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Impact of sarcopenia on clinical outcomes in pediatric chronic liver disease post-liver transplantation: prevalence and implications

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ABSTRACT

Aim: The purpose of this retrospective single-center study was to determine the frequency of sarcopenia and its association with mortality and other morbidities in children with chronic liver disease who had undergone liver transplantation.

Background: Sarcopenia, a muscle-wasting syndrome, is common in patients with advanced liver disease and is associated with increased morbidity and mortality. While sarcopenia in adults has been extensively studied, there is little information in this regard about children and adolescents with chronic liver diseases.

Methods: The study included 108 children and adolescents who had undergone liver transplantation. Sarcopenia was measured using skeletal muscle index at the third lumbar vertebral level and assessed using abdominal computed tomography imaging.

Results: The frequency of sarcopenia in the studied population was found to be 45.7%. Patients with sarcopenia were more likely to be male (P<0.0001), older (P<0.0001), and had lower height-for-age z-scores (P=0.012). Genetic/metabolic diseases were the most common underlying cause of sarcopenia in children. Except for a higher rate of transplant rejection in the sarcopenia group (P=0.035), there was no significant difference in mortality rates (P=0.688) or post-LT complications between the two groups. One year after LT, computed tomography-derived body composition parameters revealed no significant differences between children who survived and those who did not.

Conclusion: Our findings indicated a high frequency of sarcopenia in children with chronic liver disease, implying that more research is needed to better understand its impact on clinical outcomes in this population.

Keywords: Sarcopenia, Pediatrics, Liver transplantation, Outcome.

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Introduction

Sarcopenia is a muscle-wasting syndrome characterized by a reduction in muscle strength, quantity/quality, and physical performance. It is particularly prevalent in cirrhotic patients. A combination of sarcopenia and end-stage liver diseases (ESLD) is associated with increased mortality and morbidity, greater rates of cirrhosis complications, infections, hospitalizations, and waitlist mortality. It is also linked to poorer clinical outcomes following liver transplantation (LT), such as rejection, longer hospital stays, diminished quality of life and functional independence, and mortality (1-4).

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As LT remains the only curative option for patients with decompensated cirrhosis, early recognition and management of sarcopenia may play a role in its better management. Several different imaging tools such as computed tomography (CT) and magnetic resonance imaging (MRI) are used to assess sarcopenia in chronic liver disease patients. Recently, the secondary analysis of CT images for the evaluation of body composition has been developed as an objective, precise, and gold-standard approach to diagnosing skeletal muscle abnormalities. CT-measured muscle cross-sectional area at the level of the third lumbar vertebrate (L3), normalized to the patient's height and reported as skeletal muscle index (SMI), is a robust indicator of whole-body muscle mass (5-7).

The prevalence of sarcopenia varies, ranging from 40% to 70% (8). This discrepancy might be related to different quantitative measurements of the muscle mass, chosen criteria, cutoff points for sarcopenia, and ethnic differences among the studied populations. Sarcopenia in pediatric chronic liver disease has remained undermeasured. However, recently few studies have been published that demonstrate a high prevalence of sarcopenia in this vulnerable age group. An association between sarcopenia and outcomes, particularly post-transplant outcomes, was also reported (9-11). The use of the total psoas muscle area on CT imaging at L3/4 and L4/5 seems promising as a measure of sarcopenia. Recent efforts to define pediatric-specific norms for skeletal muscle area and skeletal muscle index will help advance the field (12).

Sarcopenia is a new concept in pediatrics, and there is little information on its prevalence as well as effect on children and adolescents with chronic liver disease. Given the possible consequences of sarcopenia on clinical outcomes, additional research into this issue is crucial. In this study, we aimed to assess the frequency of sarcopenia and its relationship with mortality and other morbidities in children with chronic liver diseases in our referral center using abdominal CT imaging.

Methods

Study design and population

A retrospective single-center study was conducted on 108 children and adolescents (below the age of 18) who had undergone LT at Abu-Ali Sina Hospital in Shiraz, Iran, between June 2018 and January 2022. All eligible children that had an accessible CT scan at radiology ward of Abu-Ali Sina Hospital were enrolled in our study. Medical records were thoroughly reviewed to collect demographic information and clinical features including underlying disease, Pediatric End-Stage Liver Disease (PELD) scores, or Model for End-Stage Liver Disease (MELD) scores, besides anthropometric measurements, post-LT ICU stay, and intubation hours.

Biochemical values including complete blood count, bilirubin (direct, and total), alanine aminotransferase (ALT), aspartate aminotransferase (AST), gamma-glutamyl transferase (GGT), alkaline phosphatase (ALP), albumin, international normalized ratio for thrombin (INR), and renal function tests were extracted from the database based on the CT imaging date. Post-LT early complications including biliary and vascular (hepatic artery thrombosis or stenosis) complications, primary non-function, infections, allograft rejection, graft loss, and death were gathered by reviewing the medical records.

Sarcopenia assessment

As part of the liver assessment before transplantation, a CT scan is routinely performed at our center. We utilized a single-source dual-energy CT scanner, specifically the Toshiba Aquilion Prime One model, to perform spiral scanning of the abdomen and pelvis in three phases. The acquisition parameters consisted of 120 kilovoltage peak, 80 milliamperes (dependent on patient size), 0.5 gantry rotation time, 3 millimeters slice thickness, and a pitch of one.

Abdominal CT imaging data were retrieved from our institution Picture Archiving and Communication System to measure muscular (SMA) and visceral fat. We employed body composition analysis software developed using MATLAB version R2014a (Mathworks Inc, Natick, MA). Digital Imaging and Communications in Medicine (DICOM) slices of the abdomen at the level of L3 were provided as input to the software. We adjusted the Hounsfield unit (HU) thresholds to analyze the data, setting them at -29 to +150 for skeletal muscle and -190 to -30 for subcutaneous and intermuscular adipose tissue. The software allowed the user to draw a line separating the abdominal muscles within the peritoneal cavity, thus enabling the measurement of the skeletal muscle area (SMA) and visceral fat in square centimeters (cm^2).

Finally, we obtained the skeletal muscle index (SMI) through dividing SMA by the patient's squared height in square meters (m^2).

Due to the absence of established gender-specific cut-off points for CT-derived sarcopenia among children with liver cirrhosis, we utilized the values of skeletal muscle index (SMI) at the L3 level, as observed in cirrhotic adults (SMI < 52.4 cm^2/m^2 in males and < 38.5 cm^2/m^2 in females).

Ethical consideration

This study was conducted in agreement with the Declaration of Helsinki, with ethical approval for our method and informed consent waiver (based on the retrospective nature of this study) obtained from the Research Ethics Board of Shiraz University of Medical Sciences (Approval code: IR.SUMS.MED.REC.1400.498).

Statistical analysis

The data were analyzed using IBM SPSS Statistics for Windows, version 26.0, (IBM Corp., Armonk, NY, USA, 2019). To evaluate the normality of continuous variables, we used the Kolmogorov-Smirnov test. Descriptive statistics such as mean and standard deviation or median and interquartile range (IQR) were used to describe continuous variables depending on normality, while frequency and percentage were used for categorical variables. An independent sample t-test was used to compare continuous variables between different groups. If the data did not meet the parametric assumptions, the Mann-Whitney U test was used instead. The chi-square test was employed for comparing the categorical variables. In addition, Pearson's correlation was calculated for the correlation between the two continuous variables. Univariate Cox regression analysis was conducted for the influence of Sex, Age at TX, Height/Length for age z-score, PELD/MELD, Rejection, Cause of liver cirrhosis, Graft type, Donor relation, Sarcopenia, Sepsis, Post-LT ICU admission days, ALT, ALP, and Hepatic artery thrombosis on survival. Variables with significant or borderline significant values ($p \leq 0.2$) in the univariate analysis were entered into the Cox model for multiple analyses. The statistical significance was determined as a P-value < 0.05 for all tests.

Table 1. Association of sarcopenia with baseline data among cirrhotic children who had undergone liver transplantation (n=105)

Variable	Total (n=105 [1])	Sarcopenia		P
		Negative (n=57)	Positive (n=48)	
Gender				
Girl	46 (43.8) [2]	34 (59.6)	12 (25.0)	<0.0001 [3]
Boy	59 (56.2)	23 (40.4)	36 (75.0)	
Age	6 (2, 13) [4]	2 (1, 6)	11 (6.25, 13.75)	<0.0001 [5]
Height/Length for age z-score				
-3 SD	40 (38.1)	31 (54.4)	9 (18.8)	0.012 [3]
-2 SD	14 (13.3)	7 (12.3)	7 (14.6)	
-1 SD	18 (17.1)	5 (8.8)	13 (27.1)	
Normal	25 (23.8)	11 (19.3)	14 (29.2)	
+1 SD	4 (3.8)	1 (1.8)	3 (6.3)	
+2 SD	2 (1.9)	1 (1.8)	1 (2.1)	
+3 SD	2 (1.9)	1 (1.8)	1 (2.1)	
Cause of liver cirrhosis				
Biliary tract diseases	43 (41.0)	32 (56.1)	11 (22.9)	0.014 [3]
Genetic/Metabolic	36 (34.3)	15 (26.3)	21 (43.8)	
PSC/AIH/PBC/BS/neonatal hepatitis	10 (9.5)	3 (5.3)	7 (14.6)	
Cryptogenic	7 (6.7)	3 (5.3)	4 (8.3)	
Others	9 (8.6)	4 (7.0)	5 (10.4)	
PELD/MELD				
PELD (n=68)	20 (16,25, 24.5)	20 (16, 24)	20 (18, 25)	0.697 [5]
MELD (n=30)	20 (16, 25)	26.5 (23.5, 28.75)	17.5 (14.5, 23)	0.003 [5]

[1] Out of the total sample size of 108, three children lacked sufficient data for assessing sarcopenia.
[2] Count (%)
[3] Chi-square test
[4] Median (IQR)
[5] Mann-Whitney *U* test
Abbreviations= MELD, model for end-stage liver disease; PELD, model for pediatric end-stage liver disease; BA, biliary atresia; PFIC, progressive familial intrahepatic cholestasis; PSC, primary sclerosing cholangitis; AIH, autoimmune hepatitis; PBC, primary biliary cholangitis; BS, biliary sclerosis.

Results

One hundred and eight eligible children with chronic liver disease participated in the study. All of them underwent LT. Their median age was 6 (IQR: 2, 13) years, 59 (56.2%) were boys, and 46 (43.8%) were girls (Table 1). The one-year post-LT mortality rate was 17.1% (18 patients). In addition, regarding the post-LT complications, the rates of hepatic artery thrombosis, bile leakage or common bile duct (CBD) stenosis, and sepsis were 8.6% (9 patients), 1.9% (2 patients), and 6.7% (7 patients), respectively. Moreover, the rates of transplant rejection, graft failure, and re-transplantation were 23.8% (25 patients), 4.8% (5 patients), and 5.7% (6 patients), respectively (Table 2).

The frequency of sarcopenia was calculated as 45.7% (48 out of 105 patients). Note that three children lacked sufficient data for assessing sarcopenia. Children with sarcopenia were males and older compared to those who did not have sarcopenia (75% vs. 40.4%, P<0.0001; 11 (IQR=6.25, 13.75) vs. 2 (IQR=1, 6), P<0.0001). In addition, the frequency of lower height/length for age z-scores was significantly lower among sarcopenic children (P=0.012). Further, the most prevalent underlying cause in children with sarcopenia was genetic/metabolic diseases (43.8%). However, the most common etiology in children without sarcopenia was biliary tract diseases (56.1%) (P=0.014). Patients with sarcopenia, who an age >12 years, exhibited a significantly lower median MELD score, compared to their counterpart (17.5 (IQR=14.5, 23) vs. 26.5 (IQR=23.5, 28.75), P=0.003); however, among children aged under 12 years, there was no statistical difference regarding the median PELD score between the two groups (P=0.697) (Table 1).

We did not observe any difference in the mortality rate between children with and without sarcopenia (18.8% vs. 15.8%, P=0.688). There was no significant difference either for the post-LT ICU admission days (14 (12, 21.75) vs. 16 (IQR: 12, 26), P=0.389) and post-LT intubation hours (15 (IQR: 7.25, 20) vs. 18.5 (IQR: 8, 27), P=0.238) between the two groups. Furthermore, these two groups were not different for the rates of

Table 2. Association of sarcopenia with outcomes in cirrhotic children who had undergone liver transplantation (n=105)

Variable	Total (n=105 [1])	Sarcopenia		P
		Negative (n=57)	Positive (n=48)	
One-year post LT survival				
Deceased	18 (17.1) [2]	9 (15.8)	9 (18.8)	0.688 [3]
Survived	87 (82.9)	48 (84.2)	39 (81.3)	
Post-LT ICU admission days	16 (12, 23) [4]	16 (12, 26)	14 (12, 21.75)	0.389 [5]
Post-LT intubation hours	17 (8, 24.25)	18.5 (8, 27)	15 (7.25, 20)	0.238 [5]
Hepatic artery thrombosis				
Positive	9 (8.6)	4 (7.0)	5 (10.4)	0.535 [3]
Negative	96 (91.4)	53 (93.0)	43 (89.6)	
Bile leakage or CBD stenosis				
Positive	2 (1.9)	2 (3.5)	0	0.190 [3]
Negative	103 (98.1)	55 (96.5)	48 (100)	
Sepsis				
Positive	7 (6.7)	6 (10.5)	1 (2.1)	0.084 [3]
Negative	98 (93.3)	51 (89.5)	47 (97.9)	
Rejection				
Positive	25 (23.8)	9 (15.8)	16 (33.3)	0.035 [3]
Negative	80 (76.2)	48 (84.2)	32 (66.7)	
Graft failure				
Positive	5 (4.8)	3 (5.3)	2 (4.2)	0.793 [3]
Negative	100 (95.2)	54 (94.7)	46 (95.8)	
Re-transplantation				
Positive	6 (5.7)	3 (5.3)	3 (6.3)	0.828 [3]
Negative	99 (94.3)	54 (94.7)	45 (93.8)	

[1] Out of the total sample size of 108, three children lacked sufficient data for assessing sarcopenia.
[2] Count (%)
[3] Chi-square test
[4] Median (IQR)
[5] Mann-Whitney *U* test
Abbreviations= LT, liver transplantation; CBD, common bile duct.

Table 3. Association of one-year post-LT survival with CT-derived body composition parameters in cirrhotic children who had undergone liver transplantation (n=108)

Variable	Total (n=108)	Survived (n=90)	Deceased (n=18)	P
SMA, cm^2	47.90 (33.83, 68.76) [1]	48.73 (35.26, 67.79)	40.53 (29.62, 72)	0.380 [2]
SFA, cm^2	17.94 (12.59, 33.60)	18.1 (13.07, 33.6)	16.52 (10.85, 37.66)	0.586 [2]
VFA, cm^2	12.97 (8.31, 26.42)	13.96 (8.41, 26.41)	9.51 (6.04, 38.52)	0.431 [2]
SMA/SFA	2.40 (1.72, 3.47)	2.46 (1.72, 3.45)	2.24 (1.44, 3.6)	0.818 [2]
SMI, cm^2/m^2	48.30 (38.06, 63.09)	48.30 (38.27, 64.23)	49.28 (31.33, 56.57)	0.513 [2]

[1] Median (IQR)
[2] Mann-Whitney *U* test
Abbreviations= SMA, skeletal muscle area; SFA, subcutaneous fat area; VFA, visceral fat area; SMI, skeletal muscle index.

Table 4. Correlation matrix of CT-derived body composition parameters

R / *P*	SMA	SFA	VFA	SMA/SFA	SMI
SMA	1				
SFA	0.728(<0.0001)	1			
VFA	0.409(<0.0001)	0.434(<0.0001)	1		
SMA/SFA	-0.195(0.047)	-0.515(<0.0001)	-0.170(0.087)	1	
SMI	-0.157(0.111)	-0.027(0.788)	-0.273(0.005)	-0.078(0.438)	1

Abbreviations= SMA, skeletal muscle area; SFA, subcutaneous fat area; VFA, visceral fat area; SMI, skeletal muscle index.; correlation coefficient(P-value)

hepatic artery thrombosis (P=0.535), bile leakage or CBD stenosis (P=0.190), sepsis (P=0.084), graft failure (P=0.793), and re-transplantation (P=0.828). However, the rate of rejections was significantly higher in cirrhotic children with sarcopenia than those without sarcopenia (33.3% vs. 15.8%, P=0.035) (Table 2).

Regarding the CT-derived quantitative body composition parameters, no significant difference was found between the deceased and survived children one year post liver transplantation, including SMA, SFA, VFA, SMA/SFA ratio, and SMI (Table 3).

The SMI revealed an inverse, but insignificant, correlation with skeletal muscle area (SMA) (R= -0.157, P=0.111), subcutaneous fat area (SFA) (R= -0.027, P=0.788), and SMA/SFA ratio (R= -0.078, P=0.438). However, a weak inverse correlation was observed between the SMI and visceral fat area (VFA) (R= -0.273, P=0.005). The correlation matrix of SMA, SFA, VFA, SMA/SFA, and SMI is reported in Table 4. The univariate and multiple Cox regression analyses for the influence of Sex, Age at TX, Height/Length for age z-score, PELD/MELD, Rejection, Cause of liver cirrhosis, Graft type, Donor relation, Sarcopenia, Sepsis, Post-LT ICU admission days, ALT, ALP, and Hepatic artery

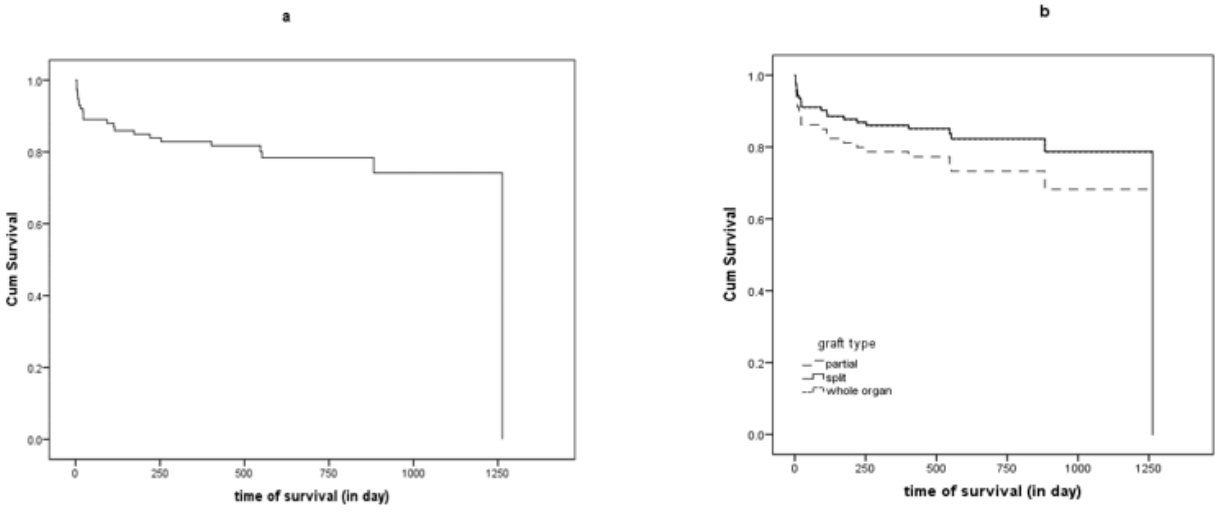

Figure 1. The survival curve for multiple cox regression model totally (a) and after controlling the graft type variable (b).

thrombosis are presented in Table 5. The univariate analysis for overall survival revealed that post-LT intubation hours was a significant risk factor for death at the level of 0.05. An increase in one-hour in post-LT intubation hours had a 0.3% (95% CI 0.1% to 0.5%) decrease in time to the event (survival time to death). The variables with significant level less than 0.2 were used for multiple Cox regression analysis. Donor relation variable that has a linearly dependence with graft type variable is deleted from multiple survival model. Post-LT intubation hours was a significant risk factor after adjusting for the graft type (Table 5). The median (IQR) of survival time (time to event) was 588.5 (800.5-461.25) day for non-event and 58 (364.75-7.5) day for event groups ($p<0.0001$). The survival curve for multiple cox regression model totally (a) and after controlling the graft type variable (b) has been drawn in Figure 1.

Discussion

Sarcopenia is the clinical and radiological finding of the disruption of skeletal muscle homeostasis which is a systemic presentation of ESLD. Increased gluconeogenesis in skeletal muscles, activation of pro-catabolic (e.g. myostatin) and anti-anabolic and systemic inflammatory agents in response to hyperammonemia, increased serum aromatase activity, cholestasis and dysbiosis, and finally malnutrition all promote muscle degradation and sarcopenia in this

Table 5. Univariate and Multiple Cox regression analysis

		univariate			multiple		
Variable		**Hazard Ratio (HR)**	**95% CI for HR**	**P-value**	**Hazard Ratio (HR)**	**95% CI for HR**	**P-value**
Graft type	Partial (ref)	-	-				
	Split	0. 546	0.12-2.4	0.42	0.622	0.14-2.79	0.535
	Whole organ	0.55	0.22-1.36	0.197	0.634	0.25-1.63	0.343
Post-LT intubation hours		1.003	1.001-1.005	0.006	1.002	1-1.004	0.015
sex	Girl (ref)						
	boy	1.279	0.55-2.96	0.57			
Age at TX	-	0.989	0.92-1.07	0.76			
Height/Length for age z-score	-3 SD	1.14	0.33-3.88	0.84			
	-2 SD	1.12	0.25-5.04	0.89			
	-1 SD	2.92	0.85-10.02	0.09			
	Normal (ref)	-	-	-			
	+1 SD	0	-	0.97			
	+2 SD	2.35	0.26-21.21	0.45			
	+3 SD	4.05	0.45-36.7	0.21			
PELD/MELD	-	1.03	0.975-1.09	0.298			
Rejection	Positive	1.47	0.62-3.47	0.378			
	Negative (ref)	-	-				
Cause of liver cirrhosis	Biliary tract diseases (ref)	-					
	Genetic/Metabolic	0.673	0.23-2.01	0.48			
	PSC/AIH/PBC/BS/Neonatal hepatitis	1.56	0.42-5.77	0.5			
	Cryptogenic	0.695	0.09-5.5	0.73			
	Others	2.942	0.98-8.81	0.054			
Donor relation	Relative (ref)	-	-				
	cadaver	0.549	0.24-1.27	0.16			
sarcopenia	Positive	1.11	0.49-2.52	0.797			
	Negative (ref)	-	-				
Sepsis	Positive	2.004	0.59-6.81	0.265			
	Negative (ref)	-	-				
Post-LT ICU admission days	-	0.976	0.94-1.01	0.22			
ALT	-	0.99	0.99-1.004	0.44			
ALP	-	1	0.999-1	0.445			
Hepatic artery thrombosis	Positive	0.876	0.21-3.74	0.86			
	Negative (ref)	-	-	-			

group (10). Prevalence of sarcopenia, especially in children suffering from cirrhosis, can be affected by several determinants: from the disease itself to alternation in nutrition and growth failure. In our survey, 45.7% of the studied population were sarcopenic. This is in the same line with a previous study on 25 Canadian children which reported a prevalence of 40% in children with ESLD awaiting LT (13). A single study from Rome among population aged 1–16 years found a sarcopenia prevalence of 56% (14).

We found that sarcopenic patients were significantly male and older compared to others. This is consistent with the results of Ooi et al.'s study in which myopenia with low subcutaneous adipose tissue was associated with the older and male population (15). However, in Mager et. al.'s study, younger female children had a higher prevalence of sarcopenia (16). Different fat distribution and puberty processes as well as timing among the two genders may lead to bias in our interpretation. It should also be noted that, despite using gender-matched criteria in all the mentioned studies, lacking exact, precise, and true gender-specific definitions might affect these findings.

The association of sarcopenia with conventional anthropometric measures is very controversial. Woolfson et al. showed a significant association between lower z-scores for weight, height, and sarcopenia (13). In contrast, in a recent systematic review, sarcopenia did not correlate with weight, height, weight-for-height, or body mass index (BMI) (10, 14). In our study, z-scores for height, but not weight, were different between sarcopenic and non-sarcopenic children; however, univariate and multiple Cox regression analysis did not show any association between z-scores for height and mortality.

The most prevalent underlying cause in sarcopenic children was genetic/metabolic diseases, while it was biliary tract disease in the other group. Different underlying diseases may affect the progression of skeletal muscle wasting. Although very few studies have addressed this issue, a previous study indicated that the odds ratio for sarcopenia in autoimmune liver diseases was 14.5 compared to non-alcoholic fatty liver diseases (17). Another study reported biliary atresia as the most underlying disease among the studied population (18).

We did not observe any difference in the mortality rate, post-LT ICU admission days, post-LT intubation hours, vascular and biliary complications, sepsis, and re-transplantation. Post-LT intubation hours was the only significant risk factor for death based on multiple Cox regression analysis. Woolfson et al. reported that children with sarcopenia had a longer duration of pediatric intensive care unit (PICU) stay post-LT, but no association has been reported between biliary plus vascular complications and mortality in one and two-year follow-up and sarcopenia (13). Similarly, Jitwongwai et al. concluded that there was no correlation between vascular/biliary complications, infections, post-transplant mortality, and sarcopenia (19). However, in a study by Takeda et al., sarcopenia was associated with longer operating time, higher degree of blood loss, and greater risks for portal vein stenosis, septicemia, and ventilator dependency (20). There was no association between PELD and sarcopenia in our study which is compatible with previous studies (10, 14). However, MELD score had a significant difference between sarcopenic and non- sarcopenic group. It seems children with even lower MELD score have lower muscle mass area. MELD/PELD scores predict more serious conditions without liver transplantation; however, these scores often ineffectively detect the severity of the disease. It seems that no strong relationship can be established between post-LT mortality and sarcopenia in adults cannot be set in the pediatric population (21).

Interestingly, we found a significant difference between sarcopenia and non-sarcopenia group based on the graft rejection. The rejection rate is twice more common in cirrhotic children with sarcopenia. However, univariate and multiple Cox regression analysis did not find any association between the graft rejection and mortality. This is consistent with the findings of some previous studies (13, 14). A systematic review and meta-analysis investigated the role of sarcopenia among solid organ transplant recipients, indicating that sarcopenia lowered the risk of acute rejection (22). Wakabayashi et al. also reported reduced incidence of rejection among adult liver transplant recipients with low muscle mass (23). Although sarcopenia has a negative impact on long-term graft survival, it seems this negative effect is unlikely to be related to rejection. Alterations in T and NK cells may be possible mechanisms by which sarcopenia reduces the risk of acute rejection (22).

Among CT-derived variables, an inverse correlation was only observed between the SMI and VFA (R= -

0.273); regarding the associations of these variables including SMA, SFA, VFA, SMA/SFA ratio, and SMI and one-year post-LT mortality, we could not find any significant relationship. In a previous study, children with ESLD had a 23% reduction in the muscle mass, a 69% and 29% elevation in the visceral fat and subcutaneous fat, respectively (24). However, in another study, VFA of sarcopenic patients was greater than patients without sarcopenia, but there were no differences in the subcutaneous fat area or thickness in the groups (17).

To the best of our knowledge, this is the first study which investigated sarcopenia in children with ESLD in the Middle East, and our study population is the largest of its own kind worldwide reported in the literature. We examined sarcopenia via CT imaging in a single center which is the gold standard used to assess sarcopenia; this strengthens the value of the study (25).

On the other hand, we faced some limitations; the most important one was the retrospective nature of the study. Further, we did not study delisted patients and only assessed post-LT mortality plus its relationship with pre-LT sarcopenia.

Given the differences between the features of studies, such as evaluation of sarcopenia, study design, and study era, it is suggested that further studies should be conducted with a larger number of recipients and more detailed mechanistic studies to examine the recipients' immune cell function in the sarcopenic state.

Conclusion

In our study, children with chronic liver diseases who had undergone liver transplantation showed a high prevalence of sarcopenia. The prevalence of sarcopenia was different based on gender, age, and height-for-age z-scores, underlying cause, and MELD. Post-LT intubation hours was only significant risk factor after adjusting for the graft type. There were no significant differences in mortality or post-transplant complications between the two groups. However, the group with sarcopenia had a higher rate of rejection. Our findings highlighted the significance of sarcopenia management in pediatric patients with chronic liver diseases. More research is warranted to investigate the long-term effects of sarcopenia and develop targeted interventions for these vulnerable patients.

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Conflict of interests

The authors report no conflicts of interest in this work.

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