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The association between body mass index and in-hospital outcome among patients with acute myocardial infarction—Insights from China Acute Myocardial Infarction (CAMI) registry

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Abstract *Background:* The relationship between body mass index (BMI) and in-hospital mortality risk among patients with acute myocardial infarction (AMI) remains controversial.
Methods and Results: We included 35,964 patients diagnosed with AMI in China Acute Myocardial Infarction registry between January 2013 and December 2016. Patients were categorized into 4 groups according to BMI level: BMI <18.5, 18.5–24.9, 25–30, and ≥30 kg/m^2 for underweight, normal, overweight, and obese groups, respectively. Clinical data were extracted for each patient, and multivariable logistic regression analysis was used to examine the association between BMI level and in-hospital mortality. Compared with normal-weight patients, obese patients were younger, more often current smokers, and more likely to have hypertension, hyperlipidemia, and diabetes. Multivariable regression analysis results demonstrated that compared with normal group, underweight group had significantly higher in-hospital mortality (odds ratio [OR]: 1.34; 95% confidence interval [CI]: 1.06–1.69; $p = 0.016$), while overweight group (OR: 0.86; 95% CI: 0.77–0.97; $p = 0.011$) and obese group (OR: 0.65; 95% CI: 0.46–0.91; $p = 0.013$) had lower mortality. All subgroups showed a trend toward lower in-hospital mortality risk as BMI increased.
Conclusions: Our study provided robust evidence supporting "obesity paradox" in a contemporary large-scale cohort of patients with AMI and demonstrated that increased BMI was independently associated with lower in-hospital mortality.

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What is already known about this subject?

1. Obesity is a well-established risk factor for cardiovascular disease
2. Some early studies found obese patients had lower in-hospital mortality than normal-weight patients in the setting of acute myocardial infarction

What does this study add?

1. In a large-scale contemporary cohort of consecutive patients with AMI, we provide evidence for the existence of obesity paradox, with higher BMI associated with decreased in-hospital mortality
2. Among most subgroups, there was a trend toward lower in-hospital mortality risk as BMI increased.

Introduction

Although obesity is a well-established risk factor for cardiovascular disease, many studies demonstrated that overweight or obese patients have lower risk of in-hospital or longer term adverse events than those with normal weight in various clinical settings [1]. Ellis et al. first described that among patients with coronary artery disease (CAD) undergoing percutaneous coronary intervention (PCI), in-hospital mortality risk was lower among patients with body mass index (BMI) 26–34 kg/m^2 than those with normal-weight [2]. Subsequently, many studies investigated the association between BMI and in-hospital outcome among patients with acute myocardial infarction (AMI). Some studies supported the phenomenon of “obesity paradox” by demonstrating that overweight and obesity were associated with decreased mortality risk [3–6], while other studies found no significant association between BMI and in-hospital outcome [7,8]. Notably, most studies were early studied (enrollment prior to 2008) when patient characteristics and AMI management differed significantly from now.

More recently, one large-scale study enrolled 345,192 patients with CAD to examine the relationship between BMI and adverse outcomes following PCI [9]. Subgroup analysis results showed that among patients with unstable angina or non-ST segment myocardial infarction (NSTEMI), in-hospital mortality risk decreased with higher BMI; among patients with STEMI, this association was not significant after confounding adjustment. However, many patients with AMI in real-world clinical practice do not receive PCI, and there is limited data on “obesity paradox” among contemporary cohort of consecutive patients with AMI.

Methods

Data source

We used data from China Acute Myocardial Infarction (CAMI) registry to perform our analysis. Detailed information regarding CAMI registry has been published [10]. Briefly, CAMI registry was a prospective multicenter registry enrolling patients with AMI from January 1, 2013 to January 31, 2016. A total number of 108 hospitals from 27 provinces and 4 municipalities participated in the project. CAMI registry collected data on patients’ characteristics, laboratory test results, management, and outcomes, all of which were collected at first registration. Weight and height were measured, and BMI was calculated by physicians at first registration. CAMI registry was approved by the institutional review board central committee at Fuwai Hospital, NCCD of China. Written informed consent was obtained from each patient registered in the study.

Patient population

From January 1, 2013 to January 31, 2016, a total of 45,203 patients with AMI were registered in CAMI registry. All patients were admitted within 7 days of ischemic symptoms. We included all patients except those with age <18 years or >100 years, missing data on BMI or in-hospital outcome, heart rate >250 bpm, Hb <50 or Hb >200 g/L, or K^+ <1 mmol/L or >10 mmol/L because we consider these are outliers and may have a negative effect on the accuracy of the results. Finally, we included a total of 35,964 patients. Patients were divided into 4 groups according to BMI level: <18.5, $18.5–<25$, $25–<30$, and ≥ 30 kg/m^2 according to World Health Organization definition. Data regarding baseline characteristics, lab test results, in-hospital outcome etc were extracted. Patients were also divided into 4 groups by BMI cut-off for Chinese population (<18.5, $18.5–<24$, $24–<29$, and ≥ 29 kg/m^2) to assess the association between BMI category and in-hospital mortality risk.

Variable definitions

All patients were diagnosed as AMI in line with the third universal definition of MI [11]. According to the definition, types 1, 2, 3, 4b, and 4c were eligible for CAMI registry while types 4a and 5 were not included in CAMI registry. Primary outcome was in-hospital mortality, defined as all-cause death during hospitalization.

Statistical analysis

Continuous variables were presented as mean $\pm$ SD or median and interquartile range, and were compared by using one-way analysis of variance. Categorical variables were presented as count and frequency and were compared by using X^2 test. To adjust for potential confounders, multivariable logistic regression model was fitted to compare in-hospital mortality across different groups. A total of two models were built: model one adjusted for age (as continuous variable) and sex, and model two adjusted for age, sex, hypertension, Killip classification, previous myocardial infarction, previous PCI, anterior wall infarction, systolic blood pressure, cardiac arrest, smoking status, previous stroke, ST-elevation, serum potassium, hyperlipidemia, and diabetes.

Subgroup analysis was performed to assess whether the association between BMI and in-hospital mortality differed by baseline characteristics. For interaction test, we planned 12 independent subgroup interaction tests. To correct false positive rate caused by multiple tests, a p value less than 0.004 (0.05/12) was used as threshold for significance [12]. For other statistical tests, p value less than 0.05 was considered significant. All analyses were performed with SAS 9.4 system (SAS Institute, Cary, NC, USA).

Results

We included 35,964 patients with valid data on BMI and in-hospital outcome, registered in CAMI registry from January 1st 2013 to December 5th 2016. Patients were divided into four groups according to BMI value: underweight group (BMI < 18.5 kg/m^2, $N = 919$), normal-weight group (BMI 18.5–24.9 kg/m^2, $N = 21{,}984$), overweight group (BMI 25–30 kg/m^2, $N = 11{,}675$), and obese group (BMI ≥ 30 kg/m^2, $N = 1386$). These four groups accounts for 2.6%, 61.1%, 32.5%, and 3.8% of our study population. The study population had a median (interquartile range) hospital stay of 11 (7–15) days.

Baseline characteristics

Baseline characteristics were shown in Table 1. Compared with normal-weight patients, obese patients were on average 7 years younger (57 years vs. 64 years). Obese patients were more likely to have traditional risk factors including hypertension (63.6% vs. 47.9%), hyperlipidemia (19% vs. 5.9%), diabetes (26.2% vs. 17.7%), and family history of premature CAD (5.0% vs. 2.8%) than normal-weight patients. Anterior MI was less common in obese group than that in normal-weight group (48.5% vs. 52.7%).

Underweight patients were on average 7 years older than normal-weight patients and were less likely to be male (58.1% vs. 73.6%). Anterior wall MI (55.1% vs. 52.7%) and heart failure (22.5% vs. 15.2%) were more common in underweight group than that in normal-weight group.

In-hospital outcome

In-hospital mortality decreased as BMI increased, with mortality rate 11.3%, 6.0%, 4.2%, and 3.0% for underweight, normal, overweight, and obese group, respectively ($p < 0.001$, Table 2). Unadjusted OR of in-hospital mortality was 2.01 (95% CI: 1.62–2.48; $p < 0.001$) in underweight group, 0.69 (95% CI: 0.62–0.76; $p < 0.001$) in overweight group, and 0.49 (95% CI: 0.36–0.67; $p < 0.001$) in obese group, compared with OR = 1 in normal group (reference group). Difference in mortality was attenuated but remained significant after adjustment for age (as continuous variable) and sex (model 1). Similar results were obtained when age was adjusted as categorical variable (data not shown), or further adjusted for Killip classification, systolic blood pressure, anterior wall infarction, hypertension, hyperlipidemia, diabetes, previous myocardial infarction, previous PCI, cardiac arrest, previous stroke, smoking status, ST-elevation, and serum potassium (model 2, Table 2). In addition, we also divided patients into four groups according to BMI cut-off for Chinese population (Table 3). Similarly, compared with normal-weight group, underweight group had higher in-hospital mortality (OR: 1.29; 95% CI: 1.02–1.64, $p = 0.034$) while overweight (OR: 0.83; 95% CI: 0.75–0.93; $p = 0.001$) and obese group (OR: 0.72; 95% CI: 0.56–0.92; $p = 0.009$) had lower in-hospital mortality. For all subgroups, no significant interaction tests were observed by applying the corrected p value, and the association between BMI and in-hospital mortality risk was consistent with overall population (Table 4).

Discussion

Major findings

Our study provides an opportunity to examine the association between BMI and in-hospital mortality risk in a large-scale contemporary cohort of consecutive patients with AMI. We provide evidence for the existence of obesity paradox, with higher BMI associated with decreased in-hospital mortality, both among the whole study population and most subgroups.

Comparison with previous studies

Many previous studies also reported obesity was paradoxically associated with lower in-hospital mortality risk in the setting of AMI. However, most studies included selected patients with AMI with specific characteristics, such as STEMI patients [13,14] or patients receiving PCI [5,9,15] and may not comprehensively reflect “obesity paradox” among patients with AMI. In addition, most of these studies were early studies, while patient profile and management of AMI have changed significantly since then. Our study is a large-scale prospective study enrolling contemporary cohort of consecutive patients with AMI, and further confirmed the existence of obesity paradox.

Implication of co-morbidities, socio economic factors and complications

It is not surprising to find that cardiovascular risk factors were more common among overweight or obese patients because obesity is a well-established risk factor for diabetes, hypertension, and dyslipidemia. However, patients in overweight group still had lower in-hospital mortality than those in normal-weight group. This could be explained by the relatively short-term outcome, in-hospital mortality, in our study. During in-hospital stay, there is little chance that diabetes or hypertension caused complications leading to poorer prognosis among these patients. In addition, although underweight patients have lower rate of traditional cardiovascular risk factors, these patients are older and may develop cachexia and other severe diseases [16].

Table 1 Baseline characteristics by BMI.

Variable	BMI <18.5 kg/m^2 N = 919	BMI 18.5–24.9 kg/m^2 N = 21,984	BMI 25–30 kg/m^2 N = 11,675	BMI ≥30 kg/m^2 N = 1386	p value
Age (years)	70.63 ± 11.42	63.99 ± 12.22	60.15 ± 12.16	56.63 ± 13.25	<0.0001
Male	534 (58.1%)	16,176 (73.6%)	9013 (77.2%)	1021 (73.7%)	<0.0001
Diagnose					0.0147
NSTEMI	244 (26.6%)	5545 (25.2%)	2773 (23.8%)	343 (24.7%)	
STEMI	675 (73.4%)	16,439 (74.8%)	8902 (76.2%)	1043 (75.3%)	
Chest pain	603 (65.6%)	14,311 (65.1%)	7151 (61.3%)	850 (61.3%)	<0.0001
Anterior wall MI	506 (55.1%)	11,585 (52.7%)	5884 (50.4%)	672 (48.5%)	<0.0001
Heart failure	207 (22.5%)	3339 (15.2%)	1513 (13.0%)	216 (15.6%)	<0.0001
Cardiac shock	41 (4.5%)	774 (3.5%)	343 (2.9%)	35 (2.5%)	0.002
Fatal arrhythmia	77 (8.4%)	1432 (6.5%)	675 (5.8%)	73 (5.3%)	0.001
Cardiac arrest	11 (1.2%)	232 (1.1%)	107 (0.9%)	9 (0.6%)	0.282
Killip classification					<0.0001
I	604 (65.7%)	16,547 (75.3%)	9148 (78.4%)	1050 (75.8%)	
II	193 (21.0%)	3473 (15.8%)	1700 (14.6%)	232 (16.7%)	
III	69 (7.5%)	1064 (4.8%)	440 (3.8%)	65 (4.7%)	
IV	53 (5.8%)	900 (4.1%)	387 (3.3%)	39 (2.8%)	
SBP (mmHg)	126.1 ± 27.42	128.24 ± 25.16	130.67 ± 24.96	132.95 ± 25.61	<0.0001
DBP (mmHg)	76.34 ± 15.84	78.39 ± 15.44	80.43 ± 15.71	82.18 ± 16.80	<0.0001
Heart rate (beat/min)	80.31 ± 20.91	77.99 ± 18.98	78.01 ± 18.16	79.06 ± 17.40	0.0005
Hemoglobin (g/L)	126.2 ± 19.24	134.37 ± 19.36	139.56 ± 18.86	142.28 ± 19.51	<0.0001
K^+ (mmol/L)	4.04 ± 0.58	3.98 ± 0.52	3.95 ± 0.49	3.97 ± 0.50	<0.0001
Hypertension	354 (38.5%)	10,534 (47.9%)	6408 (54.9%)	882 (63.6%)	<0.0001
Hyperlipidemia	28 (3.0%)	1293 (5.9%)	1173 (10.0%)	263 (19.0%)	<0.0001
Diabetes	101 (11.0%)	3890 (17.7%)	2565 (22.0%)	363 (26.2%)	<0.0001
Smoking status					<0.0001
Nonsmoker	486 (52.9%)	9860 (44.9%)	4815 (41.2%)	579 (41.8%)	
Ex-smoker	111 (12.1%)	2622 (11.9%)	1251 (10.7%)	129 (9.3%)	
Current smoker	322 (35.0%)	9502 (43.2%)	5609 (48.0%)	678 (48.9%)	
Family history of premature CAD	15 (1.6%)	609 (2.8%)	520 (4.5%)	69 (5.0%)	<0.0001
Previous angina	221 (24.0%)	5068 (23.1%)	2862 (24.5%)	378 (27.3%)	0.0003
Previous MI	92 (10.0%)	1536 (7.0%)	869 (7.4%)	111 (8.0%)	0.0037
Previous PCI	31 (3.4%)	954 (4.3%)	629 (5.4%)	91 (6.6%)	<0.0001
Previous CABG	4 (0.4%)	66 (0.3%)	46 (0.4%)	11 (0.8%)	0.0426
Previous heart failure	52 (5.7%)	536 (2.4%)	232 (2.0%)	24 (1.7%)	<0.0001
Previous stroke	96 (10.4%)	2060 (9.4%)	1067 (9.1%)	111 (8.0%)	0.1955
Peripheral artery disease	5 (0.5%)	153 (0.7%)	75 (0.6%)	9 (0.6%)	0.8978
Chronic kidney disease	17 (1.8%)	266 (1.2%)	120 (1.0%)	30 (2.2%)	0.0021
Previous heart failure	52 (5.7%)	536 (2.4%)	232 (2.0%)	24 (1.7%)	<0.0001
Previous stroke	96 (10.4%)	2060 (9.4%)	1067 (9.1%)	111 (8.0%)	0.1955
COPD					
Hospital stay	10 (7, 14)	11 (7, 15)	11 (7, 15)	11 (7, 15)	0.032

Values are presented as mean ± SD, median (interquartile range) or n (%).
NSTEMI: non-ST segment elevation myocardial infarction; STEMI: ST-segment elevation myocardial infarction; CAD: coronary artery disease; MI: myocardial infarction; PCI: percutaneous coronary intervention; COPD: chronic obstructive pulmonary disease.

Regarding socio-economic factors, previous meta-analysis has indicated an association between low socio-economic status (SES) and obesity [17], and poor SES is a powerful predictor of all-cause and cardiovascular mortality [18]. The explanation for higher survival rate among obese patients with AMI despite potential lower SES may be associated with short-term in-hospital outcome of our study as SES might not have a significant effect on patient's prognosis during hospital stay. In addition, as discussed above, underweight patients are older and more likely to be fragile, and fragility is a well-established powerful predictor of mortality [19].

The implications of complications remain to be elucidated. On the one hand, patients with BMI <25 kg/m^2 had higher risk of bleeding, which may attribute to the poor in-hospital outcome among this patient group [20]. On the other hand, one study found that after adjustment of in-hospital complications, overweight and obesity still had lower protective effect on in-hospital mortality [21]. Another large-scale retrospective study found that among patients with cardiogenic shock complicating AMI, obese patients had lower adjusted in-hospital mortality than nonobese patients [22].

Mechanism underlying obesity paradox

A number of mechanisms have been proposed for obesity paradox: First, intensive treatment may contribute to the protective effect of BMI. Compared with normal weight patients, obese patients are 1–10 years younger [20] and less likely to have complex high-risk lesions assessed by

Table 2 Odds ratio of in-hospital mortality by BMI group according to WHO classification.

Variable	BMI <18.5 kg/m^2 N = 919	BMI 18.5–24.9 kg/m^2 N = 21,984	BMI 25–30 kg/m^2 N = 11,675	BMI ≥30 kg/m^2 N = 1386
In-hospital mortality	104 (11.3%)	1315 (6.0%)	488 (4.2%)	42 (3.0%)
Unadjusted in-hospital mortality				
OR (95% CI)	2.01 (1.62, 2.48)	reference	0.69 (0.62, 0.76)	0.49 (0.36, 0.67)
p value	<0.001		<0.001	<0.001
Adjusted in-hospital mortality				
Model 1				
OR	1.36 (1.09, 1.68)	reference	0.86 (0.77, 0.95)	0.69 (0.50, 0.94)
p value	0.0061		0.0050	0.0204
Model 2				
OR	1.34 (1.06, 1.69)	reference	0.86 (0.77, 0.97)	0.65 (0.46, 0.91)
p value	0.016		0.011	0.013

Values are presented with *n* (%).
OR: odds ratio; 95% CI: 95% confidence interval.
Model 1 adjusted for age (as continuous variable) and sex.
Model 2 adjusted for age, gender, hypertension, Killip classification, previous myocardial infarction, previous PCI, anterior wall infarction, systolic blood pressure, cardiac arrest, smoking status, previous stroke, ST-elevation, serum potassium, hyperlipidemia, and diabetes.

Table 3 Odds ratio of in-hospital mortality by BMI cut-off for Chinese population.

Variable	BMI <18.5 kg/m^2 N = 919	BMI 18.5–<24 kg/m^2 N = 16,420	BMI 24–<29 kg/m^2 N = 16,296	BMI ≥29 kg/m^2 N = 2356
In-hospital mortality	104 (11.3%)	1047 (6.4%)	715 (4.4%)	83 (3.5%)
Unadjusted in-hospital mortality				
OR (95% CI)	2.01 (1.62, 2.48)	reference	0.69 (0.62, 0.76)	0.49 (0.36, 0.67)
p value	<0.001		<0.001	<0.001
Adjusted in-hospital day mortality				
Model 1				
OR	1.31 (1.06–1.64)	reference	0.84 (0.76–0.93)	0.76 (0.60–0.96)
p value	0.015		<0.0001	0.022
Model 2				
OR	1.29 (1.02–1.64)		0.83 (0.75–0.93)	0.72 (0.56–0.92)
p value	0.034		0.001	0.009

Model 1 adjusted for age (as continuous variable) and sex.
Model 2 adjusted for age, gender, hypertension, Killip classification, previous myocardial infarction, previous PCI, anterior wall infarction, systolic blood pressure, cardiac arrest, smoking status, previous stroke, ST-elevation, serum potassium, hyperlipidemia, and diabetes.

angiography [23]. Therefore, patients with higher BMI tend to receive more aggressive treatment and optimal medical therapy, which may explain their lower risk of in-hospital mortality. Second, body fat can serve as nutritional reserves to help them survive MI when metabolic demands increased sharply [24]. Third, some studies demonstrated that higher BMI was associated with lower risk of bleeding, ischemic, as well as heart failure, which may mediate decreased risk of mortality among overweight or obese patients [25]. Finally, pre-clinical experiments indicated that adipose tissue is an important endocrine tissue producing hormones including leptin and adiponectin [26]. These two hormones may exhibit cardioprotective effect via anti-inflammatory and anti-apoptotic properties [27,28].

Clinical implications and limitations

First, we still recommend patients to prevent obesity post AMI. This is because most studies demonstrated that obese patients were at higher risk of comorbidities including diabetes, hyperlipidemia, and hypertension. Obese patients are also at higher risk of AMI, which is further supported by the phenomenon that they are generally younger than normal-weight patients with a first AMI. In addition, body fat itself may not be the major explanation for obesity paradox. As discussed above, intensive treatment, less complex lesions, and optimal medication therapy may serve as predominant reasons for the observed lower in-hospital mortality risk among obese patients. Finally, although moderate overweight exerts protective effect, severely obese patients have a trend toward higher death risk. Therefore, we still encourage patients post AMI to maintain a normal BMI.

The second implication of our results is that clinicians should pay more attention to underweight patients. Consistent with most prior studies, underweight patients are at higher risk of death than with normal-weight. Patients at the lowest BMI level are generally more fragile and less responsive to supportive therapy [29]. A low BMI is usually interpreted as malnutrition and is associated with worse prognosis among patients with chronic diseases [30]. Therefore, when treating underweight patients

Table 4 Association between BMI and in-hospital mortality by baseline characteristics.

Variable	BMI <18.5 kg/m^2 N = 919	BMI 18.5–24.9 kg/m^2 N = 21,984	BMI 25–30 kg/m^2 N = 11,675	BMI ≥30 kg/m^2 N = 1386	$P_{interaction}$ value
Female (N = 9220)	1.20 (0.86, 1.69)	reference	0.93 (0.77, 1.12)	0.53 (0.31, 0.90)	0.0546
Male (N = 26,744)	1.51 (1.09, 2.10)	reference	0.82 (0.71, 0.96)	0.77 (0.50, 1.19)	
Prior PCI (N = 1705)	1.66 (0.49, 5.64)	reference	0.39 (0.20, 0.79)	0.23 (0.03,1.82)	0.083
No prior PCI (N = 34,259)	1.32 (1.04, 1.68)	reference	0.88 (0.79, 0.99)	0.67 (0.48, 0.95)	
Anterior wall MI (N = 18,647)	1.40 (1.03, 1.89)	reference	0.98 (0.84, 1.14)	0.70 (0.45, 1.09)	0.0090
No anterior wall MI (N = 17,317)	1.24 (0.85, 1.81)	reference	0.72 (0.60, 0.87)	0.58 (0.34, 0.97)	
<55 years old (N = 9962)	4.47 (1.85, 10.76)	reference	0.87 (0.62, 1.22)	0.63 (0.29, 1.34)	0.0310
55–64 years old (N = 9212)	1.50 (0.72, 3.11)	reference	0.79 (0.60, 1.04)	0.94 (0.49, 1.79)	
65–74 years old (N = 9451)	1.39 (0.92, 2.11)	reference	0.89 (0.73, 1.09)	0.70 (0.36, 1.36)	
≥75 years old (N = 6519)	1.17 (0.85, 1.62)	reference	0.89 (0.73, 1.08)	0.47 (0.25, 0.90)	
Prior heart failure (N = 844)	1.87 (0.88, 4.00)	reference	0.91 (0.55, 1.50)	0.58 (0.12, 2.82)	0.2786
No prior heart failure (N = 35,120)	1.30 (1.01, 1.66)	reference	0.85 (0.76, 0.96)	0.66 (0.47, 0.93)	
Hypertension (N = 18,178)	1.69 (1.21, 2.37)	reference	0.86 (0.74, 1.00)	0.59 (0.39, 0.90)	0.0425
No hypertension (N = 17,786)	1.09 (0.79, 1.52)	reference	0.87 (0.72, 1.04)	0.79 (0.45, 1.39)	
Diabetes (N = 6919)	1.31 (0.69, 2.49)	reference	0.81 (0.64, 1.02)	0.50 (0.27, 0.94)	0.4623
No diabetes (N = 29,045)	1.34 (1.04, 1.73)	reference	0.87 (0.76, 1.00)	0.71 (0.47, 1.06)	
Hyperlipidemia (N = 2757)	0.48 (0.06, 4.08)	reference	0.63 (0.37, 1.06)	0.72 (0.29, 1.77)	0.1124
No hyperlipidemia (N = 33,207)	1.35 (1.07, 1.71)	reference	0.88 (0.78, 0.99)	0.64 (0.44, 0.92)	
COPD (N = 713)	1.89 (0.53, 6.75)	reference	0.73 (0.32, 1.65)	0.42 (0.08, 2.13)	0.1500
No COPD (N = 35,251)	1.31 (1.03, 1.66)	reference	0.86 (0.77, 0.97)	0.67 (0.47, 0.94)	
Chronic kidney disease (N = 433)	1.68 (0.65, 4.36)	reference	1.68 (0.65, 4.36)	0.00 (0.00, I)	0.2308
No chronic kidney disease (N = 35,531)	1.31 (1.03, 1.67)	reference	0.85 (0.76, 0.96)	0.66 (0.47, 0.93)	
Previous MI (N = 2608)	1.69 (0.88, 3.22)	reference	0.74 (0.51, 1.08)	0.36 (0.11, 1.23)	0.2970
No previous MI (N = 33,356)	1.30 (1.01, 1.67)	reference	0.87 (0.77, 0.99)	0.68 (0.48, 0.97)	
STEMI (N = 27,059)	1.14 (0.85, 1.51)	reference	0.87 (0.76, 0.99)	0.65 (0.44, 0.96)	0.0435
NSTEMI (N = 8905)	2.02 (1.32, 3.07)	reference	0.84 (0.66, 1.08)	0.67 (0.33, 1.34)	

Values are presented with odds ratio (95% confidence interval).
Adjusted for age, gender, hypertension, Killip classification, previous myocardial infarction, previous PCI, anterior wall infarction, systolic blood pressure, cardiac arrest, smoking status, previous stroke, ST-elevation, serum potassium, hyperlipidemia, and diabetes.
PCI: percutaneous coronary intervention; MI: myocardial infarction; COPD: chronic obstructive pulmonary disease; STEMI: ST-elevation myocardial infarction; NSTEMI: non-ST elevation myocardial infarction.

with AMI, clinicians should not only start a regular secondary prevention treatment but also manage other prognostic factors including malnutrition status and potential comorbidities. Our study has several limitations: First, all participants were from China, future studies should enroll participants of other ethnic groups. Second, CAMI registry did not collect data on central obesity assessed by waist circumference. Several studies have shown that central obesity as assessed by waist circumference or waist to hip ratio [31] was an important risk factor for long-term mortality among patients with AMI [32], or patients with CAD at baseline [33]. Third, it is possible that we did not adjust for potential unmeasured confounders. Fourth, changes in BMI have an effect on the association between BMI and in-hospital mortality, while CAMI registry only collect BMI once at first registration. Fifth, although we adjusted for some common comorbidities including hypertension, previous myocardial infarction stroke, hyperlipidemia, and diabetes, we were unable to further adjust the severity of disease because CAMI registry did not collect relevant data. In addition, it is possible that we did not adjust some potential illness. Finally, due to the limitation of retrospective study, we were unable to draw causal associations between BMI and in-hospital mortality.

Conclusions

Our results further provide evidence supporting “obesity paradox”, with increased BMI independently associated with decreased in-hospital mortality in a large contemporary cohort of patients with AMI both among the whole study population and among most subgroups. Note that, underweight patients are at higher risk of in-hospital mortality than normal-weight patients, indicating these patients require closer clinical observation.

Disclosures

The authors declare no conflicts of interest.

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