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Longitudinal Anthropometry and Body Composition in Children With SARS-CoV-2-Associated Multisystem Inflammatory Syndrome

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ABSTRACT

Objectives: Acute coronavirus disease 2019 infection has been shown to negatively affect body composition among adult and malnourished or obesity children. Our aim is to longitudinally evaluate body composition in children affected by the Multisystem Inflammatory Syndrome (MIS-C).

Methods: In this cohort study, we recruited 40 patients affected by MIS-C, aged 2–18 years old, who were admitted in our clinic between December 2020 and February 2021. Physical examination for each participant included weight, height, body mass index (BMI) *z* score, circumferences, and skinfolds assessment. The same measurements were repeated during outpatient follow-up at 10 (T2), 30 (T3), 90 (T4), and 180 (T5) days after hospital discharge. Fat mass and fat free mass were calculated according to skinfolds predictive equations for children and adolescents. A control group was randomly selected among patients attending a pediatric nutritional outpatient clinic.

Results: BMI *z* score significantly decrease between preadmission and hospital discharge. Similarly, arm circumference *z* score, arm muscular area *z* score, and arm fat area *z* score significantly decreased, during hospital stay. Fat mass index (FMI) significantly increased over time, peaking at T3. Fat free mass index decreased during hospitalization.

Conclusions: To the best of our knowledge, this is the first study to assess body composition in a numerically large pediatric MIS-C population from acute infection to 6 months after triggering event. FMI and anthropometric parameters linked to fat deposits were significantly higher 6 months after acute event. Thus, limiting physical activity and having sedentary lifestyle may lead to an accumulation of adipose tissue even in healthy children who experienced MIS-C and long hospitalization.

What Is Known

- Malnutrition can negatively impact the severity of severe acute respiratory syndrome coronavirus 19 infections also in the pediatric age as well.
- Multisystem Inflammatory Syndrome in Children (MIS-C) requires a long hospital stay.

What Is New

- Longitudinal body composition on MIS-C children shows a full recovery of growth, with a significant increase in fat mass index and anthropometric parameters 6 months after the acute event.
- A reduction in physical activity and sedentary behaviors are not recommended in patients who have had a long hospitalization for MIS-C.

Key Words: anthropometric parameters, body composition, fat free mass, fat mass, Multisystem Inflammatory Syndrome in Children (MIS-C), skinfolds

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The ethical approval was obtained from Institutional Review Board of the hospital (protocol number 2021/ST/004). Children's parents gave their written consent for inclusion after being informed about the nature of the study.

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Since November 2020, when the World Health Organization declared coronavirus disease 2019 (COVID-19) a pandemic, the clinical characteristics of patients infected with COVID-19 infection have been described (1). Acute COVID-19 infection has been shown to have an impact on sarcopenia in the adult population, for which a multidisciplinary approach including nutritional support is required to avoid long-term COVID-19 syndrome (2–4). On the other hand, body composition may also influence the severity of acute COVID-19 disease and the persistence of functional impairment (5). Several studies have focused on the association between body mass index (BMI) and the course of COVID-19 disease, considering BMI as a surrogate for body composition (6). Data collected on pediatric and adult population reported that malnutrition and obesity were associated with higher harshness of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection, elevated mortality rates, and need for invasive mechanical ventilation (7).

COVID-19 disease is more severe in malnourished children under 5 years of age. In addition, malnourished children over 5 years of age are more likely to develop severe infection cases than their peers with no history of malnutrition (8).

Current meta-analyses reporting the association between childhood obesity and worse prognosis of SARS-CoV-2 infection are in line with studies showing a correlation between BMI greater than or equal to 35 kg/m^2 and the need for invasive mechanical ventilation in adults with COVID-19 disease (9,10). Further studies are needed to clarify the mechanisms whereby obesity contributes to the severity of pediatric COVID-19 infection (11).

Since April 2020, a new severe manifestation of SARS-CoV-2 infection, called Multisystem Inflammatory Syndrome in Children (MIS-C), has been described (12,13). According to the Centers of Diseases Control and Prevention (CDC), MIS-C affects patients from 2 to 18 years of age, with ongoing or recent SARS-CoV-2 infection, presenting with fever for at least 24 hours, laboratory evidence of inflammation, and the involvement of at least 2 organs (cardiac, renal, respiratory, hematological, gastrointestinal, dermatological, or neurological) (14). A multidisciplinary evaluation at 6 months showed muscle weakness, reduced exercise capacity, anxiety, and emotional difficulties. In this regard, among the malnourished and bedridden elderly, the hyper-inflammatory and highly catabolic state underlying SARS-COV-2 infection caused myofibril breakdown and muscle degradation, resulting in acute sarcopenia that has been shown to adversely affect the course of the disease (2).

Patients hospitalized for MIS-C were predominantly of healthy nutritional status. A high number of children with obesity were reported compared to a few cases of overweight and underweight ones (15,16). Comparisons with short- and long-term body composition of children with MIS-C are not currently reported, although it is well established that nutritional status influence the clinical course of the disease.

Consequently, accurate screening for nutritional risk and appropriate assessment of anthropometric measures could be crucial to the clinical management of children affected by MIS-C. In hospitalized children, timely nutritional intervention on body composition is helpful in reversing linear growth arrest, promoting tolerance to therapeutic regimens, improving quality of life, and reducing length of hospital stay (17). When no assessment was carried out, full recovery of nutritional status occurred within 6 months after discharge. The nutritional achievements contrasted with previous studies of critically ill pediatric patients. Severely burned children showed persistent long-term hypermetabolism and hypercatabolism. Studies reported a drop in lean body mass up to 9 months (18) and growth retardation up to 2 years after the burn (19).

Later studies have analyzed body composition after the acute phase of Kawasaki disease, another inflammatory disease that may result from SARS-CoV-2 infection. Despite conflicting data (20–23), monitoring the body composition of children with Kawasaki disease may be helpful in avoiding the occurrence of central obesity. Since MIS-C related to SARS-CoV-2 infection shares similarities with Kawasaki disease, we designed this study to estimate the aftereffects of the illness on body composition.

The aim of our work was to evaluate the body composition trends linked to nutritional status in children and adolescents with MIS-C diagnosis, compared to healthy children, from admission, during hospitalization, and up to 6 months after discharge.

MATERIALS AND METHODS

A prospective study was conducted among children and adolescents, without concomitant diseases, with MIS-C diagnosis according to the CDC classification (14). They were recruited at Children's Hospital V. Buzzi, in Milan, between December 2020 and February 2021. For all patients, anthropometric measurements have been recorded, on admission (T0), at discharge (T1), after 10 (T2), 30 (T3), 90 (T4) and, 180 (T5) days. Patients with moderate/severe impairment of the multiple organs, in particular cardiac function, severe hydro-electrolyte disturbance, or shock patients, required admission at the pediatric intensive care unit (PICU). During ICU care, feeding was minimal, with a few cases requiring parenteral nutrition. Physical examination including anthropometric measurements (weight, height, circumferences, skinfolds) was assessed for each patient. Weight and height before admission have been collected from a previous pediatric examination (maximum 3 months before). Weight and height, during hospitalization, were measured using a mechanical column scale with altimeter (Seca 711 and Seca 220), arm and waist circumferences (AC and WC) were measured with measuring tape (Seca 201), then AC *z* score (ACz) and WC *z* score (WCz) were calculated (24,25). Skinfolds tricipital (TSF), bicipital, subscapular, and supra-iliac were measured using a caliper (Holtain 610). The *z* score for tricipital skinfold (TSFz) were detected (26). All the anthropometric measures were collected by the same dietitian from admission at the hospital up to 180 days after dismission. BMI and BMI *z* score (BMIz) were established according to CDC growth chart reference values (27). Arm muscular area (AMA), arm fat area (AFA), and their *z* score (AMAz; AFAz) were calculated (24). Fat mass (FM), free fat mass (FFM), and indices (FMI and FFMI) were calculated according to skinfolds predictive equations for children and adolescents (28–31), at admission and dismission from the hospital and at 10, 30, 90, and 180 days after hospitalization and FMI/FFMI ratio were detected. The STRONGkids questionnaire (32), was performed during hospital stay by a dietitian to assess the risk of malnutrition. Furthermore, before discharge, nutritional advice was provided to each patient according to the principles of the Mediterranean diet, focusing on reducing sugar daily intake, on consuming whole cereals and 5 portion per day of fresh fruits/vegetables. Physical activity was limited up to 6 months after discharge, both in athletes and non-athletes children, according to the recent position statement from European Society of Cardiology (33).

Control subjects were randomly selected from the children and adolescents referring to the International Center for the Assessment of Nutritional Status (University of Milan, Italy), a nutritional outpatient clinic of the University of Milan (6,34). Children with overweight and obesity were measured at the beginning of a weight-loss program, whereas the children with normal weight were measured at the inception of a nutrition counseling program. Parents of each child gave written informed consent for the use of their child's clinical data for research purposes. The Ethics Committee of the University of Milan approved the study procedures (study protocol No. 23/2016). We performed an individual 1:1 matching and each child with MIS-C was matched with a control child of the same sex, age class (0–3; 3–6; 6–9; 9–12; 12–15; 15–18 years), and BMI *z* score class (−1+1; +1+2; +2+3; ≥+3; −2−1; −3−2; ≤−3) at the time of discharge. This approach allowed us to understand whether the children affected by MIS-C had abnormal body composition at discharge.

The study was conducted according to the guidelines of the Declaration of Helsinki and approved by the Institutional Review Board of the hospital (protocol number 2021/ST/004). Children's parents gave their written consent for inclusion after being informed about the nature of the study.

Statistical Analysis

Statistical analysis was performed using STATA version 12.0 (StataCorp, College Station, TX). Continuous variables were checked for normality using the Kolmogorov-Smirnov test. As no variations from normality were observed, all continuous variables are presented as mean and standard deviation. Coarsened exact matching was used to match patients with MIS-C with control subjects on sex, age, and BMI. A *t* test for independent samples was used to test differences in outcomes of interest between patients with MIS-C and control patients. Pearson or Spearman (for dichotomous variables) correlation was used to test the association between anthropometry and body composition at hospitalization and STRONGkids with disease outcomes (length of hospitalization, day of ventilation, PICU stay). A paired *t* test was used to test changes in outcomes of interest between hospitalization and hospital discharge in patients with MIS-C. To test BMI changes during hospitalization and changes over time of the outcomes of interest from hospital discharge a repeated-measures analysis of variance , followed by a Bonferroni multicomparison test, was used. To test the effect of potential confounders (duration of hospital stay, preadmission BMI, gender, age, nutrients intake, PICU stay and time on ventilation) on anthropometrical measurements changes, mixed-effects linear regression models were used. Dichotomous confounders were categorized as follows: sex 0 = female, 1 = male; ventilation 0 = no, 1 = yes; ICU 0 = no, 1 = yes. Continuous confounders were categorized in 2 groups as follows: age 0 = <10 years, 1 = ≥10 years; preadmission BMIz 0 = −1 to +1 *z* score, 1 = ≥+1 *z* score; duration of hospitalization (on median value) 0 = <13 days, 1 = ≥13 days; energy 0 = <25th percentile of sex-for-age reference value, 1 = ≥25th percentile of sex-for-age reference value (35); carbohydrates 0 = <50%, 1 = ≥50%, sugars 0 = <15%, 1 = ≥15%, lipids 0 = <30%, 1 = ≥30%, proteins 0 = <2 g/kg body weight, 1 = ≥2g/kg body weight. To select confounders to include in the multivariate model, univariate mixed-effects linear regression models were performed. Significant confounders were included in the multivariate model. Only confounders that remained significant in the multivariate model were left. Confounders, time, and confounder × time interaction were included as fixed-effect predictors and the patient as random effect. A *P* value <0.05 was considered statistically significant.

RESULTS

Table 1 shows anthropometric parameters for all recruited children from admission to discharge. Twenty-four subjects, due to severity of symptoms, required admission in ICU. BMI *z* score significantly decreased between preadmission and hospital discharge (0.949 ± 1.121 vs 0.497 ± 1.084, *P* < 0.001) as also shown in Figure 1. Similarly, ACz (−0.457 ± 1.307 vs −0.069 ± 1.301, *P* < 0.001) and AMAz (−1.367 ± 1.403 vs −0.807 ± 1.361, *P* < 0.001) significantly decreased and AFAz (0.478 ± 0.828 vs 0.628 ± 0.856, *P* < 0.001) significantly increased between hospital admission and discharge (see Fig. 1).

Forty consecutive patients with MIS-C were enrolled in the study, 82.5% of whom were males. Patients were aged 1–17 [mean age: 9 years; standard deviation (SD) ± 4]; all subjects were normal weight for age and sex. During hospitalization STRONGkids questionnaire was performed to all children and the mean value was 3.65 (±0.67), as reported in Table 2. The average length of stay (LOS) for a hospitalization was 13.5 days (long LOS is defined when LOS ≥ 10 days (36)). Descriptive characteristics of 37 of 40 recruited patients compared to 37 healthy patients were shown in Table 2.

Groups were accurately matched according to age groups (0–3; 3–6; 6–9; 9–12; 12–15; 15–18 years), sex (the same), race/ethnicity, and BMIz (±1 SD). Sex, age, BMI, FFMI, and FMI did not differ between the 2 groups; however, AMAz was significantly lower in the MIS-C group. In Table 1, Supplemental Digital Content 1, *http://links.lww.com/MPG/D53*, we perform a correlation between anthropometry and body composition at hospitalization and STRONGkids with disease outcomes, but no associations were found.

Table 3 shows changes in anthropometric measures from discharge up to 6 months after hospitalization for all recruited patients (n = 40). BMI *z* score was significantly increased at each observation with respect to hospital dismission; the highest value was detected at T3 (BMIz at T1 0.497 ± 1.084 vs BMIz at T3 0.935 ± 1.008; *P* = 0.001) as shown in Figure 1; however, BMI *z* score at T3 did not differ from that before admission (BMIz before admission: 0.949 ± 1.121 vs BMIz at T3: 0.935 ± 1.008, *P* = 0.983). As well as ACz (−0.069 ± 1.301 vs 0.439 ± 1.092, *P* = 0.001), TSFz, instead, was significantly increased at T4 compared to baseline and with respect to the others' follow-up (0.826 ± 0.858 vs 1.093 ± 0.859, *P* = 0.001). Consistently, FMI significantly

TABLE 1. Anthropometric parameters in MIS-C patients from hospital admission to hospitaldischarge

	Pre-hospitalization		Hospitalization		Discharge		
	Mean	SD	Mean	SD	Mean	SD	*P* value*
BMIz†	0.949$_a$	1.121	0.597$_b$	1.103	0.497$_b$	1.084	**<0.001**
WCz†			1.455	1.332	1.371	1.367	0.145
ACz†			−0.457	1.307	−0.069	1.301	**<0.001**
TSFz†			0.778	0.906	0.826	0.858	0.206
WHR			0.5	0.055	0.495	0.055	0.058
FMI, kg/m^2			3.26	1.97	3.32	1.81	0.286
FFMI, kg/m^2			15.3	1.44	15.09	1.51	0.043
FMI/FFMI			0.211	0.12	0.218	0.112	0.112
AMAz†			−1.367	1.403	−0.807	1.361	**<0.001**
AFAz†			0.478	0.828	0.628	0.856	**<0.001**

Values are mean and standard deviations (SD) of anthropometric measurements and indices at different time points. Different subscript letters indicate statistically significant differences (*P* < 0.05) at Bonferroni multicomparison test. AC = arm circumference; AFA=arm fatty area; AMA = arm muscular area; BMI = body mass index; FFMI = fat free mass index; FMI = fat mass index; MIS-C = Multisystem Inflammatory Syndrome in Children; TSF = tricipital skinfold; WC = waist circumference; WHR = waist-to-height ratio. *P values have been obtained from repeated measured ANOVA for BMI and from paired *t* test for other variables. †Values are *z* scores.

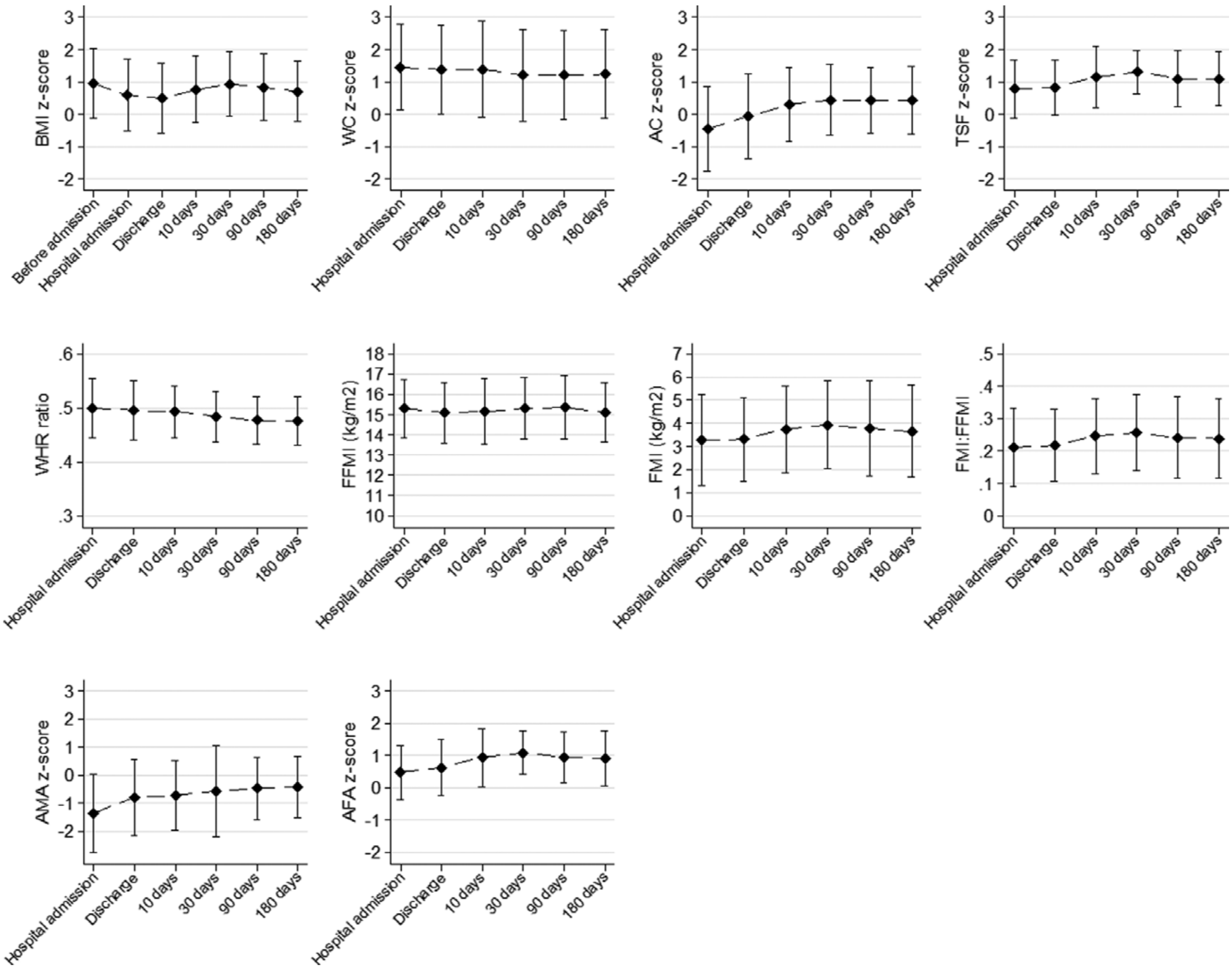

FIGURE 1. Anthropometric parameters and body composition indicex of recruited children from admission up to six months after discharge. AC *z* score =arm circumference *z* score; AFA *z* score = arm fatty area *z* score; AMA *z* score = arm muscular area *z* score; BMI *z* score = body mass index *z* score; FFMI *z* score = fat free mass index *z* score; FMI *z* score = fat mass index *z* score; TSF *z* score = tricipital skinfold *z* score; WC *z* score = waist circumference *z* score; WHR *z* score = waist-to-height ratio *z* score.

increases (see Fig. 1). FFMI at T1 was lower, then at T4 slightly increased, and at T5 remained mostly stable compared to hospital discharge (Fig. 1). FMI/FFMI ratio significantly increases, showing a peak a T2. AFAz result was significantly different between T0 and T2 (0.628 ± 0.856 vs 0.930 ± 0.912, $P = 0.001$). Moreover, we tested if changes over time of the outcomes of interest differed between patients in function of preadmission BMIz, hospitalization (LOS > 13 days), ventilation, gender, age, and nutrients intake. Regarding nutrients intake no significant associations were found. As shown in Table 2, Supplemental Digital Content 2, *http://links.lww.com/MPG/D54*, patients with BMIz preadmission ≥+1 showed a lower increment of BMIz at 6 months from discharge compared to children who were normal weight at preadmission. Children with LOS ≥ 13 days and an ICU admission with noninvasive mechanical ventilation showed a significant higher increase in WC at T4 and T5 than those who had LOS < 13 days and any ventilation, as well as waist-to-height ratio. Regarding ACz, males had a higher increment than females after discharge, and patients with a preadmission BMIz≥ +1 had a lower increment at 30 and 90 days from discharge compared to children who were normal weight at preadmission. Finally, children aged >10 years old showed lower increment of TSFz and AFAz at 10 days from discharge than younger children, but higher increment of FFMI at 3 months from discharge.

DISCUSSION

In this study we investigated the anthropometric measures and body composition longitudinally, in children and adolescents affected by MIS-C, focusing on those parameters linked to nutritional status.

We analyzed the trend between BMIz pre and after hospitalization. We also detected ACz, TSFz, FMI, and FFMI to observe trends of body composition. We found that BMIz at discharge significantly decreased with respect to preadmission values, while remaining in adequate range. At the same time, AMAz and ACz decreased and AFAz increased at discharge, suggesting a loss of lean mass and a gain in fat mass. This occurred due to reduced food intake as a consequence to diarrhea or vomiting episodes or lack of appetite. The STRONGkids questionnaires performed during hospital stay confirmed this observation, revealing a medium-to-high score of malnutrition, which might lead to a loss of metabolically active mass. Looking over the time, at T5, BMIz were respect to preadmission values, all anthropometric measures

TABLE 2. Comparison of the anthropometric measurements and indices between matched MIS-C children and control children

	Controls (n = 37)		MIS-C (n = 37)		
	Mean	SD	Mean	SD	*P* value
Sex (M/F)	30/7		30/7		1.000
Age, y	9.8	3.7	9.3	4.1	0.650
BMIz*	0.606	1.067	0.376	1.091	0.361
WCz*	0.996	1.503	1.343	1.411	0.310
ACz*	0.375	0.984	−0.022	1.108	0.108
TSFz*	0.399	1.115	0.870	0.794	**0.040**
WHR	0.46	0.06	0.48	0.05	**0.043**
FFMI	14.64	2.10	14.93	1.51	0.516
FMI	3.95	2.22	3.34	1.85	0.214
FMI:FFMI	0.26	0.12	0.22	0.11	0.103
AMAz*	0.133	0.855	−0.848	1.231	**<0.001**
AFAz*	0.423	1.032	0.697	0.785	0.204
Sk-Q			3.65	0.67	

Values are mean and standard deviations (SD) of anthropometric measurements and indices of matched MIS-C children at the time of discharge and control children. P values have been obtained from a chi square test for sex distribution and from *t* test for other variables. AC = arm circumference; AFA = arm fatty area; AMA = arm muscular area; BMI = body mass index; FFMI = fat free mass index; FMI = fat mass index; Sk-Q = STRONGkids questionnaire; TSF = tricipital skinfold; WC = waist circumference; WHR = waist-to-height ratio. *Values are *z* scores.

related to body fat accumulation, such as ACz, TSFz, AFAz, and FMI, are significantly increased. These results suggest that linear growth was restored within 6 months from the acute event, but the lean mass lost during hospitalization was not fully recovered and the fat mass has increased simultaneously. Furthermore, despite all patients having received nutritional advice to follow after hospital discharge, they were following anti-inflammatory cortisone therapy from dismission up to 10 days later, which is known to lead to hyperphagia and redistribution of lean mass and fat mass (37). Studies on adults patients, affected by SARS-CoV-19, reported that a long stay in the hospital could rise the risk of malnutrition induced by weight loss, reduced appetite, and difficulty in feeding in patients especially those with mechanical ventilation (continuous positive airways pressure mask) (38,39). In children, during the acute phase of MIS-C, metabolic and fatty acids blood profile alterations were detected (40,41), and long terms effects of malnutrition, such as a loss of lean mass, has been related to SARS-CoV-19 severity (8). In fact, even in our sample, a greater increase in WC was found both at 3 and 6 months after discharge for those who had a long hospital stay and had received noninvasive mechanical ventilation. It can therefore be hypothesized that in more severe forms of the disease there is an increased susceptibility to the accumulation of abdominal fat tissue and concomitant loss of lean mass up to several months after discharge. Moreover, among children with obesity, loss of muscle mass was highly prevalent. However, in our sample the anthropometric parameters described a normal resumption of the growth trajectory, probably due to the healthy condition (for instance, to an adequate nutritional status in most patients) and the absence of chronic illness before hospitalization in all children and adolescents enrolled. The FFMI did not seriously decline, suggesting the ability to face the acute phase of the disease, especially for male children older than 10 years. Besides, our interesting finding was that, even though patients lost muscle mass in acute phase and then they maintained FFM over time the fraction of FM increased over time, and this may be due as physical activity was suspended up to 6 months after infection. These observations led us to infer that following hospital discharge, a slow resumption of daily activities may lead to an accumulation of adipose tissue even in healthy MIS-C children. The limitation of moderate-to-vigorous intensity physical activity in the following 3–6 months that was recommended by cardiologists (33), depend on the heart damage reported by the patients, and the subsequent establishment of sedentary habits may have contributed to the excessive accumulation of fat mass. Speculating, we can say that a loss of muscular strength was probably experienced, in fact some of the patients in our sample made a subsequent admission to our hospital complaining of difficulty in walking or holding objects and most of them experiencing difficulty in climbing steps and premature fatigue overall; still some of them reported a consistent loss of hair, as a consequence of MIS-C already described in the literature (42,43), which might be linked to a poor nutritional status (44).

TABLE 3. Changes in anthropometric measurements overtime

	Discharge		10 days		30 days		90 days		180 days		
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	*P* value*
BMIz†	0.497$_{a}$	1.084	0.762$_{b,c}$	1.032	0.935$_{c}$	1.008	0.837$_{b,c}$	1.042	0.700$_{a,b}$	0.937	**<0.001**
WCz†	1.371	1.367	1.389	1.484	1.202	1.418	1.212	1.369	1.237	1.370	0.205
ACz†	−0.069$_{a}$	1.301	0.297$_{b}$	1.131	0.439$_{b}$	1.092	0.435$_{b}$	1.013	0.419$_{b}$	1.041	**<0.001**
TSFz†	0.826$_{a}$	0.858	1.151$_{a,b}$	0.958	1.312$_{b}$	0.671	1.093$_{a,b}$	0.859	1.097$_{a,b}$	0.847	**0.002**
WHR	0.495$_{a}$	0.055	0.493$_{a}$	0.048	0.484$_{a,b}$	0.047	0.477$_{b}$	0.044	0.476$_{b}$	0.045	**<0.001**
FFMI (kg/m^2)	15.09	1.51	15.15	1.62	15.31	1.51	15.37	1.55	15.12	1.45	0.226
FMI (kg/m^2)	3.32$_{a}$	1.81	3.75$_{b}$	1.88	3.94$_{b}$	1.89	3.77$_{b}$	2.06	3.67$_{a,b}$	2.00	**0.002**
FMI/FFMI	0.218$_{a}$	0.112	0.246$_{b}$	0.115	0.256$_{b}$	0.118	0.242$_{a,b}$	0.126	0.239$_{a,b}$	0.122	**0.007**
AMAz†	−0.807	1.361	−0.738	1.256	−0.577	1.623	−0.473	1.115	−0.427	1.101	0.313
AFAz†	0.628$_{a}$	0.856	0.930$_{b}$	0.912	1.090$_{b}$	0.682	0.940$_{b}$	0.779	0.914$_{b}$	0.856	**<0.001**

Values are mean and standard deviations (SD) of anthropometric measurements and indices at different time points. Different subscript letters indicate statistically significant differences ($P < 0.05$) at Bonferroni multicomparison test. AC = arm circumference; AFA = arm fatty area; AMA = arm muscular area; BMI = body mass index; FFMI = fat free mass index; FMI = fat mass index; TSF = tricipital skinfold; WC = waist circumference; WHR = waist-to-height ratio. **P* values have been obtained from repeated measured ANOVA. †Values are *z* scores.

CONCLUSIONS

To the best our knowledge this is the first study to enroll a large pediatric MIS-C population and assess anthropometric measurements and body composition during acute infection and a follow-up of 6 months after discharge. The important feature identified was that the MIS-C population was comparable to healthy children before developing the syndrome and that despite the long hospital stay, they recovered their growth curve. The limitation of our study is that it was not possible to have all anthropometric measures before hospital admission except for BMIz. What is noteworthy is that reduced physical activity and limited movement, due to both medical indications and COVID-related long-term symptoms, may have had a greater negative influence on body composition to the detriment of lean mass. Therefore, in children who are affected by MIS-C and have been hospitalized for a long time, it may be useful to identify an early resumption of unstructured physical activity (ie, have a walk, cycling, dancing, playing at the park, and doing house work) alongside standard nutritional assessment and advices, in order to prevent poor nutritional and sedentary habits resulting in early excessive FM accumulation.

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