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Body Habitus and Risk of Mortality in Pediatric Sepsis and Septic Shock: A Retrospective Cohort Study

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Objective To investigate the association between body habitus and mortality in critically ill children with sepsis or septic shock.

Study design This was a retrospective cohort study of prospectively collected data of children admitted to US pediatric intensive care units (PICUs) with a primary or secondary diagnosis of sepsis or septic shock. We separated body habitus into underweight, normal weight, overweight, and obese. Outcomes were mortality (primary), treatment with invasive mechanical ventilation (secondary), and time to PICU discharge for survivors (secondary). Multivariable analyses using mixed-effects logistic regression and shared frailty models clustered by unit and adjusted for confounding variables were used to assess the association between body habitus and outcomes.

Results There were 7038 children with sepsis or septic shock. Mortality was 10.1% (n = 714) and 52.9% (n = 3720) required invasive mechanical ventilation. Body habitus was not associated with mortality after controlling for hospital level effects and confounding variables. Children who were overweight and obese had greater odds of invasive mechanical ventilation (overweight OR 1.23 [95% CI 1.05-1.45], $P = .011$ and obese OR 1.57 [95% CI 1.37-1.80], $P < .001$) compared with children of normal weight. In survivors treated with invasive mechanical ventilation, children who were obese had a longer time to PICU discharge than children of normal weight (obese hazard ratio for discharge 0.84 [95% CI, 0.77-0.92], $P < .0001$).

Conclusions There was no association between body habitus and mortality in critically ill children with sepsis. Children who were overweight and obese were more likely to receive invasive mechanical ventilation and mechanically ventilated survivors who were obsese had a longer time to PICU discharge. *(J Pediatr 2019;210:178-83)*.

Recent data from the National Health and Nutrition Examination Survey estimate that 9.5% of infants and toddlers are overweight, 31.7% of children between 2 and 19 years are overweight, and nearly 20.4% of hospitalized children are obese.[1,2] Although obesity is associated with a myriad of public health risks, there are conflicting data regarding whether obesity is associated with improved or worse healthcare outcomes for hospitalized patients. Some have found evidence of an obesity paradox in critically ill children,[3,4] with lower risk-adjusted mortality for those who are moderately overweight. This is theorized to be related to differences in nutritional reservoirs, inflammatory state, and oxidative stress.[5-7] However, our group has previously shown in a study of a diverse group of critically ill children that when complete anthropometric data are used, specifically including height and sex, the lowest mortality is at an ideal weight for age.[8]

Obesity is associated with a chronic inflammatory state, with increased levels of proinflammatory cytokines and oxidative stress.[9-12] As such, the influence of obesity on outcomes may only be relevant for disease states in which inflammation and oxidative stress play crucial roles. In fact, a recent study has identified some evidence of the obesity paradox among children with pediatric acute respiratory distress syndrome (PARDS), with lower mortality but greater length of mechanical ventilation.[13] Others have not been able to demonstrate similar relationships when looking at all mechanically ventilated children,[14] or those with specific disease states such as asthma[15] or trauma.[16]

In critically ill adults with sepsis, there is conflicting evidence regarding whether obesity is associated with increased or decreased mortality, with more recent studies in adults finding improved survival in patients with obesity and sepsis.[17-19]

BMI	Body mass index
CCC	Complex chronic conditions
CDC	Centers for Disease Control and Prevention
HR	Hazard ratio
PARDS	Pediatric acute respiratory distress syndrome
PICU	Pediatric intensive care unit
PRISM III	Pediatric Risk of Mortality Score III
VPS	Virtual Pediatric Systems, LLC

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Although sepsis is a leading cause of death in infants and children worldwide and in the US, there are no studies on the association between obesity and outcomes in children with sepsis.[20,21]

We sought to investigate the association of body habitus and mortality in critically ill children with sepsis or septic shock. We hypothesized that children who were overweight would have lower risk-adjusted mortality. Secondary outcome measures included treatment with invasive mechanical ventilation, length of mechanical ventilation, and time to pediatric intensive care unit (PICU) discharge.

Methods

We performed a retrospective analysis of prospectively collected data using the Virtual Pediatric Systems, LLC (VPS) database from January 2009 until January 2014. All children who were younger than 18 years of age and had a primary or secondary diagnosis consistent with an infection were screened. This screening was based on 140 separate *International Classification of Diseases, Ninth Revision* codes (**Appendix**; available at www.jpeds.com). We excluded children who did not have a height recorded, as our previous study indicated that complete anthropometric data were needed to classify patients.[8] This list was subsequently narrowed to those who had a specific clinical code for sepsis or septic shock, based on the *International Classification of Diseases, Ninth Revision* codes for meningococcemia, sepsis, septicemia from any organism, bacteremia, septic shock, and toxic shock syndrome. We chose to classify severity of illness using the Pediatric Risk of Mortality Score III (PRISM III) and excluded children who did not have this value scored. Finally, we excluded children if the values entered for the combination of weight, height, and age were physiologically implausible.[8] We deemed the data as physiologically implausible if it generated a body mass index (BMI) value that was 6 SDs greater or less than the mean for age. We also removed subjects in whom the height recorded was not able to be graphed on a Centers for Disease Control and Prevention (CDC) Growth Curve Chart, as it was not possible to generate a BMI and they were deemed physiologically implausible. The study was approved by the institutional review board at Children's Hospital Los Angeles.

Data Collection and Variables

To characterize body habitus, we used World Health Organization growth curves to calculate weight-for-height percentiles for children younger than 2 years and CDC growth curves to calculate BMI-for-age percentiles for children 2 years of age and older as per CDC recommendations.[22] The weight-for-height percentile in children younger than 2 years and the BMI percentile in children older than 2 years were used to categorize the body habitus of children. For the remainder of the manuscript, this will be referred to as BMI percentile group and categorized as (1) underweight <5%, (2) normal weight 5%-85%, (3) overweight >85%-95%, and (4) obese >95%.

In addition to anthropometric data, we also collected demographic information including age, sex, race, weight, height, diagnosis, postoperative status, trauma status, as well as the 12-hour PRISM III and probability of death.[23] For analysis, we categorized age into 5 groups (1) less than 1 month; (2) 1 month to 2 years; (3) 2-8 years; (4) 8-16 years; and (5) and greater than 16 years. Age was categorized due to previous literature suggesting a nonlinear relationship between age and mortality in children with sepsis.[24,25] Race was classified into 5 groups: (1) white/European non-Hispanic; (2) African American; (3) Hispanic; (4) Asian/Indian/Pacific Islander/American/Indian/Indigenous/other/mixed; and (5) unspecified. Primary and secondary diagnoses were classified into complex chronic conditions (CCCs) and non-CCCs based on previous literature.[26-28] The presence of a CCC or a non-CCC for each child (yes/no) was used in the analysis. Primary and secondary diagnosis codes as well as additional VPS data were used to classify children as having an admission following trauma, postoperative status, a history of bone marrow transplant, a history of rheumatologic disease, and the presence of pneumonia. These variables were hypothesized to be possible confounders on the association between body habitus and mortality.

Outcomes

The primary outcome was PICU mortality. Secondary outcomes were treatment with invasive mechanical ventilation at any point during the PICU stay, time to extubation for survivors (length of mechanical ventilation), and time to PICU discharge for survivors (as defined by physical length of stay).

Statistical Analyses

Data analysis and output were generated using Statistica Academic Version 12 (StatSoft, Tulsa, Oklahoma), Stata version 14 (Stata Corp, College Station, Texas), and SAS Version 9.4 for Windows (SAS Institute Inc, Cary, North Carolina). Univariate analysis was performed for continuous variables with a Kruskal−Wallis ANOVA, as normality could not always be guaranteed. Categorical data were compared with a Pearson χ^2 or expected vs observed χ^2, as appropriate.

A multivariable mixed effects logistic regression model with the outcome of mortality[29] was used to control for hospital level effects, as well as variables that confound the relationship between mortality and BMI percentile group.[8] Variables with a univariate association with BMI percentile group ($P < .2$), or those deemed plausible biologic confounding variables were considered for the multivariable model. Variables were transformed as necessary to meet model assumptions. Variables that retained statistical significance ($P < .05$) or that altered the association between BMI percentile group and mortality by more than 15% were included in the final multivariable model. Multivariable modeling was repeated in a similar approach for the secondary outcome of treatment with mechanical ventilation.

The association between BMI percentile group and the secondary outcomes of time to extubation for survivors (length of mechanical ventilation) and time to PICU discharge in survivors was performed with a shared frailty model to adjust for the unique characteristics of each hospital that may affect length of mechanical ventilation or PICU admission.[30] Variables were tested for inclusion in the multivariable model as previously described.

We performed subgroup analysis based on age younger than 2 years and 2 years or older to assess for potential differences in weight-for-height classification using the World Health Organization growth curves for children younger than 2 years of age and BMI classification using CDC growth curves for patients 2 years of age or older. We performed additional subgroup analysis based on treatment with mechanical ventilation to determine whether mechanical ventilation modified the association between BMI percentile group and outcome.

Results

There were 52 059 children with infectious diagnoses admitted between January 2009 and January 2014, from 130 PICUs. A total of 7038 children from 53 PICUs met all inclusion and no exclusion criteria, and were used for analysis (**Figure**; available at www.jpeds.com). Of this final cohort, 714 died in the PICU (mortality 10.1%). There were significant differences between BMI percentile groups for sex, age, race, presence of a CCC, history of rheumatologic disease, PRISM III, treatment with mechanical ventilation, time to PICU discharge, and mortality (**Table I**).

Multivariable Analysis Primary Outcome

There was no association between body habitus and mortality after controlling for hospital-level effects as well as other confounding variables (underweight OR 1.03 [95% CI 0.79-1.34], *P* = .8, ref normal weight, overweight OR 1.01 [CI 0.77-1.33], *P* = .94, obese 1.19 [CI 0.95-1.48], *P* = .12, **Table II**). These results were similar in subgroup analysis based on treatment with mechanical ventilation (**Table II**). We could not analyze the outcome of mortality in the subgroup of children who did not receive mechanical ventilation, as there were an insufficient number of deaths. In subgroup analyses for children younger than 2 years of age and children 2 years of age or older, there was no association between body habitus and mortality after controlling for hospital level effects as well as other confounding variables (**Table III**; available at www.jpeds.com).

Table I. Characteristics of enrolled children

Demographics	Underweight	Normal weight	Overweight	Obese	*P* value
Number	819 (11.6%)	3740 (53.1%)	941 (13.4%)	1538 (21.9%)	
Sex					
Male	472 (57.6%)	1940 (51.9%)	491 (52.2%)	845 (54.9%)	.01
Age					
<1 mo	61 (7.5%)	263 (7.0%)	45 (4.8%)	43 (2.8%)	<.001
1 mo to 2 y	286 (34.9%)	1087 (29.1%)	258 (27.4%)	470 (30.6%)	
2-8 y	176 (21.5%)	778 (20.8%)	220 (23.4%)	403 (26.2%)	
8-16 y	175 (21.4%)	1029 (27.5%)	297 (31.6%)	452 (29.4%)	
>16 y	121 (14.8%)	583 (15.6%)	121 (12.9%)	170 (11.1%)	
Race					
White/European Non-Hispanic	404 (49.3%)	1960 (52.4%)	482 (51.2%)	779 (50.7%)	.011
African American	154 (18.8%)	643 (17.2%)	152 (16.2%)	306 (19.9%)	
Hispanic	119 (14.5%)	598 (16.0%)	158 (16.8%)	260 (16.9%)	
Asian/Indian/Pacific Islander/American Indian/other	91 (11.1%)	291 (7.8%)	88 (9.4%)	113 (7.4%)	
Unspecified	51 (6.2%)	248 (6.6%)	61 (6.5%)	80 (5.2%)	
Presence of a CCC	577 (70.5%)	2445 (65.4%)	582 (61.9%)	1015 (66.0%)	.002
Presence of a non-CCC	302 (36.9%)	1369 (36.6%)	331 (35.2%)	600 (39.0%)	.23
Admission following trauma	10 (1.2%)	50 (1.3%)	14 (1.5%)	29 (1.9%)	.45
Postoperative status	141 (17.2%)	583 (15.6%)	135 (14.4%)	222 (14.4%)	.25
Status post bone marrow transplant	36 (4.4%)	137 (3.7%)	26 (2.8%)	40 (2.6%)	.060
History of rheumatologic Disease	25 (3.1)	148 (4.0%)	50 (5.3%)	75 (4.8%)	.050
Presence of pneumonia	195 (23.8%)	805 (21.5%)	178 (18.9%)	316 (20.6%)	.075
PRISM III	8 (3, 14)	6 (3, 12)	7 (3, 13)	7 (2, 12)	<.001
Outcomes					
Use of noninvasive ventilation	148 (20.7%)	691 (20.4%)	155 (18.2%)	279 (20.3%)	.52
Presence of mechanical ventilation	465 (56.8%)	1863 (49.8%)	495 (52.6%)	897 (58.3%)	<.001
Intubated on admission	200 (43.0%)	778 (41.8%)	198 (40.0%	396 (44.2%)	.45
Intubated in first hour	147 (18.0%)	483 (12.9%)	130 (13.8%)	231 (15.0%)	.001
Length of mechanical ventilation (h) for survivors	142.7 (60.1, 306.9)	145.5 (65.8, 295.2)	163.6 (66.1, 330.1)	169.6 (75.5, 342.3)	.054
Physical length of stay (d) for survivors	4.1 (1.8, 11.3)	3.5 (1.6, 9.8)	3.3 (1.5, 9.5)	4.7 (1.7, 11.8)	<.001
Died	105 (12.8%)	355 (9.5%)	91 (9.7%)	163 (10.6%)	.033

Data are presented as the number or percentage of the group or as median and (first, third IQR). Pearson χ^2 or expected/observed χ^2 tests were used to determine the statistical differences between groups for percentages. Kruskal–Wallis ANOVA was used to determine the statistical difference between groups for median values.

Table II. Multivariable mixed effects logistic regression model for the association between BMI percentile group and mortality in children with sepsis or septic shock

	Full model overall (N = 7038)		Model in subgroup of mechanically ventilated children (N = 3720)	
BMI percentile groups	aOR (95% CI)	*P* value	aOR (95% CI)	*P* value
Underweight	1.03 (0.79-1.34)	.80	1.01 (0.76-1.33)	.95
Normal	Reference group	-	Reference group	-
Overweight	1.01 (0.77-1.33)	.94	1.00 (0.75-1.32)	.94
Obese	1.19 (0.95-1.48)	.12	1.04 (0.83-1.31)	.72

Each model is adjusted for age, presence of a CCC, history of bone marrow transplantation, presence of pneumonia, PRISM III probability of death, as well as for hospital-level effects. Underweight (BMI <5%), normal (BMI 5%-85%), overweight (BMI >85%-95%), obese (BMI >95%).

Multivariable Analysis Secondary Outcomes

Children who were obese had greater odds of treatment with invasive mechanical ventilation than children of normal weight after controlling for hospital-level effects as well as other confounding variables (underweight adjusted OR 1.12 [95% CI 0.94-1.34] *P* = .19, ref normal weight, overweight adjusted OR 1.23 [95% CI 1.05, 1.45], *P* = .011, obese adjusted OR 1.57 [95% CI 1.37-1.80] *P* < .001) (**Table IV**).

Length of mechanical ventilation was available for 2795, or 75.1% of children receiving mechanical ventilation. After controlling for hospital level effects as well as other confounding variables, we found that overweight and obesity was associated with a longer time to extubation in mechanically ventilated survivors (underweight adjusted hazard ratio [HR] 1.0 [95% CI 0.88-1.12], *P* = .95, ref normal weight, overweight adjusted HR 0.88 [95% CI 0.78-0.99], *P* = .03 obese adjusted HR 0.80 [95% CI 0.72-0.87], *P* < .0001) (**Table V**). Of note, a HR of <1 indicates a longer time to extubation as compared with the reference group.

Obesity was associated with a longer time to PICU discharge in survivors after controlling for hospital level effects as well as other confounding variables (underweight adjusted HR 0.96 [95% CI 0.88-1.04], *P* = .28, ref normal weight, overweight adjusted HR 0.93 [95% CI 0.86-1.00], *P* = .06, obese adjusted HR 0.8 [95% CI 0.75-0.86], *P* < .0001) (**Table VI**; available at www.jpeds.com). In subgroup analysis based on treatment with invasive mechanical ventilation, children who were obese had a longer length of PICU stay than children of normal weight (adjusted HR 0.84 [95% CI 0.77-0.92], *P* = .0002) (**Table VI**). For the survivors who did not receive invasive mechanical ventilation, children who were overweight had a shorter length of PICU stay as compared with weight children who were normal weight (adjusted HR 1.14 [95% CI 1.02-1.26], *P* = .017).

In subgroup analysis, the results were similar in children younger than 2 years of age and in children 2 years of age or older for the outcomes of mortality, treatment with mechanical ventilation, and time to PICU discharge as compared with the general population (**Table III**).

Discussion

In this study of critically ill children with sepsis or septic shock from primarily US PICUs, we found no association between body habitus and mortality. In survivors of sepsis, children who are obese stay in the PICU longer than children who are normal weight. In secondary analyses, we did find that children who were overweight and obese with sepsis are more likely to be treated with invasive mechanical ventilation and remain intubated longer than children of normal weight.

Our mortality findings are similar to some studies in adults that report an obesity paradox or reduced mortality for patients who are overweight or obese with sepsis that is not retained after controlling for confounding variables.[17-19] Arabi et al reported a crude OR of mortality of 0.8 for patients who

Table IV. Multivariable mixed-effects logistic regression model for the association between BMI percentile group and treatment with mechanical ventilation in children with sepsis or septic shock

	Overall (N = 3720)	
BMI percentile groups	aOR (95% CI)	*P* value
Underweight	1.12 (0.94-1.34)	.19
Normal	Reference group	-
Overweight	1.23 (1.05-1.45)	.011
Obese	1.57 (1.37-1.80)	<.001

Each model is adjusted for age, presence of a CCC, history of bone marrow transplantation, presence of pneumonia, PRISM III probability of death, as well as for hospital-level effects. Underweight (BMI <5%), normal (BMI 5%-85%), overweight (BMI >85%-95%), obese (BMI >95%). Hospital-level effects are included in the model.

Table V. Association of BMI percentile group with time to extubation for mechanically ventilated survivors, shared frailty model clustered by unit

BMI percentile groups	aHR (95% CI)	*P* value
Underweight	1.0 (0.88-1.12)	.95
Normal	Reference	
Overweight	0.88 (0.78-0.99)	.03
Obese	0.80 (0.72-0.87)	<.0001

aHR, adjusted hazard ratio.
Underweight (BMI <5%), normal (BMI 5%-85%), overweight (BMI >85%-95%), obese (BMI >95%). Hospital-level effects are included in the model.
Model was adjusted for the natural log of PRISM POD, presence of a CCC, race, age group, presence of pneumonia, and sex.
Length of mechanical ventilation data available in 2795 children.

were obese and 0.69 for patients who were very obese, although this effect was not retained after adjustment for baseline characteristics and sepsis interventions.[17] Results were similar for Kuperman et al, where the potential survival benefit of being overweight was no longer present after "adjusting for age, sex, race, severity of illness, length of stay, and comorbid conditions."[18]

Maley et al also found no relationship between mortality and obesity among hospitalized children in the US with infection, although it is unclear what percentage of those patients were critically ill.[31] We, and others, also have found that extremes of weight, either under- or overweight, are independent risk factors for mortality.[5-7] Although the aOR for the association between obesity and mortality was not statistically significant in this study, the effect estimate was in the direction of harm, indicating that in our population there is certainly no survival advantage to being obese.

Our findings as well of those of Maley et al are contrary to reports regarding body habitus and sepsis in a worldwide population.[31] Recently, Bau et al found that in the 542 patients that had a primary diagnosis of sepsis, the 28-day mortality rate was 8.9%.[32] The mortality differed significantly by body habitus: underweight 14.9%, normal weight 6.5%, overweight 3.5%, and obese 5.3% (P = .003). The participating countries in the AWARE study (Assessment of Worldwide Acute Kidney Injury, Renal Angina, and Epidemiology) included Australia, US, Canada, United Kingdom, Italy, China, South Korea, Serbia, and Indonesia.[33] There was a significant difference in mortality between these different countries. One could speculate if the difference in mortality relates to the cause of underweight status. Whether it is due to congenital syndromes, chronic disease, or malnutrition may have an impact on mortality.

In our study, the increased use of mechanical ventilation may relate to the possibility that children who are overweight and obese are more likely to develop PARDS after a sepsis trigger. It has been demonstrated in an adult population that increasing BMI was associated with the development of acute respiratory distress syndrome.[34] Further, patients who are obese developed acute respiratory distress syndrome later in their hospital course. It is possible that sepsis was the trigger in these cases. For our study, a greater incidence and severity of lung injury could explain the findings of both a greater need for invasive mechanical ventilation and a longer PICU length of stay in mechanically ventilated survivors.

Ward et al found that obese children with PARDS and indirect lung injury had a longer length of mechanical ventilation, which would be consistent with a greater severity of lung injury.[13] Children who are overweight who do not develop respiratory failure appear to have a shorter length of stay than children of normal weight. This would point toward much of the longer length of stay being mediated by the increased likelihood of respiratory failure. It would seem that children who are overweight who do not develop respiratory failure may have improved outcomes over children who are normal weight. Unfortunately, the VPS database does not include data on severity of oxygenation defect to determine whether a greater incidence and severity of lung injury explains our findings.

Children with sepsis who are overweight or obese also may be intubated earlier and stay intubated longer due to concerns for managing a potentially difficult airway. Alternatively, children with sepsis who are overweight or obese may be more likely to be nonresponsive to noninvasive respiratory support due to baseline decreased chest wall compliance and increased upper airway obstruction. One can also conjecture that the fluid resuscitation needed to support blood pressure may have an impact on the patient's respiratory status and more so when the patient is overweight or obese and ideal body weight is not used for estimating fluid resuscitation needs.

There are several limitations to our study. Our sample size was reduced because we required the patient's height to be present. Our previous work highlights the importance of height for this type of analysis.[8] Height as well as weight measurements may be inaccurate in critically ill patients, which may introduce error in our assessment of obesity. Second, diagnosis codes in the VPS database are based on clinician assessment and not necessarily congruent with current or past definitions of sepsis and septic shock. However, we do believe we have isolated many children with severe sepsis or septic shock, as there was a high mortality (10.1%). Our mortality is lower than the 25% reported in global sepsis studies[21] but greater than the range of 6.0%-7.4% adjusted mortality found in Pennsylvania PICUs.[35] In addition, we did not have data on vasopressor use or other specific organ dysfunction to identify the subgroups of children with septic shock or severe sepsis.

Third, the diagnosis of sepsis could have occurred at any point during the ICU admission, but we adjusted for severity of illness using admission PRISM III, which may not accurately reflect severity of illness at the time of sepsis. Fourth, the outcomes of time to extubation and time to PICU discharge were limited to survivors. In turn, the HRs may be presenting a misleading effect size, as they would not apply to the entire cohort. Finally, BMI is likely not the best indicator of nutritional reserves in patients who present to the intensive care unit with sepsis. The initial weight of the child could vary significantly depending on intravascular fluid status, and BMI doesn't discriminate between lean muscle mass or adipose tissue. Unfortunately, other indicators of nutrition such as pre-albumin or mid-arm circumference are not available in this data set.

We did not find an association between body habitus and mortality for children with sepsis and septic shock. Obese and overweight body habitus were associated with increased odds of requiring mechanical ventilation and a longer time to extubation than children of normal weight. Furthermore, in children who survived sepsis, children who were obese had a longer time to PICU discharge. These differences may be related to a greater propensity for the development of severe lung injury in septic overweight/obese patients or clinical management differences in treatment of children who are overweight/obese. ■

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Data Statement

Data sharing statement available at www.jpeds.com.

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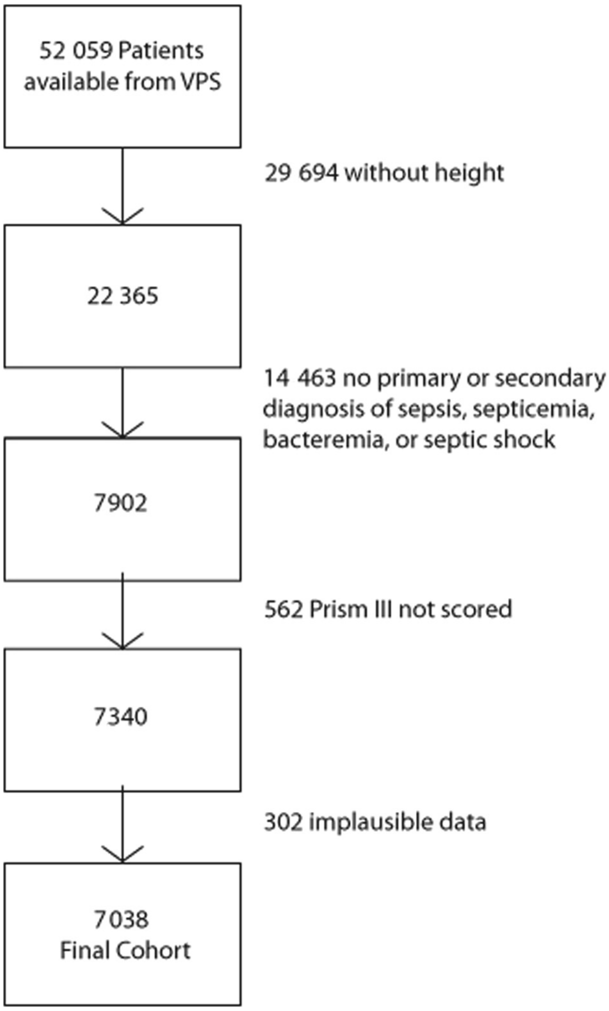

Figure. Data extraction.

Table III. Outcomes of mortality, use of mechanical ventilation, and time to PICU discharge separated by groups younger than 2 years and older than 2 years of age

	Younger than 2 years (N = 2513)		2 years and older (N = 4525)	
BMI percentile groups	**OR (95% CI)**	***P* value**	**OR (95% CI)**	***P* value**
Outcome = mortality				
Underweight	1.34 (0.92-1.95)	.13	0.83 (0.57-1.21)	.36
Normal	Reference group	-	Reference group	-
Overweight	0.89 (0.57-1.40)	.62	1.09 (0.78-1.53)	.62
Obese	1.12 (0.78-1.62)	.52	1.22 (0.93-1.62)	.16
Outcome = mechanical ventilation				
Underweight	1.16 (0.86-1.55)	.33	1.10 (0.88-1.37)	.42
Normal	Reference group	-	Reference group	-
Overweight	1.13 (0.83-1.52)	.44	1.26 (1.04-1.53)	.02
Obese	1.55 (1.20-2.00)	.001	1.56 (1.32-1.84)	<.001
Outcome = time to discharge				
Underweight	0.96 (0.84-1.09)	.54	0.96 (0.86-1.07)	.45
Normal	Reference group	-	Reference group	-
Overweight	0.89 (0.78-1.02)	.086	0.95 (0.87-1.04)	.30
Obese	0.89 (0.79-0.995)	.040	0.77 (0.71-0.83)	<.0001

Models were adjusted for the PRISM III probability of death, presence of a CCC, race, age, presence of pneumonia, history of bone marrow transplantation, and presence of rheumatologic disease.

Table VI. Association of BMI percentile group with time to physical intensive care unit discharge for survivors only, final shared frailty model

	Overall (N = 6324)		IMV (n = 2857)		Non-IMV (N = 3467)	
BMI percentile groups	**HR (95% CI)**	***P* value**	**HR (95% CI)**	***P* value**	**HR (95% CI)**	***P* value**
Underweight	0.96 (0.88-1.04)	.28	0.98 (0.87-1.10)	.71	0.98 (0.88-1.11)	.78
Normal	Reference group	-	Reference group	-	Reference group	-
Overweight	0.93 (0.86-1.00)	.060	0.92 (0.82-1.03)	.14	1.14 (1.02-1.26)	.017
Obese	0.80 (0.75-0.86)	<.0001	0.84 (0.77-0.92)	.0002	0.97 (0.88-1.06)	.52

IMV, invasive mechanical ventilation.
Models were adjusted for the PRISM POD, presence of a CCC, race, age, presence of pneumonia, history of bone marrow transplantation, and presence of rheumatologic disease.