

# Impact of Body Mass Index on In-Hospital Outcomes After Percutaneous Coronary Intervention for ST Segment Elevation Acute Myocardial Infarction

Masami Kosuge, MD<sup>1</sup>; Kazuo Kimura, MD<sup>1</sup>; Sunao Kojima, MD<sup>2</sup>; Tomohiro Sakamoto, MD<sup>3</sup>; Masaharu Ishihara, MD<sup>4</sup>; Yujiro Asada, MD<sup>5</sup>; Chuwa Tei, MD<sup>6</sup>; Shunichi Miyazaki, MD<sup>7</sup>; Masahiro Sonoda, MD<sup>8</sup>; Kazufumi Tsuchihashi, MD<sup>9</sup>; Masakazu Yamagishi, MD<sup>10</sup>; Mutsunori Shirai, MD<sup>11</sup>; Hisatoyo Hiraoka, MD<sup>12</sup>; Takashi Honda, MD<sup>3</sup>; Yasuhiro Ogata, MD<sup>13</sup>; Hisao Ogawa, MD<sup>2</sup> on behalf of the Japanese Acute Coronary Syndrome Study (JACSS) Investigators

**Background** The impact of body mass index (BMI) on outcomes after primary percutaneous coronary intervention (PCI) for acute myocardial infarction (AMI) remains unclear.

**Methods and Results** A total of 3,076 patients undergoing PCI for AMI within 48 h after symptom onset were studied. Patients were divided into 4 groups according to baseline BMI: lean (<20 kg/m<sup>2</sup>), normal weight (20.0–24.9 kg/m<sup>2</sup>), overweight (25.0–29.9 kg/m<sup>2</sup>) and obese (≥30.0 kg/m<sup>2</sup>). Obese patients were younger and had a higher frequency of diabetes mellitus, hyperlipidemia, hypertension and smoking. Lean patients were older, usually women and had a lower frequency of the aforementioned risk factors. Killip class on admission, renal insufficiency, and final Thrombolysis In Myocardial Infarction (TIMI) flow grade did not differ among the 4 groups. In lean, normal weight, overweight and obese patients, in-hospital mortality was 9.2%, 4.4%, 2.5% and 1.8%, respectively (p<0.01). Multivariate analysis showed that compared with normal weight patients, odds ratios for in-hospital death in lean, overweight and obese patients were 1.92, 0.79 and 0.40, respectively (p=NS). Independent predictors were age, Killip class on admission, renal insufficiency and final TIMI flow grade.

**Conclusion** BMI itself had no impact on in-hospital mortality in patients undergoing primary PCI for AMI. The phenomenon ‘obesity paradox’ may be explained by the fact that obese patients were younger at presentation. (Circ J 2008; 72: 521–525)

**Key Words:** Myocardial infarction; Obesity; Prognosis; Stents

A number of studies have demonstrated that obesity is associated with increased morbidity and overall mortality, as well as with cardiovascular risk factors

(Received October 4, 2007; revised manuscript received November 9, 2007; accepted November 27, 2007)

<sup>1</sup>Division of Cardiology, Yokohama City University Medical Center, Yokohama, <sup>2</sup>Department of Cardiovascular Medicine, Graduate School of Medical Sciences, Kumamoto University, <sup>3</sup>Cardiovascular Center, Saiseikai Kumamoto Hospital, Kumamoto, <sup>4</sup>Department of Cardiology, Hiroshima City Hospital, Hiroshima, <sup>5</sup>First Department of Pathology, Miyazaki Medical College, Miyazaki, <sup>6</sup>Department of Cardiovascular Respiratory and Metabolic Medicine, Graduate School of Medicine, Kagoshima University, Kagoshima, <sup>7</sup>Division of Cardiology, Department of Internal Medicine, Kinki University School of Medicine, Osaka, <sup>8</sup>Second Department of Cardiology, National Hospital Kyusyu Cardiovascular Center, Fukuoka, <sup>9</sup>Second Department of Internal Medicine, Sapporo Medical University School of Medicine, Sapporo, <sup>10</sup>Division of Cardiology, Kanazawa University Hospital, Kanazawa, <sup>11</sup>Department of Microbiology, School of Medicine, Yamaguchi University, Yamaguchi, <sup>12</sup>Department of Internal Medicine and Molecular Science, Graduate School of Medicine, Osaka University, Osaka and <sup>13</sup>Department of Cardiology, Japanese Red Cross Kumamoto Hospital, Kumamoto, Japan

Mailing address: Kazuo Kimura, MD, Division of Cardiology, Yokohama City University Medical Center, 4-57 Urafune-cho, Minami-ku, Yokohama 232-0024, Japan. E-mail: c-kimura@urahp.yokohama-cu.ac.jp

All rights are reserved to the Japanese Circulation Society. For permissions, please e-mail: cj@j-circ.or.jp

such as diabetes, hypertension and hyperlipidemia.<sup>1–4</sup> However, recent studies have suggested a paradoxical relationship between obesity and clinical outcomes in certain subsets of patients. For example, in patients with heart failure,<sup>5,6</sup> clinical outcomes and survival have been shown to be paradoxically better among obese patients than among those of normal weight, a phenomenon known as the ‘obesity paradox’. Other studies have demonstrated better outcomes in obese patients after elective coronary revascularization procedures, such as percutaneous coronary intervention (PCI) and coronary artery bypass graft surgery.<sup>7–9</sup> Yet, data on the impact of body mass index (BMI), especially in lean patients, on outcomes after primary PCI for acute myocardial infarction (AMI) remain limited.<sup>10–12</sup> The aim of the present study was to examine the relationship between a wide range of BMI and in-hospital outcomes in patients with ST segment elevation AMI who underwent primary PCI.

## Methods

### Patients

The cohort of the present study was selected from among patients enrolled in the Japanese Acute Coronary Syndrome Study (JACSS), a retrospective, observational multicenter trial. The study group comprised patients who were admitted to 35 participating hospitals in Japan within 48 h after

**Table 1 Clinical Characteristics**

	BMI				p value
	Lean ( $\leq 20$ kg/m <sup>2</sup> ) (n=337)	Normal weight (20–24.9 kg/m <sup>2</sup> ) (n=1,759)	Overweight (25–29.9 kg/m <sup>2</sup> ) (n=866)	Obese ( $\geq 30$ kg/m <sup>2</sup> ) (n=114)	
Age (years)	73 $\pm$ 11	67 $\pm$ 11	63 $\pm$ 12	57 $\pm$ 12	<0.01
Men	200 (59%)	1,314 (75%)	684 (79%)	80 (70%)	<0.01
Time from symptom onset to admission (h)	5.6 $\pm$ 7.3	5.3 $\pm$ 7.3	5.3 $\pm$ 7.3	4.6 $\pm$ 6.2	0.60
Killip $\geq 2$ on admission	66 (20%)	260 (15%)	120 (14%)	13 (12%)	0.06
Previous infarction	35 (10%)	175 (10%)	109 (13%)	14 (12%)	0.21
Preinfarction angina	109 (32%)	647 (37%)	351 (41%)	37 (33%)	0.03
Glomerular filtration rate (ml/min per 1.73 m <sup>2</sup> )	65 $\pm$ 30	66 $\pm$ 25	68 $\pm$ 25	69 $\pm$ 31	0.23
Renal insufficiency	136 (40%)	653 (37%)	304 (35%)	41 (36%)	0.39
Diabetes mellitus	76 (23%)	518 (29%)	312 (36%)	44 (39%)	<0.01
Hyperlipidemia	69 (21%)	561 (32%)	384 (44%)	57 (50%)	<0.01
Hypertension	175 (52%)	963 (55%)	507 (59%)	79 (69%)	<0.01
Smoking	131 (39%)	823 (47%)	433 (50%)	60 (53%)	<0.01
Anterior AMI	167 (50%)	874 (50%)	412 (48%)	55 (49%)	0.75
Multivessel disease	136 (40%)	735 (42%)	357 (41%)	45 (40%)	0.93
Stent implantation	281 (83%)	1,456 (83%)	691 (80%)	94 (83%)	0.26
TIMI flow grade 0 at initial CAG	216 (64%)	1,163 (66%)	601 (69%)	86 (75%)	0.05
Final TIMI flow grade $\geq 2$	326 (97%)	1,687 (96%)	826 (95%)	108 (95%)	0.69
Final TIMI flow grade 3	304 (90%)	1,583 (90%)	783 (90%)	102 (90%)	0.98
Peak creatine kinase (IU/L)	3,166 $\pm$ 2,547	3,217 $\pm$ 2,883	3,310 $\pm$ 3,262	3,265 $\pm$ 4,433	0.65
In-hospital outcomes					
Reinfarction	4 (1.2%)	36 (2.0%)	16 (1.8%)	3 (2.6%)	0.70
Heart failure	12 (3.6%)	42 (2.4%)	22 (2.5%)	2 (1.8%)	0.60
Stroke	6 (1.8%)	17 (1.0%)	5 (0.6%)	2 (1.8%)	0.22

Data are presented as the mean values  $\pm$  SD or number of patients (%).

BMI, body mass index; AMI, acute myocardial infarction; TIMI, Thrombolysis In Myocardial Infarction study; CAG, coronary angiography.

Renal insufficiency indicates glomerular filtration rate on admission of  $<60$  ml/min per 1.73 m<sup>2</sup>.

symptom onset between January 2001 and December 2003. A diagnosis of AMI required at least 2 of the following characteristics: typical chest pain persisting for 30 min or longer, ischemic electrocardiographic changes, and a peak creatine kinase level equivalent to more than twice the upper limit of normal. We studied 3,076 patients with ST segment elevation AMI who underwent emergency PCI and had adequate clinical data, including baseline weight and height, available. The study protocol was reviewed and approved by the ethical committee of each participating hospital.

### Definitions

BMI was calculated at baseline by dividing the patient's measured weight (in kg) by the square of the height (in m). By standard convention, the patients were divided into 4 groups according to baseline BMI: lean ( $<20$  kg/m<sup>2</sup>), normal weight (20–24.9 kg/m<sup>2</sup>), overweight (25–29.9 kg/m<sup>2</sup>) and obese ( $\geq 30$  kg/m<sup>2</sup>).<sup>4,13</sup> The glomerular filtration rate was calculated according to the abbreviated Modification of Diet and Renal Disease Study formula.<sup>14,15</sup> Renal insufficiency was defined as a glomerular filtration rate on admission of  $<60$  ml/min per 1.73 m<sup>2</sup>.<sup>15</sup> Diabetes mellitus was defined as a fasting glucose concentration of  $\geq 7.0$  mmol/L, a blood glucose concentration of  $\geq 11.0$  mmol/L on a 75-g, 2-h oral glucose tolerance test, or the use of antidiabetic therapy. Hypertension was defined as a history of a systolic blood pressure of  $\geq 140$  mmHg, a diastolic pressure of  $\geq 90$  mmHg, or the use of antihypertensive therapy. Hyperlipidemia was defined as a fasting total cholesterol concentration of  $\geq 220$  mg/dl, a fasting triglyceride concentration of  $\geq 150$  mg/dl, or the use of antihyperlipidemic therapy. Pre-infarction angina was defined as the presence of typical chest pain, occurring at rest or during exercise, and persist-

ing for  $<30$  min, within 24 h before the onset of AMI.<sup>16</sup>

### Coronary Angiography and Coronary Intervention

All patients were emergently taken to the cardiac catheterization laboratory for coronary angiography and received PCI when it was deemed necessary by the operator. Device selection was left to the physicians' discretion. Stenting was done in all patients in whom the procedure was feasible. The perfusion status of the infarct-related artery was assessed according to the Thrombolysis In Myocardial Infarction (TIMI) study classification.<sup>17</sup> Final TIMI flow grade was assessed on the basis of the final angiograms obtained at admission.

### Statistical Analysis

Data are expressed as the mean values  $\pm$  SD for continuous variables and as percentages for categorical variables. We made comparisons by one-way analysis of variance (ANOVA) for continuous variables, and the statistical significance of differences was calculated using the Scheffe F test. Chi-squared analysis was used to compare categorical variables. A probability value of  $<0.05$  was considered to indicate a statistically significant difference. Multiple logistic regression analysis was used to examine determinants of in-hospital mortality. Variables used for analysis included age, gender, time to admission, Killip  $\geq 2$  on admission, previous infarction, diabetes mellitus, hypertension, renal insufficiency, anterior infarction, absence of preinfarction angina, occlusion status at the culprit lesion, multivessel disease, stent implantation, final TIMI flow grade  $\leq 2$ , and BMI categories. The strength of association with BMI was assessed by comparing the 3 groups with abnormal BMI against the normal weight group (ie, BMI 20–24.9 kg/m<sup>2</sup>). Odds ratios and 95% confidence intervals

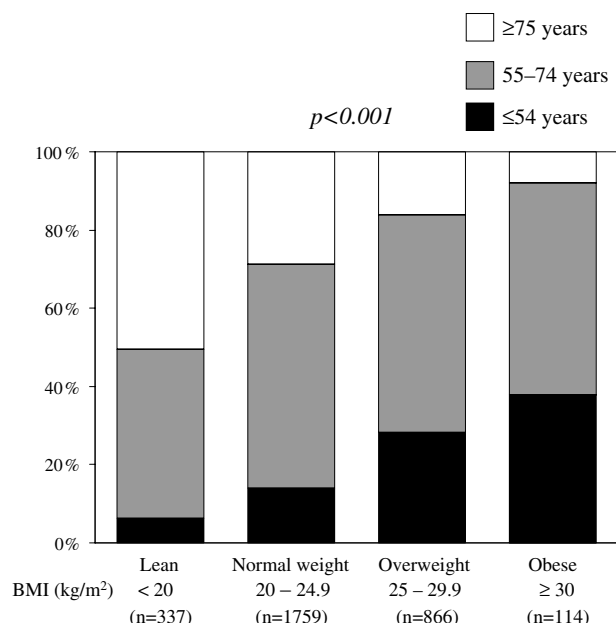


Fig 1. Age stratified according to body mass index (BMI).

were calculated. Data were analyzed using SPSS software (Version 10, SPSS Inc, Chicago, IL, USA).

## Results

### Clinical Characteristics

The 4 groups comprised: lean, 337 patients (11%); normal weight, 1,759 patients (57%); overweight, 866 patients (28%); and obese, 114 patients (4%). The baseline characteristics of the patients according to BMI are shown in Table 1. Mean age decreased with increasing BMI. As seen in Fig 1, the ratio of elder patients (≥75 years) decreased progressively, whereas that of younger patients (<55 years) increased progressively with increasing BMI. The time from symptom onset to admission and the frequencies of previous infarction and renal insufficiency did not differ among the 4 groups. There was a trend toward a lower rate of Killip class ≥2 on admission with increasing BMI, but the differences did not reach statistical significance. Lean patients were less frequently men. With increasing BMI, the frequencies of diabetes mellitus, hyperlipidemia, hypertension and smoking increased. Peak creatine kinase levels did not differ among the 4 groups.

### Angiographic Findings

Angiographic findings of the patients are shown in Table 1. There were no significant differences among the 4 groups in terms of infarct location, frequency of multivessel disease, stent implantation or final TIMI flow grade. There was a trend toward a higher rate of initial TIMI flow grade 0 with increasing BMI, but the difference did not reach statistical significance.

### In-Hospital Outcomes

During hospitalization (mean, 14 days), 132 patients (4.3%) died (94 being from cardiac causes). In-hospital mortality progressively decreased with increasing BMI (Fig 2). Especially in women, lean patients had strikingly higher in-hospital mortality (Fig 3). The frequencies of

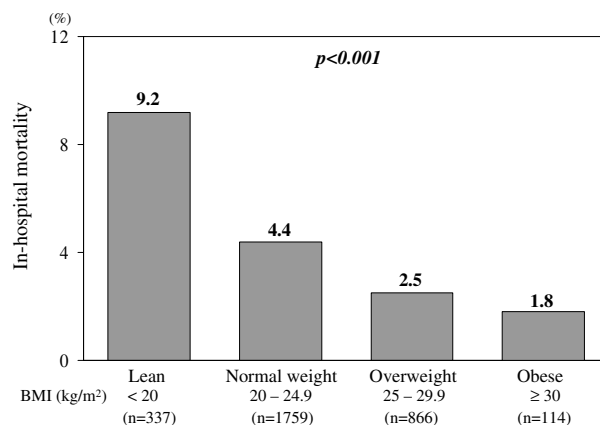


Fig 2. In-hospital mortality stratified according to body mass index (BMI).

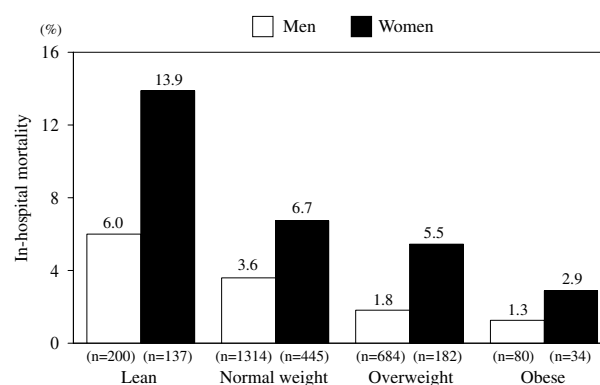


Fig 3. In-hospital mortality stratified according to gender and body mass index (BMI). BMI was related to in-hospital mortality in men ( $p=0.01$ ) and women ( $p=0.02$ ).

reinfarction, heart failure and stroke did not differ among the 4 groups (Table 1). Multivariate analysis showed that BMI itself had no impact on in-hospital mortality (Table 2). Being lean was slightly but not significantly associated with in-hospital mortality. Independent predictors were age, Killip class on admission, renal insufficiency and final TIMI flow grade.

## Discussion

The present study demonstrated that lean patients had the highest in-hospital mortality, which decreased progressively as BMI increased, for patients who underwent primary PCI for ST segment elevation AMI. However, multivariate analysis showed that BMI itself had no impact on in-hospital mortality.

Data on the relationship between BMI and outcomes in patients with AMI are limited and inconsistent in the present era of coronary intervention. Wells et al reported no relationship between BMI and death in patients with AMI,<sup>10</sup> whereas several recent studies demonstrated that obese patients (≥30 kg/m<sup>2</sup>) have a lower rate of in-hospital mortality than normal weight patients (<25 kg/m<sup>2</sup>) after primary PCI for AMI.<sup>11,12</sup> None of these studies concluded that BMI itself contributes to in-hospital mortality, which is consistent with the results of the present study. An important demographic difference, however, was that about 70% of

**Table 2 Multivariate Analysis of Factors Associated With In-Hospital Mortality**

	OR (95% CI)	p value
Normal weight (BMI 20–24.9 kg/m <sup>2</sup> )	1.00	
Lean (BMI <20 kg/m <sup>2</sup> )	1.92 (0.20–6.72)	0.11
Overweight (BMI 25–29.9 kg/m <sup>2</sup> )	0.79 (0.12–7.56)	0.56
Obese (BMI ≥30 kg/m <sup>2</sup> )	0.40 (0.43–2.55)	0.24
Age	1.51 (1.02–13.8)	<0.01
Gender	0.82 (0.49–1.36)	0.44
Time to admission	1.02 (0.97–1.03)	0.49
Killip ≥2 on admission	8.17 (4.98–13.4)	<0.01
Previous infarction	1.15 (0.61–2.19)	0.38
Diabetes mellitus	1.42 (0.85–2.38)	0.18
Hypertension	1.21 (0.72–2.02)	0.48
Renal insufficiency	1.72 (1.01–2.90)	0.04
Anterior infarction	1.47 (0.89–2.39)	0.13
Absence of previous angina	1.55 (0.91–2.73)	0.11
TIMI flow grade 0 at initial CAG	1.46 (0.28–1.48)	0.54
Multivessel disease	1.24 (0.76–2.02)	0.40
Stent implantation	0.83 (0.46–1.52)	0.55
Final TIMI flow grade ≤2	2.56 (1.43–4.87)	<0.01

OR, odds ratio; CI, confidence interval. Other abbreviations see in Table 1.

the patients in these other studies were overweight or obese compared with only 32% in the present study, perhaps reflecting differences in body weight between Japan and other countries. Despite the different prevalence of obesity, the rates of in-hospital death or reinfarction in normal weight, overweight and obese patients in the study by Mehta et al,<sup>11</sup> which is based on the Primary Angioplasty in Acute Myocardial Infarction (PAMI) database, were similar to those of the present study. Moreover, previous studies were unable to explore the clinical implications of being lean (<20 kg/m<sup>2</sup>). One study in patients undergoing elective PCI demonstrated that lean patients have a significantly higher risk of in-hospital death than patients with normal weight.<sup>4</sup> Therefore, we separated lean patients from normal weight patients in the present study and found that the former had the highest risk of in-hospital death, being equivalent to twofold that of patients with normal weight. The increased risk of in-hospital mortality was most strikingly demonstrated in lean women. However, BMI in lean patients was slightly but not significantly associated with in-hospital mortality. Thus, further studies are required to confirm or refute whether being lean is related to such outcomes.

BMI data appear to be confounded by several other factors in patients with AMI who underwent primary PCI. We found that obese patients had more cardiovascular risk factors, such as hypertension, diabetes mellitus and hyperlipidemia, which is consistent with the results of most other studies.<sup>1–4,11,12</sup> Despite such adverse clinical profiles, obese patients had better in-hospital outcomes. In contrast, lean patients had fewer cardiovascular risk factors but the highest in-hospital mortality. Lean patients were more often elderly and female. In the present study, advanced age was independently associated with increased mortality, whereas female gender was not.<sup>18</sup> Numerous studies have shown that elderly patients have poor clinical outcomes after AMI, irrespective of reperfusion modality.<sup>19–21</sup> Conversely, the obese patients in the present study were, on average, 16 years younger than the lean patients.<sup>22</sup> Younger age at presentation may have provided the survival benefit in the obese patients. More aggressive treatment because of their younger age may also be a potential explanation for the better survival rate in the obese patients. Nikolsky et al

have recently attributed the better survival rate after primary PCI in obese patients with AMI to the association of obesity with younger age and better renal function.<sup>12</sup> They evaluated renal function on the basis of creatinine clearance, which is influenced by body weight. In the present study, the creatinine clearance in lean, normal weight, overweight and obese patients was 52±27, 71±30, 91±35 and 113±50 ml/min (p<0.001), respectively. Consistent with the findings of Nikolsky et al,<sup>12</sup> results of the present study found that increased BMI was associated with improved renal function. Recently, however, glomerular filtration rate has been acknowledged as a more accurate index of renal function than creatinine clearance.<sup>14</sup> Although we found no association between BMI and renal function evaluated on the basis of glomerular filtration rate, renal insufficiency was a determinant of in-hospital mortality. Moreover, in the study by Nikolsky et al, obese patients had a higher incidence of inferior AMI,<sup>12</sup> which generally has a better prognosis than anterior AMI. In the present study, infarct location did not differ among the different BMI groups. Our data suggest that age is most likely implicated in the confounded relationship between BMI and in-hospital mortality.

As for coronary angiographic findings, the extent of underlying coronary atherosclerosis did not differ among the BMI groups, which is consistent with the findings of other studies.<sup>11,12</sup> We found that there was a trend toward a higher rate of initial TIMI flow grade 0 with increasing BMI. This may be partly due to alterations in hemostatic variables, such as increased levels of plasminogen activator inhibitor-1, associated with hypercoagulable states.<sup>23</sup> Nonetheless, postprocedural TIMI flow grades were similar among the BMI groups.

#### Study Limitations

Our study was a retrospective analysis and, thus, had several inherent limitations, including selection and referral biases. However, the database we used was relatively large and included patients treated at hospitals of various sizes and settings, making it more representative of current practice patterns than prior single-site databases. We were unable to explore adequately the significance of being severely obese (ie, ≥35 kg/m<sup>2</sup>) because of the very low prevalence of



this condition. However, we demonstrated clearly that lean patients had the highest in-hospital mortality in the contemporary reperfusion era. In the present study, because the causes of death were not examined in detail, we could not assess whether the main causes of in-hospital death differed between the lean group and the obese group. Further investigations are necessary to determine why lean patients are more likely to have poorer outcomes compared with obese patients.

The use of BMI as a measure of obesity may not characterize sufficiently the impact of body size. Data on waist circumference and waist-to-hip ratio were unavailable; such alternative criteria for obesity may be more closely related to cardiovascular disease and death than BMI<sup>24-26</sup>. Finally, changes in BMI after admission were not assessed. Because such changes may have an impact on late outcomes, we assessed only in-hospital outcomes.

## Conclusion

In patients who underwent primary PCI for ST segment elevation AMI, in-hospital mortality progressively decreased as BMI increased. Our findings suggest that this 'obesity paradox' may be explained by the fact that obese patients were younger at presentation.

## Acknowledgment

*This study was supported by a Research Grant for Cardiovascular Disease (14C-4) from the Ministry of Health, Labour and Welfare.*

## References

1. Calle EE, Thun MJ, Petrelli JM, Rodriguez C, Heath CW Jr. Body mass index and mortality in a prospective cohort of US adults. *N Engl J Med* 1999; **341**: 1097–1105.
2. Wilson PW, D'Agostino RB, Sullivan L, Parise H, Kannel WB. Overweight and obesity as determinants of cardiovascular risk: The Framingham experience. *Arch Intern Med* 2002; **162**: 1867–1872.
3. Allison DB, Fontaine KR, Manson JE, Stevens J, VanItallie TB. Annual deaths attributable to obesity in the United States. *JAMA* 1999; **282**: 1530–1538.
4. Powell BD, Lennon RJ, Lerman A, Bell MR, Berger PB, Higano ST, et al. Association of body mass index with outcome after percutaneous coronary intervention. *Am J Cardiol* 2003; **91**: 472–476.
5. Habbu A, Lakkis NM, Dokainish H. The obesity paradox: Fact or fiction? *Am J Cardiol* 2006; **98**: 944–948.
6. Fonarow GC, Srikanthan P, Costanzo MR, Cintron GB, Lopatin M; ADHERE Scientific Advisory Committee and Investigators. An obesity paradox in acute heart failure: Analysis of body mass index and in-hospital mortality for 108,927 patients in the Acute Decompensated Heart Failure National Registry. *Am Heart J* 2007; **153**: 74–81.
7. Reeves BC, Ascione R, Chamberlain MH, Angelini GD. Effect of body mass index on early outcomes in patients undergoing coronary artery bypass surgery. *J Am Coll Cardiol* 2003; **42**: 668–676.
8. Gurm HS, Brennan DM, Booth J, Tcheng JE, Lincoff AM, Topol EJ. Impact of body mass index on outcome after percutaneous coronary intervention (the obesity paradox). *Am J Cardiol* 2002; **90**: 42–45.
9. Minutello RM, Chou ET, Hong MK, Bergman G, Parikh M, Iacovone F, et al. Impact of body mass index on in-hospital outcomes following percutaneous coronary intervention (report from the New York State Angioplasty Registry). *Am J Cardiol* 2004; **93**: 1229–1232.
10. Wells B, Gentry M, Ruiz-Arango A, Dias J, Landolfo CK. Relation between body mass index and clinical outcome in acute myocardial infarction. *Am J Cardiol* 2006; **98**: 474–477.
11. Mehta L, Devlin W, McCullough PA, O'Neill WW, Skelding KA, Stone GW, et al. Impact of body mass index on outcomes after percutaneous coronary intervention in patients with acute myocardial infarction. *Am J Cardiol* 2007; **99**: 906–910.
12. Nikolsky E, Stone GW, Grines CL, Cox DA, Garcia E, Tcheng JE, et al. Impact of body mass index on outcomes after primary angioplasty in acute myocardial infarction. *Am Heart J* 2006; **151**: 168–175.
13. St Jeor ST, Brownell KD, Atkinson RL, Bouchard C, Dwyer J, Foreyt JP, et al. Obesity. Workshop III. AHA Prevention Conference III. Behavior change and compliance: Keys to improving cardiovascular health. *Circulation* 1993; **88**: 1391–1396.
14. Levey AS, Bosch JP, Lewis JB, Greene T, Rogers N, Roth D. A more accurate method to estimate glomerular filtration rate from serum creatinine: A new prediction equation: Modification of Diet in Renal Disease Study Group. *Ann Intern Med* 1999; **130**: 461–470.
15. Brosius FC 3rd, Hostetter TH, Kelepouris E, Mitsnefes MM, Moe SM, Moore MA, et al; American Heart Association Kidney and Cardiovascular Disease Council; Council on High Blood Pressure Research; Council on Cardiovascular Disease in the Young; Council on Epidemiology and Prevention; Quality of Care and Outcomes Research Interdisciplinary Working Group. Detection of chronic kidney disease in patients with or at increased risk of cardiovascular disease. *Circulation* 2006; **114**: 1083–1087.
16. Ishihara M, Sato H, Tateishi H, Kawagoe T, Shimatani Y, Kurisu S, et al. Implications of prodromal angina pectoris in anterior wall acute myocardial infarction: Acute angiographic findings and long-term prognosis. *J Am Coll Cardiol* 1997; **30**: 970–975.
17. The TIMI study group. The Thrombolysis in Myocardial Infarction (TIMI) trial. *N Engl J Med* 1985; **312**: 932–936.
18. Kosuge M, Kimura K, Kojima S, Sakamoto T, Ishihara M, Asada Y, et al; Japanese Acute Coronary Syndrome Study (JACSS) Investigators. Sex differences in early mortality of patients undergoing primary stenting for acute myocardial infarction. *Circ J* 2006; **70**: 217–221.
19. Holmes DR Jr, White HD, Pieper KS, Ellis SG, Califf RM, Topol EJ. Effect of age on outcome with primary angioplasty versus thrombolysis. *J Am Coll Cardiol* 1999; **33**: 412–419.
20. Stone GW, Grines CL, Browne KF, Marco J, Rothbaum D, O'Keefe J, et al. Predictors of in-hospital and 6-month outcome after acute myocardial infarction in the reperfusion era: The Primary Angioplasty in Myocardial Infarction (PAMI) trial. *J Am Coll Cardiol* 1995; **25**: 370–375.
21. Halkin A, Singh M, Nikolsky E, Grines CL, Tcheng JE, Garcia E, et al. Prediction of mortality after primary percutaneous coronary intervention for acute myocardial infarction: The CADILLAC risk score. *J Am Coll Cardiol* 2005; **45**: 1397–1405.
22. Shiraishi J, Kohno Y, Sawada T, Nishizawa S, Arihara M, Hadase M, et al; The AMI-Kyoto Multi-Center Risk Study Group. Relation of obesity to acute myocardial infarction in Japanese patients. *Circ J* 2006; **70**: 1525–1530.
23. De Pergola G, Pannacciulli N. Coagulation and fibrinolysis abnormalities in obesity. *J Endocrinol Invest* 2002; **25**: 899–904.
24. Yusuf S, Hawken S, Ounpuu S, Bautista L, Franzosi MG, Commerford P, et al; INTERHEART Study Investigators. Obesity and the risk of myocardial infarction in 27,000 participants from 52 countries: A case-control study. *Lancet* 2005; **366**: 1640–1649.
25. Kragelund C, Hassager C, Hildebrandt P, Torp-Pedersen C, Kober L; TRACE study group. Impact of obesity on long-term prognosis following acute myocardial infarction. *Int J Cardiol* 2005; **98**: 123–131.
26. Dagenais GR, Yi Q, Mann JF, Bosch J, Pogue J, Yusuf S. Prognostic impact of body weight and abdominal obesity in women and men with cardiovascular disease. *Am Heart J* 2005; **149**: 54–60.