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**Original Article**

# In-hospital Outcomes of Primary PCI among Elderly Relevant to Obesity-Tertiary Center Experience

**Ghada Shalaby[*1,2], Azmat Khadija Niazi[2] ,Sheeren Khaled[2,3]**
**Cardiology Department, Zagazig University- Egypt[1], Cardiac Centre, King Abdullah Medical City-Makkah, Saudi Arabia [2], Cardiology Department , Banha University Egypt[3]**

**Corresponding author**
Ghada Shalaby

**Email:**
ghadashalaby10@gmail.com

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**Abstract**

**Aim**: We aimed to assess imprints of obesity on elderly patients post-primary PCI concerning early outcomes.

**Methods:** This is a retrospective study with 1187 patients above 60 years old who underwent primary PCI identified between 2015 and 2020 and were divided into three groups according to their BMI. The study included a subgroup of 69 extremely elderly patients above 80 years old who had been further subdivided into 3 groups consistent with their BMI

**Results:** Obese elderly group included 26% (n=311). Obese elderly patients were more in need of thrombus aspiration during coronary angiography but no significant difference was found amongst groups about multivessel and left main coronary diseases. The prevalence of severe myocardial dysfunction post-primary PCI was lower in obese compared to overweight and non-obese groups. We found numerical but statistically non-significant lower in-hospital mortality in obese elderly patients in the unadjusted analysis compared to the non-obese group (4% vs. 5% vs 5%, p=0.6). Yet in-hospital stay was prolonged for obese patients in the other 2 groups. BMI is not an independent predictor of in-hospital death among the elderly post-primary PCI. Extreme age obese patients were more smokers with higher haemoglobin levels on discharge and higher left ventricular ejection fraction as less presented by anterior wall MI, less in need for tirofiban use but no significant difference was estimated between groups regarding in-hospital mortality.

**Conclusion:** obesity paradox is still significantly appearing in the elderly. Although BMI is not a predictor of mortality in this age group obesity increases the in-hospital stay with an increasing burden on the health system.

**Keywords**: obesity paradox, elderly, extreme elderly, Percutaneous coronary **intervention, in-hospital stay**

## INTRODUCTION

Acute myocardial infarction (AMI) among the elderly has been pronounced to present more with atypical symptoms. AMI is associated with significantly greater mortality in the elderly equated with the young because the elderly are usually treated less aggressively. (1,2)

Overweight and obesity are growing at epidemic magnitudes throughout the world. (3) Severe and morbidly obese patients are increasing even more than overweight and obese. Overweight and obese adversely affected most of the major coronary artery disease (CAD) risk factors, such as lipid disorders, glucose abnormalities, metabolic syndrome, diabetes mellitus, hypertension, and physical inactivity. Additionally, overweight and obesity may be independent risk factors for CAD and have opposing impacts on other cardiovascular disorders that may go along with CAD, as well as heart failure, atrial fibrillation, and risk for sudden cardiac death. (3)

In the general population, obesity is connected with several comorbidities and a higher risk of adverse consequences including cardiovascular disease and death (4,5) among chronic patients, but this link may be reversed. Evidence from observational studies of patients with heart failure suggests that obese patients may have improved short- and long-term prognoses. (6)

This phenomenon, known as the "obesity paradox," has been mentioned in several studies that have revealed either an inverse linear or U-shaped relationship between BMI and all-cause mortality in heart failure patients. (7–12) The nature of this connection is unclear, but there were several explanations have been estimated including the patient's clinical characteristics.

However, the uncertainty of the real existence of this phenomenon originated as Significant heterogeneity was found through studies backing up the presence of the obesity paradox as study grouping, other risk factors, and follow-up period. (13)

BMI influences, especially in the elderly post-primary PCI, have not been adequately evaluated. This study aimed to clarify how Obesity influences the immediate outcomes post primary PCI among elderly patients.

## PATIENTS AND METHODS

**Patients and Study Design:**

All admitted patients between 2015 and 2020 for primary PCI were included in the STEMI registry conducted in our centre. Data were picked up from the medical reports. A total of 1187 patients aged ≥60 years old were admitted during the period studied with a diagnosis of myocardial infarction and underwent primary PCI with a subgroup of extremely elderly which included 69 patients aged ≥80 years old. No informed consent was required for data collection for this registry.

The study was approved by the research ethical committee of institutes. The study was done according to The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

**Inclusion Criteria:**

Patients with acute myocardial infarction are defined as having chest pain lasting more than 30 min along with ST-segment elevation in 2 contiguous leads of at least 1 mm except for ≥ 2 mm in V2–3 or presumed new-onset left bundle branch block (LBBB).

**Exclusion Criteria:**

Standard contraindications for coronary angiography include patient refusal, allergy to contrast (dye) medium, uncontrolled blood Pressure (Hypertension), problems with blood coagulation (Coagulopathy), kidney failure or dysfunction, severe anaemia, electrolyte imbalance, fever, active systemic infection, uncontrolled rhythm disturbances (arrhythmias), uncompensated heart failure and transient Ischemic attack. Also, AMI patients who had received lytic therapy, rescue PCI patients, and patients with unstable angina or non-ST elevation myocardial infarction were excluded

**Groups definition:**

The patients were divided into three groups depending on Body mass index (BMI) which is defined as an individual's body weight divided by the square of their height. non-obese (BMI<25), overweight (25≥BMI<30), and obese (BMI≥30). The classifications for BMI used in the current study are in use by the NIH and the World Health Organization (WHO) for White, Hispanic, and Black individuals. (14,15). A subgroup of extremely elderly patients (aged above 80 years old) was also subdivided into the same 3 groups based on BMI. The study compared the studied groups regarding demographic (eg., age, gender, smoking, etc), laboratory (eg haemoglobin, troponin, creatinine, etc), echocardiography, angiography data, and in-hospital complications(eg shock, pulmonary oedema, etc).

**Statistical Analysis:**

The SPSS software was used for data analysis. Continuous and categorical data of the three groups were compared using the one-way ANOVA and chi-squared test respectively, Pearson correlations and Univariate and multivariate logistic regression analyses were used to determine predictors of hospital mortality. A p-value <0.05 was considered significant and not significant if it is >0.05).

## RESULTS

This study included a total of 1187 patients aged ≥60 years old admitted to our centre with AMI and who underwent primary PCI between 2015 to 2020, 26% of patients (n=311) were obese, 474 (40%) were overweight and 402 (34%) were non-obese. within the subgroup of extremely elderly which included 69 patients aged ≥80 years old, we found that 16% of patients (n=16) were obese, 26 (38%) were overweight and 27 (39%) were non-obese.

**1-Demographics and risk factors**

The mean BMI of our study population was 27.5±5. Over one-fourth of patients (26%) were obese who were more of male gender but the less male prevalence in comparison to the other two groups

(72%,78%, and 81%, for obese, overweight and non-obese respectively), nevertheless obese group were more diabetics, hypertensive, dyslipidaemic and more smoker. Table I

Pilgrim patients were recorded less among obese patients compared to non-obese and overweight groups (35%, 42%, and 47% p<0.001 for obese, overweight, and non-obese respectively). Although overweight and obese patients had more prevalence in the Arabic-speaking population a lower percentage was in the South Asian population. There were no significant recorded differences among the

### 3-In-hospital outcomes

Post-primary PCI complications including pulmonary oedema, ventilation, cardiogenic shock, and cardiac arrest had no significant differences obese groups (20% vs. 26% vs 27%, p=0.04 for obese, Overweight, and non-obese respectively). Figure II

Although there was numerical but statistically non-significant lower in-hospital mortality in obese patients in the unadjusted analysis compared to the non-obese group (4% vs. 5% vs 5%, p=0.6). Figure II yet in-hospital stay was prolonged for obese patients concerning the other 2 groups (6.5±8.6 vs 6.1±6.3 vs 5.5±5.8, p=0.03 respectively). Figure II

A positive correlation was detected between BMI and in-hospital stay in elderly post-primary PCI patients(p=0.004) (table III) but BMI is not an

three groups regarding smoking, previous history of cerebrovascular accident(CVA), and IHD. Table I

### 2-Coronary angiography data

It was observed that obese and overweight groups were more in need of thrombus aspiration during coronary angiography (14% vs. 11% vs. 8 %, p=0.04 for obese, overweight, and non-obese respectively) although obese, overweight, and non-obese groups, left main stem disease (LM) was estimated to be 3% vs 5% vs 4% and triple vessel coronary artery disease was observed in 18% vs 17% vs 22% respectively with an insignificant p-value. Figure I

between the three groups (p>0.05 for all). However, the prevalence of severe myocardial dysfunction post-primary PCI (EF≤30%) was lower in obese in comparison to overweight and non-

independent predictor of in-hospital death (p=0.9). table IV

### 4-Extreme elderly:

The subgroup of extreme elderly included 69 patients representing 6% of the study population, and 16 % of them were obese. Extreme age obese patients were more smokers (44% vs. 4% vs 15%, p=0.004) with higher haemoglobin levels on discharge and higher left ventricular ejection fraction as less presented by anterior wall MI(25% vs. 54% vs 63%, p=0.03), less in need for tirofiban use but no significant difference was estimated between groups regarding in-hospital mortality. Table V

**Table 1:** ***Comparison of demographic data and risk factors between the three groups of elderly ≥60 years old***

| Variable | Obese<br>311 (26%)<br>number % | Overweight<br>474 (40%)<br>number % | Non-obese<br>402 (34%)<br>number % | P value |
|---|---|---|---|---|
| Age Mean ±SD | 66.6 ± 6.6 | 67 ± 6.8 | 68 ±6.8 | 0.06 |
| Male | 223 (72 %) | 370 (78 %) | 327 (81 %) | 0.009 |
| BMI (kg/m2) Mean ±SD | 33.9 ± 4.3 | 27.4 ± 1.3 | 22.5 ± 1.9 | < 0.001 |
| DM | 196 (63 %) | 270 (57 %) | 214(53 %) | 0.03 |
| HTN | 198 (64 %) | 303 (64 %) | 224 (56 %) | 0.02 |
| Smoking | 61 (20 %) | 112 (24 %) | 88(22 %) | 0.4 |
| Dyslipidemia | 50 (16%) | 53 (11 %) | 37 (9 %) | 0.01 |
| CVA | 14(5%) | 14(3 %) | 12(3%) | 0.2 |
| Old IHD | 75 (24 %) | 107(23 %) | 22 (22 %) | 0.7 |
| Pilgrims | 108 (35%) | 199 (42 %) | 189 (47 %) | 0.003 |
| Arabic speaking | 224 (72 %) | 256(56%) | 201(50 %) | < 0.001 |
| South Asian | 60 (20 %) | 140 (30 %) | 136 (34 %) | < 0.001 |

***BMI: Body Mass Index; DM: Diabetes Mellitus; HTN: Hypertension; CVA: Crebro- Vascular Accidents ;IHD: Ischemic Heart Disease; CAD: Coronary Artery Disease***

**Table 2:** ***Comparison of laboratory and ECHO data between the three groups of elderly ≥60 years old***

| Variable | Obese<br>311 (26%)<br>number % | Overweight<br>474 (40%)<br>number % | Non-obese<br>402 (34%)<br>number % | P-value |
|---|---|---|---|---|
| Hb on admission(mg\dl) | 13.6 ± 2 | 13.4 ± 1.7 | 13 ± 2.1 | < 0.001 |
| Hb on discharge(mg\dl) | 13.2 ± 2.1 | 12.9 ± 2 | 12.7± 2 | 0.009 |
| HBA1c | 7.8 ± 2.2 | 7.7 ± 4.3 | 7.5 ± 2.2 | 0.4 |
| Creatinine on admission(mg\dl) | 1.7 ± 8.5 | 1.2 ± 0.8 | 1.3 ± 1.7 | 0.1 |
| Creatinine on discharge(mg\dl) | 1.3 ± 1.1 | 1.3 ± 1 | 1.5 ± 1.6 | 0.09 |
| Troponin on admission(mg\dl) | 70.8 ± 181 | 70.4 ± 166.7 | 88.4 ± 206 | 0.4 |
| Peak troponin (mg\dl) | 86.4± 177 | 88.4 ± 142.6 | 83.8± 117 | 0.9 |
| HDL(mg\dl) | 39.4 ± 10.6 | 36 ± 10.5 | 39.6 ± 11.7 | 0.4 |
| LDL(mg\dl) | 74.6 ± 36.3 | 76 ± 34.3 | 91.6 ± 35 | 0.1 |
| TG(mg\dl) | 135 ± 75 | 150.5 ± 104.6 | 113 ±44 | 0.2 |
| TC(mg\dl) | 137.5 ± 45.7 | 135.8 ± 46.7 | 146.7 ± 39.9 | 0.5 |
| LVEF | 45.8 ± 9.7 | 36.5 ± 10.2 | 35.7 ± 9.9 | 0.03 |

***Hb: Hemoglobin ; HBA1c : Glycosylated Hemoglobin; LDL: Low Density Lipoprotein ;HDL: High Density Lipoprotein; TG: Triglyceride; TC :total Cholesterol, LVEF; left ventricular ejection fraction***

**Table 3:** ***Correlation between BMI and in-hospital stay in elderly ≥60 years old.***

| Correlations | | | |
|---|---|---|---|
| | | BMI | Length of Stay |
| **BMI** | Pearson Correlation | 1 | -.055** |
| | Sig. (2-tailed) | | .004 |
| | Sum of Squares and Cross-products | 80626.559 | -6256.786 |
| | Covariance | 26.698 | -2.256 |
| | N | 3021 | 2775 |
| **Length of Stay** | Pearson Correlation | -.055** | 1 |
| | Sig. (2-tailed) | .004 | |
| | Sum of Squares and Cross-products | -6256.786 | 175589.038 |
| | Covariance | -2.256 | 62.177 |
| | N | 2775 | 2825 |

****. Correlation is significant at the 0.01 level (2-tailed). BMI: Body Mass Index**

**Table 4:** ***Multivariate regression analysis for in-hospital mortality ≥60 years old.***

| | ***B*** | ***S.E.*** | ***Wald*** | ***df*** | ***Sig.*** | ***Exp(B)*** |
|---|---|---|---|---|---|---|
| **Age** | .062 | .034 | 3.298 | 1 | .069 | 1.064 |
| **Male** | -.483 | .602 | .642 | 1 | .423 | .617 |
| **BMI** | -.036 | .125 | .084 | 1 | .772 | .964 |
| **BMI≥30** | -.754 | 1.081 | .486 | 1 | .486 | .471 |
| **DM** | 1.300 | .723 | 3.230 | 1 | .072 | 3.669 |
| **Smoking** | -.418 | .830 | .254 | 1 | .614 | .658 |
| **HTN** | -.418 | .652 | .411 | 1 | .521 | .658 |
| **CVA** | 1.362 | .892 | 2.330 | 1 | .127 | 3.904 |
| **LMS** | 1.347 | .761 | 3.135 | 1 | .077 | 3.845 |
| **MVD** | .315 | .611 | .266 | 1 | .606 | 1.370 |
| **No of Stents** | .073 | .272 | .073 | 1 | .787 | 1.076 |
| **Post-PCI_EF** | -.135 | .028 | 23.536 | 1 | .000 | .874 |
| **Constant** | -2.283 | 5.577 | .168 | 1 | .682 | .102 |

*BMI: Body Mass Index; DM: Diabetes Mellitus; HTN: Hypertension; CVA: Cerebro- Vascular Accidents; LMS: Left Main Disease; MVD: Multivessel disease; EF: Ejection Fraction*

**Table 5:** ***Comparison of data between the three groups of extreme elderly ≥80 years old.***

| Variable | Obese<br>16 (16%)<br>number % | Overweight<br>26 (38%)<br>number % | Non-obese<br>27 (39%)<br>number % | P value |
|---|---|---|---|---|
| Age Mean ±SD | 84.8 ± 5.3 | 84.9 ± 6.2 | 83.7 ±4.1 | 0.06 |
| Male | 10 (63 %) | 19 (73 %) | 21 (76 %) | 0.5 |
| BMI (kg/m2) Mean ±SD | 32.5 ± 1.8 | 27.3 ± 1.4 | 22 ± 1.6 | < 0.001 |
| DM | 12 (75 %) | 14 (54 %) | 16(59 %) | 0.3 |
| HTN | 12 (75%) | 14 (54 %) | 20 (74 %) | 0.2 |
| Smoking | 7 (44 %) | 1 (4 %) | 4(15 %) | 0.004 |
| CVA | 2(13%) | 2(8 %) | 1(4%) | 0.5 |
| Old IHD | 2 (13 %) | 7(27 %) | 7 (26 %) | 0.5 |
| AWMI | 4 (25%) | 14 (54 %) | 17 (63 %) | 0.03 |
| Non-AWMI | 11 (69 %) | 12(46%) | 9(330 %) | 0.03 |
| LM disease | 1(6 %) | 1 (30 %) | 2 (7 %) | 0.2 |
| MVD | 3(19 %) | 2 (8 %) | 7 (26 %) | 0.1 |
| Tirofiban use | 0(0%) | 6 (23 %) | 5 (19 %) | 0.03 |
| Hemoglobin on discharge | 14.4 ± 1.7 | 12.3± 2 | 12.3±1.8 | 0.002 |
| Triglycerides | 90.5 ± 56.8 | 88.2 ± 25.4 | 98.3 ±4.6 | 0.04 |
| LV thrombus | 0(0%) | 1(4 %) | 5 (18 %) | 0.04 |
| LVEF | 44.8 ± 9.9 | 34.5 ± 10.9 | 36.7 ± 10.9 | 0.02 |
| In-hospital death | 1(6 %) | 1 (4 %) | 1 (4 %) | 0.9 |

***BMI: Body Mass Index; DM: Diabetes Mellitus; HTN: Hypertension; CVA: Cerebro- Vascular Accidents; IHD: Ischemic Heart Disease; AWMI: Anterior wall MI; IWMI: Inferior wall MI; MVD: Multivessel disease***

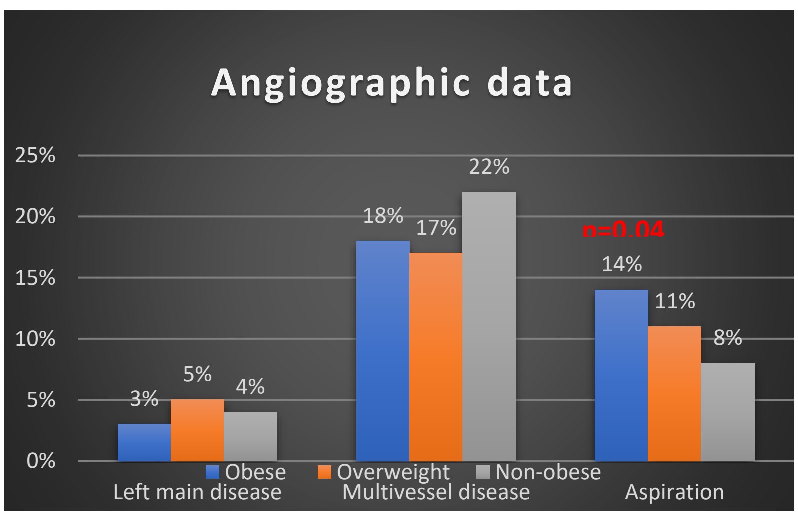


**Figure I:** ***Comparison of angiographic data of the three groups ≥60 years old***

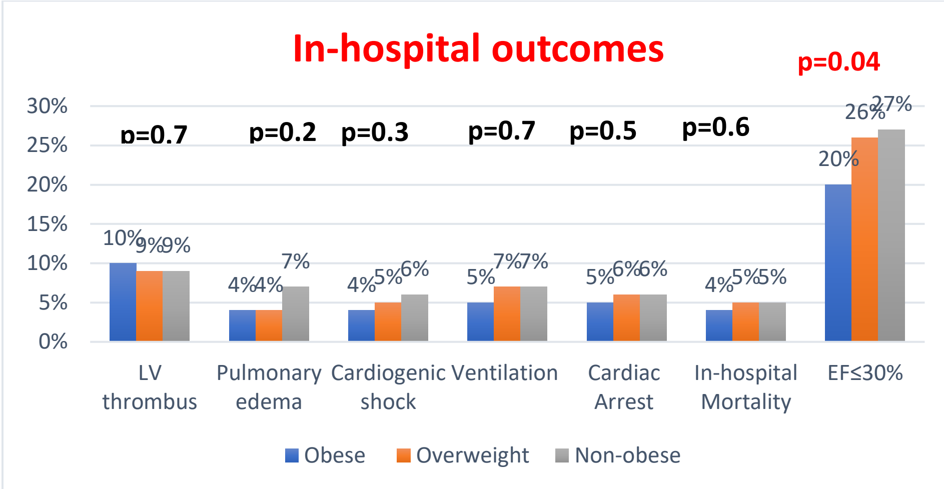


**Figure II:** ***Comparison in-hospital outcomes and mortality between the three groups ≥60 years old***

## DISCUSSION

Age is a well-known non-modifiable risk factor and a potent predictor of mortality from AMI. Although the association of both old age and obesity on early outcomes post-primary PCI was not well studied.

The study's key findings:

Protective effects of obesity (obesity paradox) were represented in our study as obese elderly patients had significantly higher post-primary PCI left ventricular function in short-term follow-up and numerically lower mortality although it was not significantly different among the three groups. (16) Similarly, Haridasan et al stated that obese groups had better LVEF and they also were more likely to be men with a higher incidence of hypertension, diabetes, and hyperlipidemia. (17). However, there were no pronounced differences between the three groups regarding post-primary PCI complications, which agreed with Camprubi et al (18), and also reflects the equal provided high care services to all patients in our centre.

Despite the obesity-associated additional CVD risk, several studies and large meta-analyses have defined an 'obesity paradox,' as that overweight and obese cardiac patients might have a better prognosis than non-obese with the same disease. (19-20)

Numerous studies including this study concluded that obese patients have a lower rate of in-hospital mortality than non-obese patients post-primary PCI but BMI itself does not predict in-hospital death. (21-24) Unlike these authors [18,25], we did not find that BMI is a predictor of mortality in this age group because these studies mainly concentrated on low body weight.

Nevertheless, the in-hospital stay was higher among obese patients as agreed by Kim et all who analyzed 2,489 AMI patients aged ≥80 years from the Korea Myocardial Infarction (KAMIR/KorMI) registries. (26) This represents more burden on hospitals and health system resources, highlighting obesity as a modifiable risk factor that, if well managed, will help in better use of medical system financial and clinical assets, especially in the elderly.

Clinical findings:

The present study provides a rough estimation of the prevalence of obesity among the elderly who underwent primary PCI. Obese elderly patients represented about 26% of the study population with more prevalence of male gender, DM, HTN, and dyslipidemia as risk factors for coronary artery disease. (27-32)

Obese elderly showed a higher prevalence of coronary thrombus (14%)which necessitates thrombus aspiration. This result could be attributed to higher susceptibility for thrombus formation in obese patients which might be explained with a theory; as plasminogen activator inhibitor-1 is a known biochemical marker of obesity that works for inhibition of endogenous fibrinolysis. (33) Bakirci et al stated that BMI and waist circumference were found to be significantly higher in patients with coronary thrombus. (34) Furthermore another study documented that all coronary artery thrombus patient's variables were positively associated with BMI, which indicates an increased possibility of thrombin formation. (35)

Although the obesity paradox was declared in multiple studies as a more favourable prognosis for leaner patients than in overweight and obese patients with CVD, still we should highlight that fitness is more vital than fatness for prognosis prediction, especially in older populations. (36-37) The struggle should be directed to increase muscle mass and power, physical activity, aerobic exercise, and resistance training with weight reduction in the same way to reduce CVD in old-age patients.

Finally, our study to our knowledge is the first study in Saudi Arabia aimed to focus on obesity in the elderly who underwent primary PCI. The power of this study is also due to our centre's unique situation as the only tertiary centre in Makkah which gives us a chance to study different ethnic groups and pilgrims in this special age group.

## CONCLUSION

obesity paradox is still significantly appearing in the elderly. Although BMI is not a predictor of mortality in this age group obesity increases the in-hospital stay with an increasing burden on the health system. The special subgroup of extremely elderly patients showed more prevalence of smoking but a lower incidence of AWMI, left ventricular dysfunction and intracoronary thrombus and bleeding.

## LIMITATIONS

--The clinical evaluation of obesity has many limitations, and an alternative might be the combined use of other anthropometric measurements such as waist circumference, which was not studied in our sample. Also reviewing abdominal obesity could play a precious role in enlightening obesity effects on the elderly.

--Functional activity, muscle mass, frailty score, and social and mental status of the elderly also are factors that should be on mind during studying the prognosis and mortality of this age group concerning any disease, especially coronary artery disease. Nevertheless, cardiorespiratory fitness should be the focus of the prognostic relationship of weight in CAD.

-- It is still unclear if lower BMI affects mortality of old or extremely old post-primary PCI or not so further studies are needed.

--Influences of obesity on mortality about time post-myocardial infarction with special consideration to weight changes should be in focus for the next studies.

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The authors declare no conflict of interest

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