0.0001). Waist circumference is a statistically acceptable significant discriminator of malnutrition with AUC= 0.703. At the level of ≤ 65 with a sensitivity and specificity were of 65.85% and 74.19% (*P-value*=0.0001). Triceps skin fold thickness is a statistically acceptable significant discriminator of malnutrition with AUC= 0.771. At the level of ≤ 4 with a sensitivity and specificity were of 97.56% and 46.77% (*P-value*=0.0001) (Figure 1).

Table 1: Comparison of age and Sex between group with MUAC >5th percentile and group with MUAC≤5th percentile

	MUAC >5th percentile n=62 (60.19%)	MUAC ≤5th percentile n=41 (39.81%)	All patients (n=103)	Test of significance *p* value
Age (years)				
- Min-Max	5.00-18.00	5.00-16.00	5.00-18.00	$Z_{(MW)}$=1.703
- Median (IQR)	10.50 (9-14)	9.00 (8 -11)	10.00 (8-14)	p=.089
Sex				
- Male	26 (41.94%)	23 (56.10%)	49 (47.57%)	X^2= 1.985
- Female	36 (58.06%)	18 (43.90%)	54 (52.43%)	p=.159
Total	62 (60.19%)	41 (39.81%)	103 (100.00%)	

n: Number of patients, IQR: Inter-quartile range, MW: Mann-Whitney U test, X^2: Pearson Chi Square test.

Table (2): Comparison of the etiology of chronic liver diseases between group of children with MUAC>5th percentile and group with MUAC≤5th percentile.

Diagnosis	MUAC >5th percentile n=62 (60.19%)	MUAC ≤5th percentile n=41 (39.81%)	Total n= 103	Z test *P* value
Metabolic	22 (35.48%)	8 (19.51%)	30 (29.13%)	Z =1.7464 *p*=.08012 NS
Within metabolic				
- Wilson	15 (24.19%)	5 (12.20%)	20 (19.42%)	
- GSD	6 (9.68%)	1 (2.44%)	7 (6.80%)	
- Galactosemia	1 (1.61%)	0 (0.00%)	1 (6.80%)	
- Alpha One Antitrypsin	0 (0.00%)	2 (4.88%)	2 (1.94%)	
Viral	17 (27.42%)	7 (17.07%)	24 (23.30%)	Z =1.2158 *p*=.22246 NS
Within Viral				
- HCV	14 (22.58%)	6 (14.63%)	20 (19.42%)	
- HBV	3 (4.84%)	1 (2.44%)	4 (3.88%)	
Cholestasis	7 (11.29%)	7 (17.07%)	14 (13.59%)	Z =0.8383 *p*=.4009 NS
Within Cholestasis				
- Post kasai	3 (4.84%)	2 (4.88%)	5 (4.85%)	
- PFIC	3 (4.84%)	4 (9.76%)	7 (6.80%)	
- BRIC.	1 (1.61%)	0 (0.00%)	1 (0.97%)	
- Sclerosing Cholangitis	0 (0.0%)	1 (2.44%)	(0.97%)	
Cryptogenic	10 (16.13%)	4 (9.76%)	14 (13.59%)	Z =0.9238 p=0.3575 NS
Vascular	5 (8.06%)	7 (17.07%)	12 (11.65%)	Z =1.3949 *p*=.16452 NS
Within Vascular				
- PVT	3 (4.84%)	4 (9.76%)	7 (6.80%)	
- Budd chiari syndrome	2 (3.23%)	1 (2.44%)	3 (4.85%)	
Ductal Plate Malformation	1 (1.61%)	8 (19.51%)	9 (8.74%)	Z =3.1489 *p*=.00164*
Within Ductal Plate Malformation				
- Ductal Plate Malformation	0 (0.00%)	1 (2.44%)	1 (0.97%)	
- CHF	1 (1.61%)	5 (12.20%	6 (5.83%)	
- Caroli Syndrome	0 (0.00%)	2 (4.88%)	2 (1.94%)	
Test of significance (*p* value)	$\chi^2_{(df=5)}$ = 15.408 $p_{(MC)}$= .007*			

n: Number of patients, IQR: Inter-quartile range, MW: Mann-Whitney U test, χ^2: Pearson Chi Square test, df: degree of freedom, * : Statistically significant (p<0.05), NS: Statistically not significant (p≥0.05)

Table (3): Comparison of Dietary history between group with MUAC>5th percentile and group with MUAC≤5th percentile.

Studied parameter	MUAC >5th percentile n=62 (60.19%)	MUAC ≤5th percentile n=41 (39.81%)	All patients (n=103)	*p* value
Average caloric intake (kcal/day)				
- Min-Max - Median - IQR	550.00-2161.67 1138.00 (919.33-1471.67)	398.93-1574.67 935.67 (808.50-1184.00)	398.93-2161.67 1072.00 (851.20-1362.33)	$Z_{(MW)}$=2.715 *p*=.007*
Calories Deficit - Min-Max - Median - IQR	51.67-3282.83 1027.23 (696.33-1428.33)	-30.00-2461.90 871.33 (566.33-1178.33)	-30.00-3282.83 922.17 (658.67-1351.67)	$Z_{(MW)}$=*1.647* *p*=.100 NS
Vitamins intake	22 (35.48%)	14 (34.15%)	36 (34.95%)	$\chi^2_{(df=1)}$= 0.019 *p*=.889
Allergy	6 (9.68%)	4 (9.76%)	10 (9.71%)	$\chi^2_{(Y)(df=1)}$= 0.000 $p_{(Y)}$= 1.000 NS

n : Number of patients, IQR: Inter-quartile range, □^{2}: Pearson Chi Square test, Y: Yates's (correction for continuity for Chi-Square test), df: degree of freedom, * : Statistically significant (p<0.05), NS: Statistically not significant (p≥0.05).

Table (4): Comparison of Z score values of the anthropometric parameters between MUAC>5th percentile and MUAC≤5th percentile groups (Egyptian Z score).

	MUAC >5th percentile n=62 (60.19%)	MUAC ≤5th percentile n=41 (39.81%)	Total	Test of significance (*p* value)
Egyptian Z Score Weight Normal – n – % within Malnutrition	28 90.32%	15 57.69%	43 75.44%	X^2=8.126 *p*=0.006
Abnormal – n – % within Malnutrition	3 9.68%	11 42.31%	14 24.56%	
Total – n – %	31 54.39%	26 45.61%	57 100.00%	
Egyptian Z Score Height Normal – n – % within Malnutrition	57 91.94%	26 63.41%	83 80.58%	X^2=12.830 *p*=0.001
Abnormal – n – % within Malnutrition	5 8.06%	15 36.59%	20 19.42%	
Total – n – %	62 60.19%	41 39.81%	103 100.00%	
Egyptian Z Score BMI Normal – n – % within Malnutrition	59 95.16%	32 78.05%	91 88.35%	X^2=5.457 *p*=0.019
Abnormal – n – % within Malnutrition	3 4.84%	9 21.95%	12 11.65%	
Total – n – %	62 60.19%	41 39.81%	103 100.00%	

BMI: Body mass index, IQR: Inter-quartile range, MUAC: Mid upper arm circumference, n : Number of patients, , X^2: Pearson Chi Square test

Table (5): Comparison of Bio electrical Impedance Analysis (BIA) findings between group with MUAC>5th percentile and group with MUAC≤5th percentile.

Studied parameter	MUAC >5th percentile n=62 (60.19%)	MUAC ≤5th percentile n=41 (39.81%)	All patients (n=103)	Test of significance *p* value
Fat range (%) - Min-Max - Median (IQR)	8.30-35.10 24.45 (21.00-29.50)	11.70-31.90 20.80 (17.90-23.80)	8.30-35.10 23.40 (19.60-26.60)	$Z_{(MW)}$=3.328 *p*=.001
Fat mass (kg) - Min-Max - Median (IQR)	3.50-29.20 8.10 (6.60-12.90)	3.00-28.00 5.20 (4.20-6.00)	3.00-29.20 6.70 (4.80-10.10)	$Z_{(MW)}$=5.496 *p*=<.001
Fat free mass (kg) - Min-Max - Median (IQR)	9.20-60.20 24.15 (18.10-37.30)	10.30-47.90 18.60 (14.40-24.00)	9.20-60.20 21.30 (16.40-34.50)	$Z_{(MW)}$=5.496 *p*=<.001
Body water (%) - Min-Max - Median (IQR)	5.90-44.10 20.25 (14.60-29.00)	7.50-32.80 13.60 (10.50-17.60)	5.90-44.10 16.20 (12.70-26.10)	$Z_{(MW)}$=3.780 *p*=<.001
Bone mass - (kg) Min-Max - Median - (IQR)	0.60-3.00 1.35 (1.10-1.90)	0.60-2.30 1.10 (0.80-1.30)	0.60-3.00 1.20 (1.00-1.80)	$Z_{(MW)}$=3.307 *p*=.001
Muscle mass (kg) - Min-Max - Median (IQR)	12.220-57.20 24.25 (18.60-35.40)	9.70-45.50 17.5 (13.60-22.70)	9.70-57.20 22.60 (16.40-32.90)	$Z_{(MW)}$=3.662 *p*=<.001
Phase angel - Min-Max - Median (IQR)	3.00-6.40 4.90 (4.50-5.40)	2.80-6.40 4.30 (3.90-5.00)	2.80-6.40 4.80 (4.30-5.20)	$Z_{(MW)}$=3.524 *p*=<.001

IQR: Inter-quartile range, MUAC: Mid upper arm circumference, MW: Mann-Whitney U test, n: Number of patients,

Table (6): Comparison of neck circumference and waist circumference between group with MUAC>5th percentile and group with MUAC≤5th percentile:

	MUAC >5th percentile n=62 (60.19%)	MUAC ≤5th percentile n=41 (39.81%)	All patients (n=103)	Test of significance *p* value
Neck circumference (cm)				
- Min-Max - Median - IQR	19.00-38.00 28.75 (26.00-32.00)	19.00-37.00 25.50 (23.50-27.00)	19.00-38.00 27.00 (25.00-30.50)	$Z_{(MW)}$=3.785 *p*=<.001
Waist circumference (cm)				
- Min-Max - Median - IQR	37.00-108.00 70.50 (65.00-79.00)	38.00-94.00 62.00 (58.00-70.50)	37.00-108.00 68.00 (59.50-74.00)	$Z_{(MW)}$=3.478 *p*=.001

IQR: Inter-quartile range, MUAC: Mid upper arm circumference, n: Number of patients,, MW: Mann-Whitney U test

Table (7): Comparison of Liver function tests of MUAC>5th percentile group and MUAC≤5th percentile group

Liver function test	MUAC >5th percentile n=62	MUAC ≤5th percentile n=41	All patients (n=103)	Test of significance *p* value
- Total bilirubin (mg/dl) - Min-Max -Median (IQR)	0.21-25.58 0.85(0.60-1.80)	0.10-26.90 0.90(0.70-2.50)	0.10-26.90 0.90(0.60-2.00)	$Z_{(MW)}$=0.925 *p*=0.355 NS
- Direct bilirubin (mg/dl) - Min-Max - Median (IQR)	0.08-16.40 0.20 (0.11-0.85)	0.02-22.80 0.31 (0.16-1.28)	0.02-22.80 0.25 (0.13-1.13)	$Z_{(MW)}$=1.153 *p*=0.249 NS
- Total protein (mg/dl) - Min-Max - Median (IQR)	4.50-9.40 6.90 (6.40-7.40)	5.10-9.00 6.90 (6.40-7.40)	4.50-9.40 6.90 (6.40-7.40)	$Z_{(MW)}$=0.270 *p*=0.787 NS
- ALB (gm/dl) - Min-Max - Median (IQR)	2.40-4.90 4.00 (3.50-4.30)	1.80-5.40 3.70 (3.10-4.30)	1.80-5.40 3.90 (3.40-4.30)	$Z_{(MW)}$=1.063 *p*=0.288 NS
- AST (U/L) - Min-Max - Median (IQR)	13.00-1054.00 35.00 (28.00-88.50)	3.00-1200.00 44.00 (29.00-87.00)	3.00-1200.00 39.00 (29.00-88.00)	$Z_{(MW)}$=0.208 *p*=0.835 NS
- ALT (U/L) - Min-Max - Median (IQR)	11.00-1066.00 32.50 (24.00-57.50)	9.00-490.00 40.00 (23.00-75.00)	9.00-1066.00 33.00 (23.00-68.00)	$Z_{(MW)}$=0.269 *p*=0.788 NS
- ALP (U/L) - Min-Max - Median (IQR)	21.00-807.00 263.50 (156.00-363.00)	31.00-620.00 211.00 (136.00-422.00)	21.00-807.00 235.00 (156.00-364.00)	$Z_{(MW)}$=0.494 *p*=0.622 NS
- PT (seconds) - Min-Max - Median (IQR)	33 11.60-42.00 13.60(12.90-14.80)	20 11.50-20.40 14.20(12.85-15.95)	53 11.50-42.00 13.90(12.90-15.20)	$Z_{(MW)}$=0.725 *p*=0.468 NS

n: Number of patients, IQR: Inter-quartile range, NS: Statistically not significant (p≥0.05), X^2:Pearson Chi Square test.

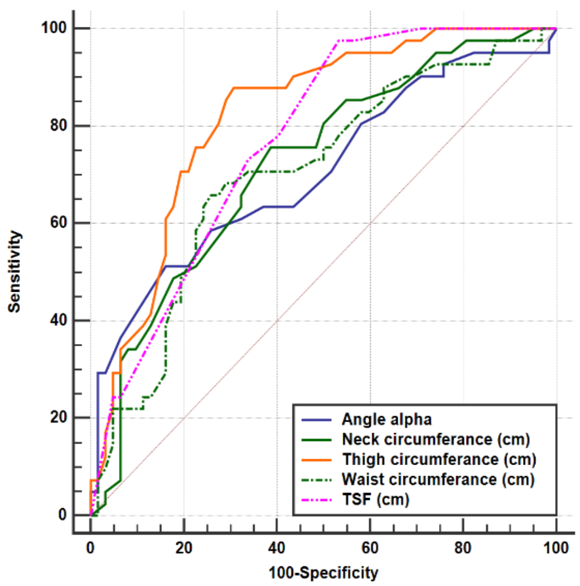

Figure 1: ROC curve of phase angel, neck circumference, thigh circumference, waist circumference and triceps skin fold thickness for discrimination of malnutrition in children with chronic liver diseases.

DISCUSSION:

In the present study, there were statistically significant differences between group 1 and group 2 as regard the median of Egyptian Z score of weight, height and body mass index. A previous Egyptian study had compared between a total of 69 patients with CLD and 50 healthy controls aged from 6 months to 6 years and revealed that the mean Z score of anthropometric parameters (weight for age, height for age and MUAC) was < zero, a finding denotes that all CLD patients have been nutritionally affected. Generally, they reported significant statistical differences between the two studied groups according to those anthropometric measures [4].

In the present study, fat mass measured by BIA was (8.1) and (5.2) Kg while skeletal mass was (1.35) and (1.1) Kg in MUAC>5th percentile and MUAC≤5th percentile groups respectively, with a significant statistical difference between the two groups. In a previous study, fat mass was (8.38) and (10.2) Kg respectively with significant statistical differences between the two studied groups as regards to all the mentioned parameters [5].

Nevertheless, a recent study was conducted on adult patients and also found significant statistical differences between malnourished and well-nourished adults with liver cirrhosis regarding muscle mass. They also concluded that malnutrition and sarcopenia are interrelated problems in CLD patients [6].

The body’s compartments have different bio impedance. fat, skin, and bones harbors small amount of fluids and electrolytes and so they have low conductivity [7]. Our result showed a significant statistically difference of body water between MUAC>5th percentile group and MUAC≤5th percentile group.

We reported that the median of the phase angle was (4.9°) for MUAC>5th percentile group which was higher than that of MUAC≤5th percentile group (4.3°) with a statistically significant difference. As far as our search, we did not find a study that discussed phase angle as a nutritional assessment tool in children with CLD.

Nevertheless, a previous study used angle alpha to assess malnutrition in adults with CLD and found that it had higher values in well-nourished patients, (6.5°) vs (5°) in malnourished patients. It was also significantly correlated with MUAC, triceps skin fold thickness (this also matched our results in children with CLD) and albumin and was inversely correlated with age. It was found that phase angle ≤ 5.18º with relative risk increase of 2.5 for death, concluding that the BIA-derived angle alpha is a relevant nutritional evaluation tool in CLD [8].

Conclusion:

Anthropometric parameters including neck, waist, thigh circumferences and triceps skin fold thickness can be used for assessment of nutritional status in children with CLD. Bioelectrical impedance analysis especially for analysis of fat range, fat range percent, fat free mass, body water, muscle mass, bone mass and phase angle is an effective tool for evaluation of nutritional state of CLD children.

Conflict of Interest:

No conflict of interest.

No financial or non-financial benefits have been received or will be received from any party related directly or indirectly to the subject of this article.

This work has not been published in its current form or substantially similar form elsewhere including on a website.

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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تقييم الحالة التغذوية لدى الاطفال المصابين بالامراض الكبدية المزمنة: دور القياسات البشرية والمعاوقة الكهربية البيولوجية.

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الهدف من الدراسة: تهدف هذه الدراسة الى تقييم الحالة التغذوية لدى الاطفال المصابين بالامراض الكبدية المزمنة عن طريق تحليل مكونات الجسم من دهون وعضلات بواسطة جهاز BIA وباستخدام المقاييس الجسمية.

خلفية البحث: يعد سوء التغذية من المضاعفات الخطيرة للأمراض الكبدية المزمنة.

ادوات البحث: تم إجراء هذا البحث على مائه وثلاث من الأطفال المصابين بالامراض الكبدية المزمنة . تم تقسيم الاطفال قيد البحث الى مجموعتين؛ وقد شملت المجموعة الاولى الاطفال الذين تخطى قياس محيط منتصف الذراع لديهم النسبة المئوية الخامسة (62 طفل) بينما شملت المجموعة الثانية الاطفال الذين قل قياس محيط منتصف الذراع لديهم عن النسبة المئوية الخامسة او وافقها (41طفل). تم إخضاع جميع الحالات قيد البحث للاتي: التاريخ المرضي للمريض،الفحص الإكلينيكي الشامل،المقاييس الجسمية،تحليل مكونات الجسم من دهون وعضلات بواسطة جهاز BIA.

النتائج: أبرزت النتائج وجود فروق ذات دلالة احصائية بين المجموعة الاولى والثانية فيما يخص متوسط الدرجة المعيارية (z score) المصرية للوزن والطول ومؤشر كتلة الجسم (القيمة الاحتمالية = 0.006 ، 0.001، 0.019 على التوالى). وايضا فيما يخص نسبة الدهون و كتله الدهون والكتلة الخالية من الدهون وماء الجسم وكتلة العظام وزاوية ألفا (القيمة الاحتمالية = 0.001 لكل منهم).

الاستنتاج: معايير القياسات البشرية يمكن استخدامها لتقييم الحالة التغذوية للأطفال المصابين بأمراض الكبد المزمنة. كما ان تحليل المعاوقة الكهربائية الحيوية BIA يعتبر أداة فعالة لتقييم الحالة التغذوية لهؤلاء الأطفال.