The Impact of Malnutrition on the Obesity Paradox among Patients with ESKD Requiring Maintenance Dialysis

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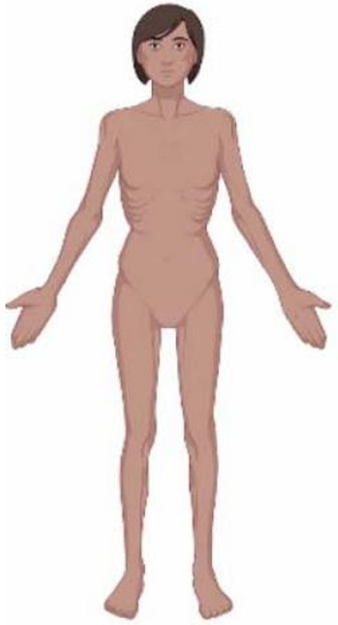
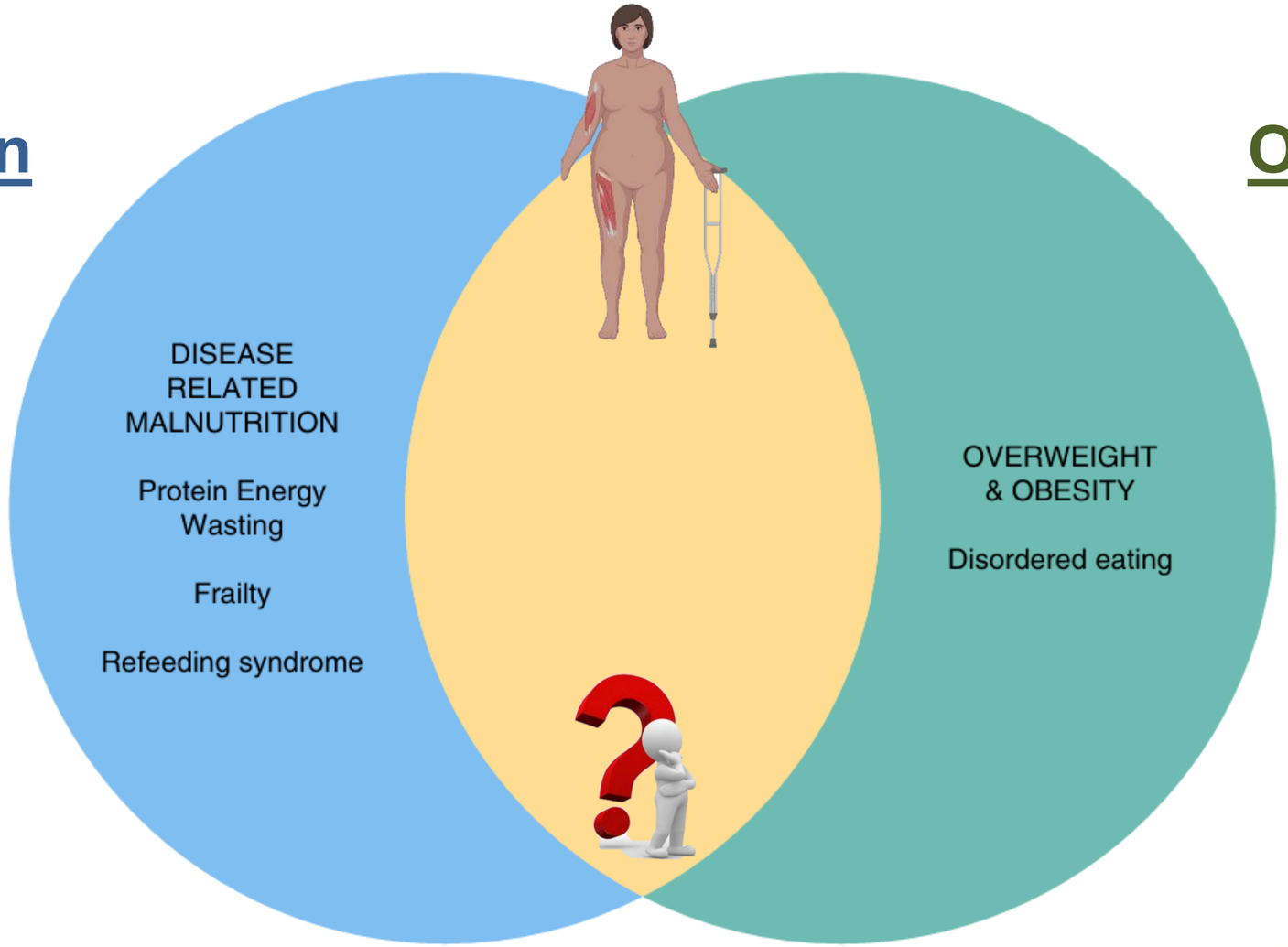
Disclosures

No relevant financial relationships with ineligible companies.

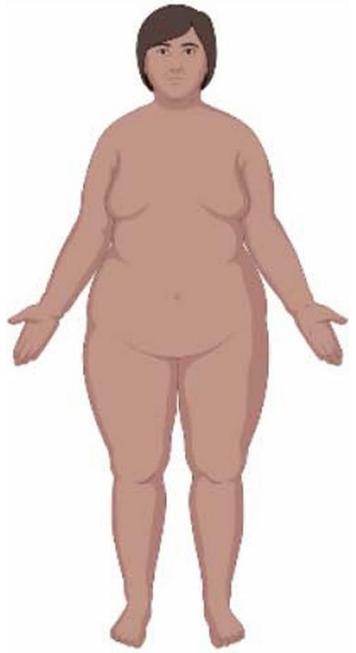
Introduction

Undernutrition





Over-nutrition



↑ Risk of death

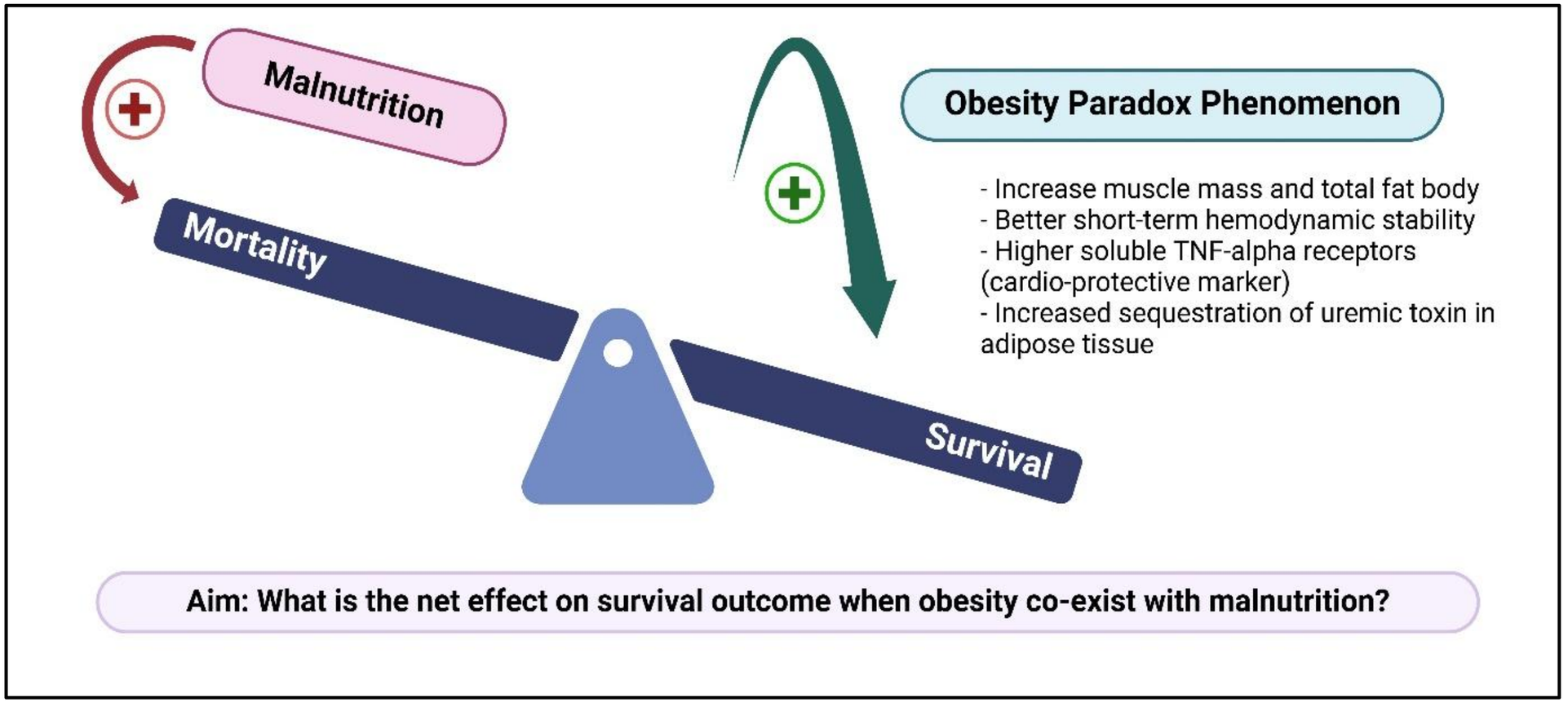
ESKD patients requiring maintenance dialysis

↓ Risk of death (Obesity Paradox)

Adapted from CJASN 20: 1610–1622, 2025.

Study objectives

(1) To investigate whether **malnutrition** influences the **obesity paradox (survival benefits)** in hospitalized patients with **ESKD requiring maintenance dialysis.**



Study objectives

(2) To explore the relationship between obesity with/ without malnutrition and **in-hospital outcomes**, including **adverse clinical outcomes**, **inpatient treatments**, and **resource utilization** among hospitalized ESKD patients on maintenance dialysis.

Adverse clinical outcomes; sepsis, catheter-related bloodstream infections (CRBSI), and volume overload

Inpatient treatments; use of vasopressors, total parenteral nutrition (TPN), mechanical ventilator and blood transfusions

Resource utilization; length of hospital stay and hospitalization costs

Methods

Study design: A Retrospective Cohort Study

Data source: National Inpatient Sample (NIS) Database*

Study periods: During 2016 and 2021

* The largest publicly accessible all-payer inpatient care database in the United States. This database includes data on over 7 million hospital admissions and a weighted estimate of 35 million annual hospital stays, derived from a 20% stratified sample of more than 4,000 hospitals.

Study populations

Study populations:

- To determine **patient eligibility** and categorized patients, the International Classification of Diseases, Tenth Revision, Clinical Modification (**ICD-10-CM**) code were employed.

Inclusions: Adult hospitalized patients (aged ≥18 years) with ESKD patients on maintenance dialysis, including hemodialysis (HD) and peritoneal dialysis (PD) modalities.

Exclusions: Patients with acute kidney injury, kidney transplants, or non-dialysis dependent CKD (NND-CKD).

- We categorized patients into **three groups**: (1) **obesity without malnutrition**, (2) **obesity with malnutrition**, and (3) a **non-obese** group (the reference group).

Lists of ICD-10 coded used

Diagnosis	ICD 10 codes
Malnutrition	E40, E41, E42, E43, E44.0, E44.1, E46, R64
Obesity	E66.0—Obesity due to excess calories, E66.09—Other obesity due to excess calories, E66.1—Drug-induced obesity, E66.2—Morbid obesity with alveolar hypoventilation, E66.8—Other obesity, E66.9—Obesity, unspecified
ESRD	N185, N186
Acute kidney injury	N170, N171, N172, N178, N179, N19, N990, O904
Peritoneal dialysis	3E1M39Z
Hemodialysis	5A1D70Z, 5A1D80Z, 5A1D90Z
Kidney transplantation	Z94.0

Statistical Analysis

- **Clinical characteristics** were compared among the obesity without malnutrition, obesity with malnutrition, and non-obese groups using **one-way ANOVA** for continuous variables and the **Chi-squared test** for categorical variables.
- ***Categorical variables*** are presented as unweighted counts (n) and percentage (%).
- ***Continuous variables*** with a normal distribution are reported as mean ± standard deviation (SD), while skewed continuous variables are expressed as median with interquartile ranges (IQR).

Statistical Analysis

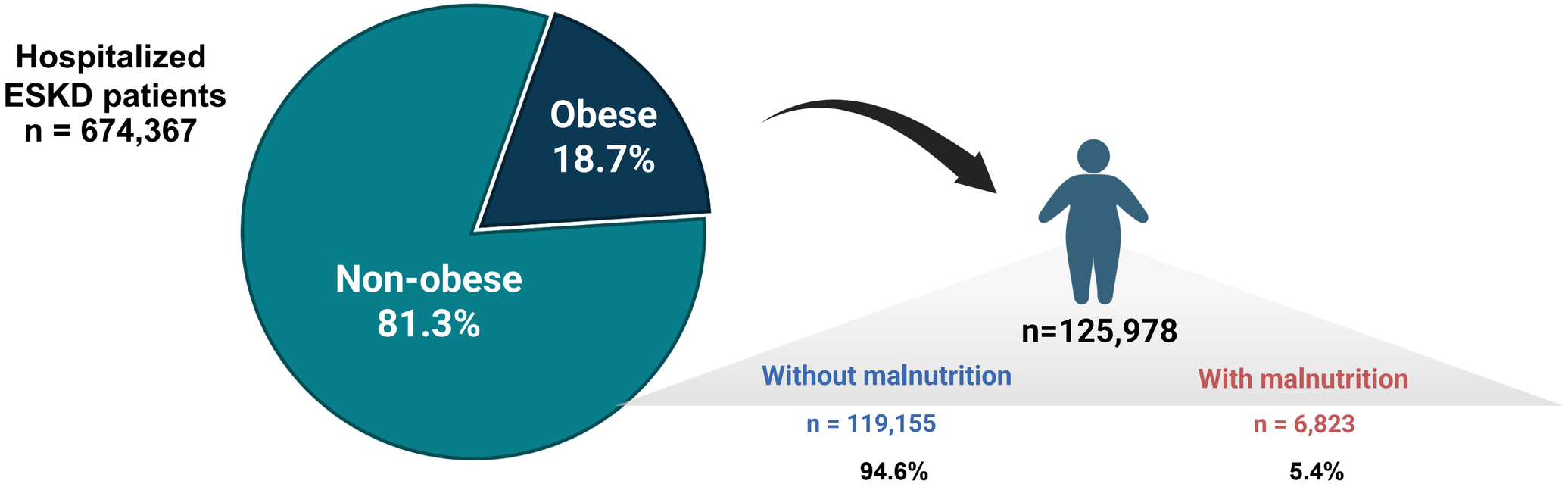
- The association of obesity with/ without malnutrition and **adverse clinical outcomes**, as well as **inpatient treatments**, was evaluated using **logistic regression analysis**.
- Meanwhile, the association between obesity with/without malnutrition and **resource utilization** was assessed using **linear regression analysis**.
- These associations were adjusted for potential patient-level factors and hospital-level factors in the **multivariable analysis**.

Statistical Analysis

- For **binary outcomes**, **odds ratios (ORs)** with 95% confidence intervals (CIs) were provided, and for **continuous outcomes**, **mean differences** with 95% CIs were reported.
- A two-tailed **p-value of less than 0.05** was considered statistically significant.
- All statistical analyses were performed using Stata version 16 (StataCorp LLC, College Station, TX, USA).

Results

Patient characteristics

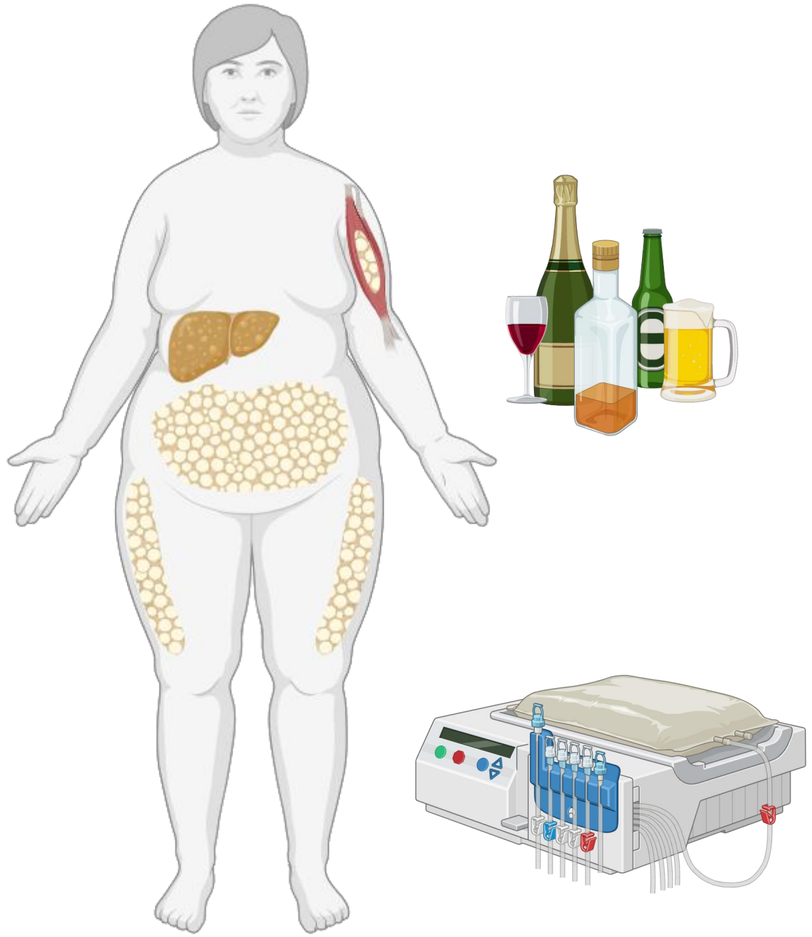


- A total of 674,367 hospitalized ESKD patients were identified from the NIS database between 2016 and 2021, with **125,978 (18.7%) diagnosed with obesity**.
- Among those with obesity patients, **119,155 (94.6%) were not malnourished**, while **6,823 (5.4%) had malnutrition**.

Table 1. Patient characteristics of ESKD patients by obesity and malnutrition status.

Variables	Non obese (n=548,389)	Obesity		P-value
		Without malnutrition (n=119,155)	With malnutrition (n=6,823)	
Age (years)	62.1±15.5	59.9±13.1	62.5±12.8	<0.001
Male sex, n (%)	309,052 (56.4)	56,490 (47.4)	2,920 (42.8)	<0.001
Race, n (%)				<0.001
- **White**	209,489 (40.7)	51,537 (45.8)	3,130 (48.9)	
- **Black**	184,923 (35.9)	40,123 (35.6)	2,120 (33.1)	
- **Hispanic**	94,710 (18.4)	18,085 (16.1)	993 (15.5)	
- **Asian or Pacific Islander**	25,404 (4.9)	2,877 (2.6)	162 (2.5)	
Mode of KRT, n (%)				<0.001
- **Hemodialysis**	508,983 (92.8)	111,288 (93.4)	6,267 (91.8)	
- **Peritoneal dialysis**	39,406 (7.2)	7,867 (6.6)	556 (8.2)	
Charlson comorbidity score, median (IQR)	5 (4-7)	6 (4-7)	6 (5-7)	<0.001
Elixhauser score, median (IQR)	6 (4-7)	7 (6-8)	8 (7-10)	<0.001
Comorbidity, n (%)				
- **Diabetes mellitus**	338,002 (61.6)	93,201 (78.2)	5,225 (76.6)	<0.001
- **Hypertension**	521,290 (95.1)	114,574 (96.2)	6,388 (93.6)	<0.001
- **Dyslipidemia**	218,487 (39.8)	58,674 (49.2)	2,970 (43.5)	<0.001
- **Congestive heart failure**	276,133 (50.3)	65,840 (55.3)	3,802 (55.7)	<0.001
- **Coronary artery disease**	91,643 (16.7)	19,795 (16.6)	997 (14.6)	<0.001
- **Cerebrovascular disease**	51,505 (9.4)	8,895 (7.5)	648 (9.5)	<0.001
- **Peripheral vascular disease**	71,184 (13.0)	13,247 (11.1)	848 (12.4)	<0.001
- **Cirrhosis**	54,236 (9.9)	8,748 (7.3)	993 (14.6)	<0.001
- **Cancer**	29,515 (5.4)	4,280 (3.6)	446 (6.5)	<0.001
- **Dementia/ cognitive impairment**	35,401 (6.5)	3,680 (3.1)	399 (5.9)	<0.001
Smoking, n (%)	122,164 (22.3)	26,622 (22.3)	1,083 (15.9)	<0.001
Alcohol use, n (%)	15,125 (2.8)	1,944 (1.6)	217 (3.2)	<0.001

Patient characteristics

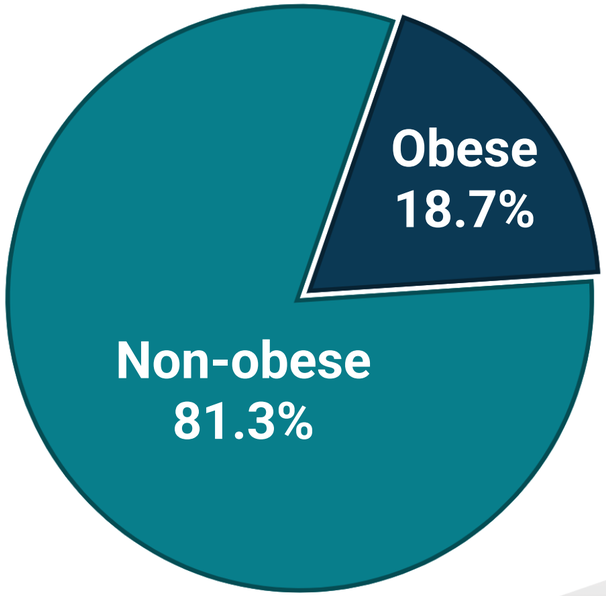


Malnourished obesity

- Compared to non-malnourished obese ESKD patients, those with **malnourished obesity** were more likely to be **older**, **female**, **White**, receiving **PD modality** and have a **history of alcohol consumption**.
- Additionally, they had a **higher prevalence of chronic conditions**, including cerebrovascular disease, peripheral vascular disease, cirrhosis, cancer, and dementia/ cognitive impairment, resulting in a **higher Elixhauser Comorbidity index**.

In-hospital mortality outcome

Hospitalized ESKD patients n = 674,367



Association between obesity with/without malnutrition and in-hospital mortality

n=125,978

Multivariable regression model

In hospital mortality

Without malnutrition

n = 119,155

Odds ratio 0.87

(95%CI 0.84-0.91)

"Obesity paradox"

With malnutrition

n = 6,823

Odds ratio 2.08

(95%CI 1.90-2.27)

"Reverse obesity paradox"

In-hospital outcomes	Non-obese (n=548,389)	Obesity without malnutrition (n=119,155)				Obesity with malnutrition (n=6,823)			
		Univariable analysis		Multivariable analysis		Univariable analysis		Multivariable analysis	
		OR (95% CI)	P-value	Adjusted OR* (95% CI)	P-value	OR (95% CI)	P-value	Adjusted OR* (95% CI)	P-value
Adverse clinical outcomes									
In hospital mortality	Ref.	0.75 (0.73-0.78)	<0.001	0.87 (0.84-0.91)	<0.001	2.20 (2.02-2.39)	<0.001	2.08 (1.90-2.27)	<0.001
Sepsis	Ref.	1.01 (0.99 -1.03)	0.12	1.07 (1.05-1.08)	<0.001	2.77 (2.63-2.91)	<0.001	2.63 (2.50-2.77)	<0.001
CRBSI	Ref.	1.09 (1.03-1.15)	0.003	1.09 (1.03-1.15)	0.003	1.68 (1.43-1.98)	<0.001	1.70 (1.44-2.00)	<0.001
Volume overload	Ref.	1.08 (1.05-1.10)	<0.001	1.08 (1.06-1.11)	<0.001	0.84 (0.77-0.92)	<0.001	0.91 (0.83-0.99)	0.03
Inpatient treatments									
Need for vasopressors	Ref.	0.96 (0.91-1.01)	0.10	1.06 (1.01-1.12)	0.02	2.80 (2.49-3.15)	<0.001	2.56 (2.26-2.89)	<0.001
TPN use	Ref.	0.49 (0.43-0.57)	<0.001	0.57 (0.50-0.66)	<0.001	4.83 (4.04-5.77)	<0.001	4.36 (3.63-5.24)	<0.001
Mechanical ventilation	Ref.	1.84 (1.79-1.89)	<0.001	1.85 (1.80-1.90)	<0.001	1.98 (1.82-2.16)	<0.001	1.95 (1.79-2.13)	<0.001
Blood transfusion	Ref.	0.82 (0.80-0.84)	<0.001	0.89 (0.87-0.91)	<0.001	1.61 (1.50-1.72)	<0.001	1.60 (1.49-1.72)	<0.001
		Coefficient (95% CI)	P-value	Adjusted coefficient* (95% CI)	P-value	Coefficient (95% CI)	P-value	Adjusted coefficient* (95% CI)	P-value
Resource utilization									
LOS (days)	Ref.	0.00 (-0.07, 0.06)	0.93	0.14 (0.08, 0.20)	<0.001	7.57 (7.12, 8.02)	<0.001	7.14 (6.69, 7.58)	<0.001
Hospitalization cost ($)	Ref.	-948 (-2,385, 489)	0.20	2,811 (1,561, 4,061)	<0.001	104,245 (95,581, 112,908)	<0.001	99,514 (90,932, 108,096)	<0.001

*Adjusted for age, sex, race, year of hospitalization, Charlson comorbidity score, diabetes mellitus, hypertension, congestive heart failure, coronary artery disease, cerebrovascular disease, peripheral vascular disease, cirrhosis, cancer, dementia/cognitive impairment, smoking, alcohol drinking, hospital location/teaching status, mode of KRT and admission type

Discussion

Discussion

The Relationship Among Obesity, Nutritional Status, and Mortality in the Critically Ill*

Malcolm K. Robinson, MD[1]; Kris M. Mogensen, MS, RD, LDN, CNSC[2]; Jonathan D. Casey, MD[3]; Caitlin K. McKane, BS, RN[4]; Takuhiro Moromizato, MD[5]; James D. Rawn, MD[1]; Kenneth B. Christopher, MD[6]

- **Observational study during 2004 to 2011**
- **6,518 adult patients treated in ICU**

	Mortality OR (95% CI)[a]							
	BMI							
	< 18.5 kg/m²		25–29.9 kg/m²		30–39.9 kg/m²		≥ 40.0 kg/m²	
Variable	OR (95% CI)	p	OR (95% CI)	p	OR (95% CI)	p	OR (95% CI)	p
30-day mortality								
Crude	1.06 (0.79–1.42)	0.69	0.96 (0.83–1.11)	0.59	0.85 (0.72–1.0[illegible])		[illegible]	0.040
Adjusted[b]	1.09 (0.80–1.48)	0.60	0.93 (0.80–1.09)	0.38	0.80 (0.67–0.96)	0.016	0.69 (0.49–0.97)	0.032
Adjusted + albumin[c]	1.01 (0.74–1.39)	0.94	0.95 (0.81–1.11)	0.51	0.80 (0.67–0.96)	0.016	0.67 (0.47–0.94)	0.021
Adjusted + nutrition[d]	0.78 (0.56–1.08)	0.13	1.01 (0.86–1.19)	0.89	0.90 (0.75–1.07)	0.24	0.77 (0.55–1.08)	0.14
PS matched cohort[e]	0.85 (0.45–1.60)	0.61[f]	1.07 (0.83–1.37)	0.60[g]	1.04 (0.83–1.29)	0.74[h]	0.86 (0.61–1.22)	0.40[i]

Survival benefit in BMI ≥ 30 kg/m2

Adjusted Associations Among Albumin, hs-CRP, Malnutrition, and 30-Day Mortality in Cohort Patients With BMI ≥ 30.0 kg/m2

Variable	OR (95% CI)	p
Nutrition status[a]		
Malnutrition	1.58 (1.21–2.07)	0.001
Well nourished	1.00 (referent)	
hs-CRP[b]		
≥ 100 mg/L	1.25 (0.90–1.75)	0.10
< 100 mg/L	1.00 (referent)	
Albumin[c]		
< 3.4 g/dL	2.67 (2.06–3.44)	< 0.001
≥ 3.4 g/dL	1.00 (referent)	

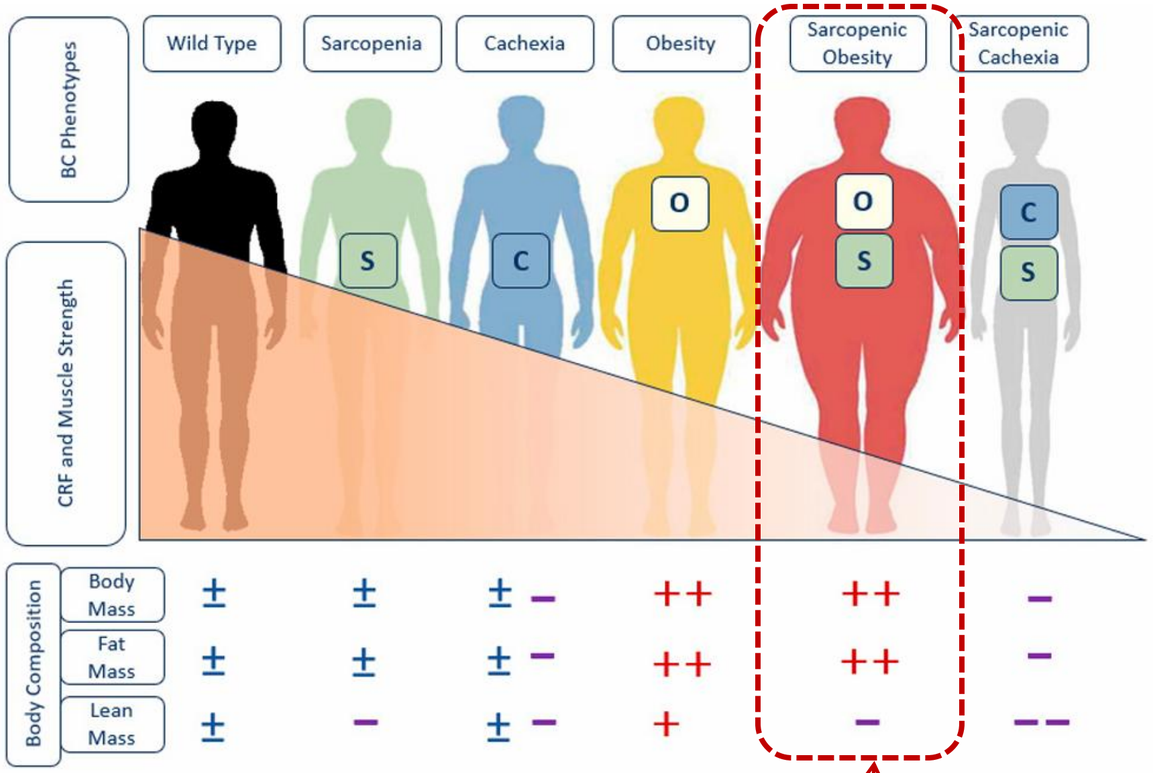
Obesity is confounded by malnutrition status.

Critically ill obese patients with malnutrition have worse outcomes than those without malnutrition.

Crit Care Med. 2015 Jan;43(1):87-100.

Discussion

- These findings imply that conventional diagnostic methods, using **phenotypic criteria** such as ***low BMI*** and ***percentage weight loss***, may lead to a **malnutrition under-diagnosis**.



Insufficient to identify body composition change esp. muscle mass

Limitation of BMI measurement alone

- Missing **muscle mass** composition
  - Low SMM: **sarcopenic obesity**
- Missing **body fat distribution**
- Inaccurate in **edematous state**

Cannot identify

- **Visceral protein** (e.g. **serum albumin**)
- **Micronutrient deficiency**

Discussion

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- Missing **muscle mass** composition
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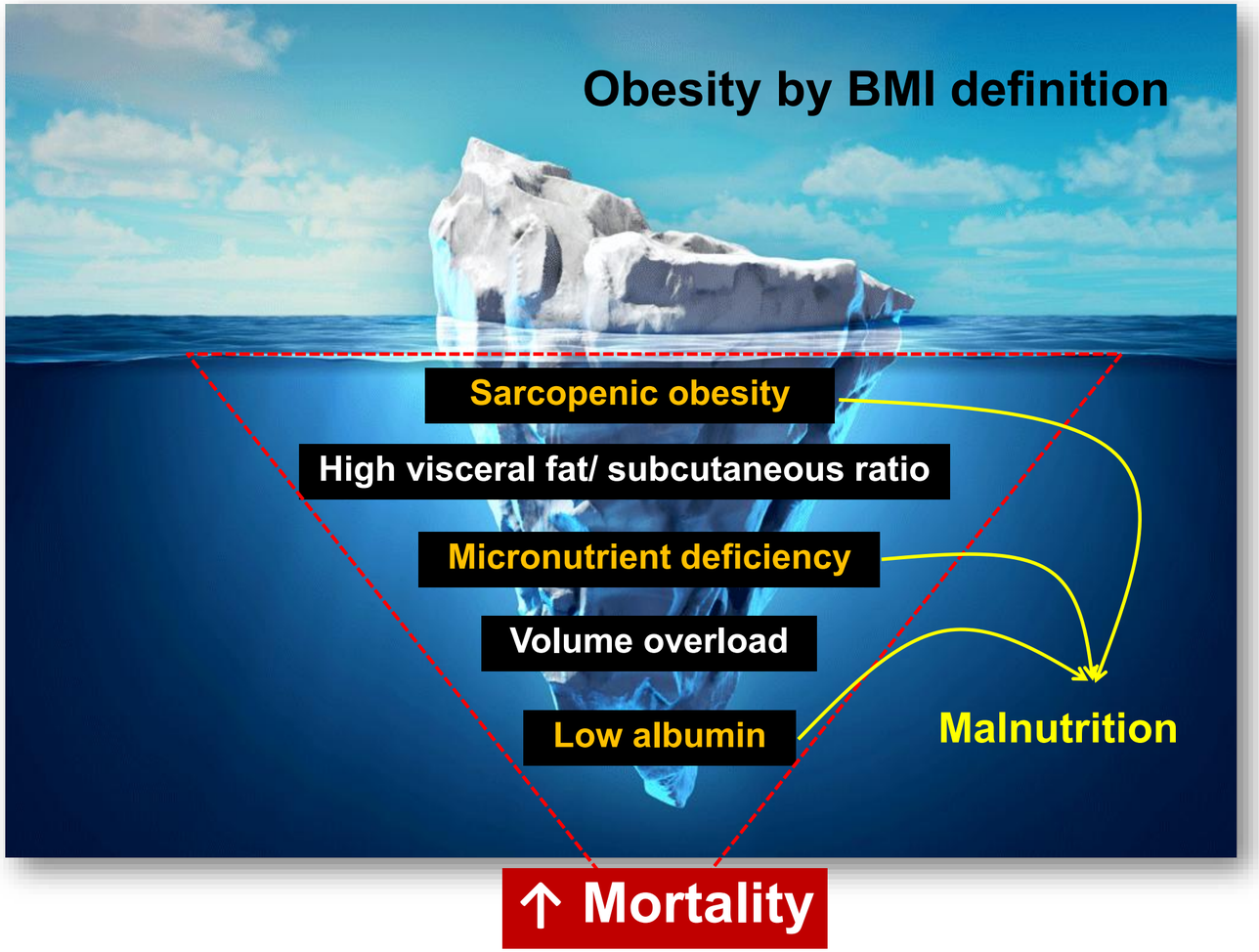
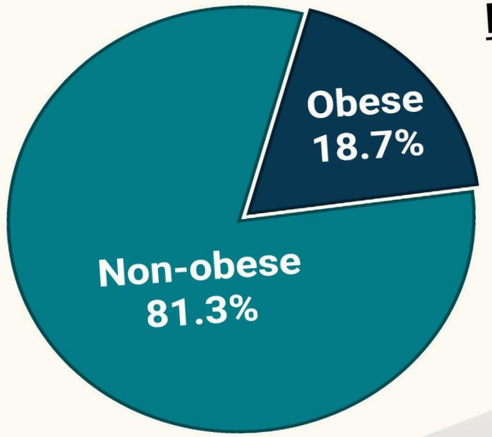


Limitations

- First, its observational designs **limits the ability to establish causal relationships**.
- Second, because this study is based on an inpatient database, we are **unable to assess out-of-hospital mortality or post-discharge deaths** related to ESKD and obesity-related comorbidities.
- Finally, the study relies on clinical coding standards, which follow **ICD-10-CM diagnostic and procedural coding**, potential **under-coding** or **coding errors** are unavoidable.

Conclusions



Hospitalized End-Stage Kidney Disease Patients
(National Inpatient Sample from 2016 to 2021)

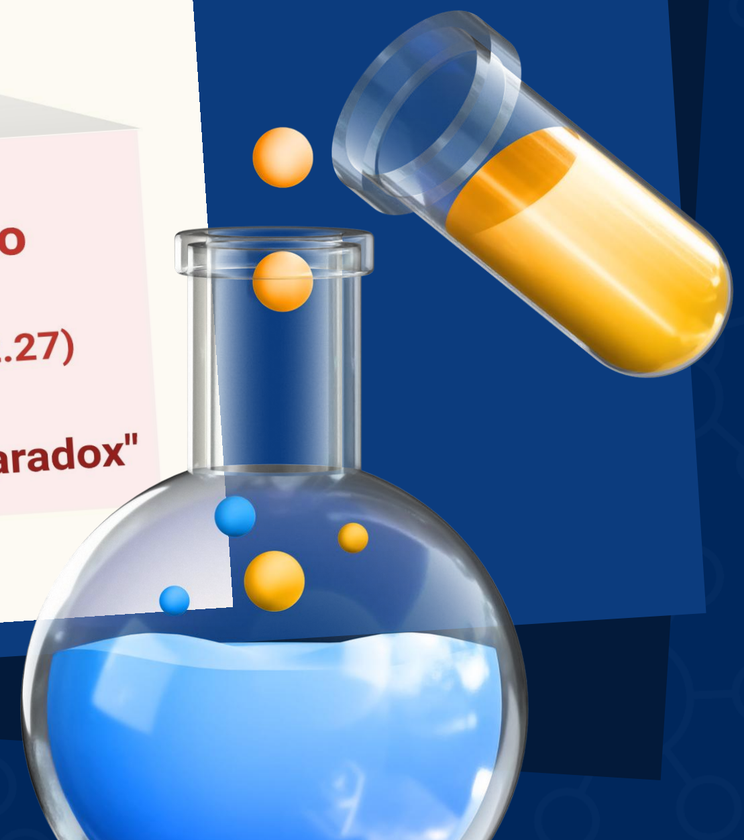
Multivariable regression model

n=125,978

Without malnutrition	With malnutrition
n = 119,155	n = 6,823
Odds ratio 0.87 (95%CI 0.84-0.91)	Odds ratio 2.08 (95%CI 1.90-2.27)
"Obesity paradox"	"Reverse obesity paradox"

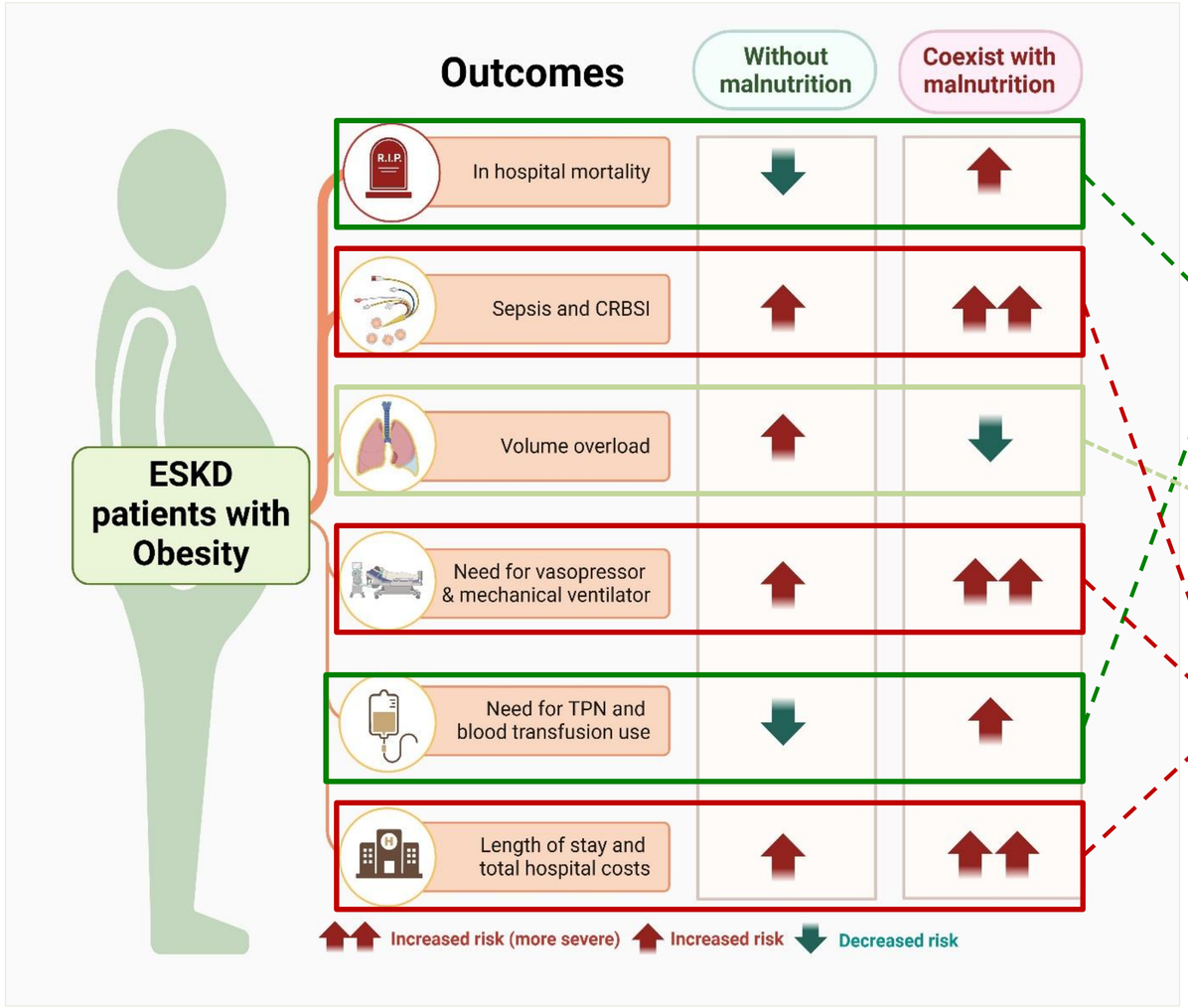
R.I.P.

In hospital mortality



THANK YOU FOR YOUR ATTENTION!

Overview of study's findings



Summary	Outcomes
Protective effects of **obesity without malnutrition**	↓ In hospital mortality ↓ Need for TPN ↓ Need for blood transfusion
Protective effect of **obesity with malnutrition**	↓ Volume overload
Detrimental effects of **obesity with/ without malnutrition***	↑ Infection (sepsis and CRBSI) ↑ Need for vasopressor ↑ Need for mechanical ventilator ↑ LOS ↑ Total hospital cost

*These effects were notably more pronounced when malnutrition was present.