Original Article

Association of Body Mass Index with In-Hospital Left Ventricular Failure after Percutaneous Coronary Interventions

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Abstract:

***Background*: Obesity is an independent cardiovascular risk factor. The most common anthropometric measurement used to quantify obesity is body mass index (BMI). Percutaneous coronary intervention (PCI) is associated with various types of complications. The relationship between BMI and in-hospital complications particularly left ventricular failure (LVF) after PCI has not been thoroughly investigated, especially in Bangladesh.**

***Methods:* This cross sectional observational study was conducted at National Institute of Cardiovascular Diseases, on total 100 patients who underwent PCI with two equally divided groups on the basis of BMI of Asian ethnicity: Group I (BMI < 23 kg/m2) and Group II (BMI e" 23.0 kg/m2). In-hospital LVF after PCI were observed and recorded.**

***Results*: The mean BMI of study population was 23.9 ± 1.9 kg/m^2. The sum of occurrence of adverse in-hospital outcomes was 14.0%. Complications were significantly (p < 0.01) higher in Group I than Group II. Among all adverse in-hospital outcomes, only acute left ventricular failure was found to be statistically significant between groups (p < 0.01). The difference of mean duration of hospital stay after PCI was higher in Group-I which was statistically significant (p < 0.01). Diabetes mellitus and dyslipidemia were found to be the independent predictors for developing adverse in-hospital outcome (OR= 1.68 and 1.46; 95% CI = 1.25 – 2.24 and 1.16 – 1.83; p = 0.018 and 0.040, respectively). BMI was inversely associated with in-hospital outcomes after PCI (OR = 0.95; 95% CI = 0.91 – 0.98; p = 0.007).**

Conclusion: BMI is inversely associated with in-hospital LVF after PCI. The underweight and normal weight people are at greater risk to experience in-hospital LVF than overweight and obese people following PCI.

Key words: Obesity, Body Mass Index, Left Ventricular Dysfunction, Percutaneous Coronary Intervention.

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Introduction:

Ischemic heart disease (IHD) is a major and increasing health care issue in Bangladesh.[1] Only a limited number of small-scale epidemiological studies are available. IHD prevalence was between 2.7% and 3.4% in two studies with a rural sample and 19.6% with an urban sample of working professionals.[2] Despite marked disparity in values, there seems to be a rising prevalence of coronary artery disease (CAD) in Bangladesh.[3] Globally, 30% of all deaths can be attributed to cardiovascular disease, of which more than half are caused by CHD.[4]

With the combination of sophisticated equipment, experienced operators, and modern drug therapy, coronary angioplasty has evolved into an effective nonsurgical modality for treating patients with CAD.[1,5]The number of PCIs is expected to grow modestly (1% to 5%) over the next decade as a result of the aging population and an increased frequency of diabetes and obesity.[6]

Institute for Health Metrics and Evaluation at University of Washington reported 17% of adults of Bangladesh as overweight or obese.[7]Overweight and obesity are established risk factors for major debilitating chronic diseases including hypertension, type II diabetes mellitus, dyslipidemia, stroke, and CAD.[8–11] There are limited data, however, on the relationship of body mass index (BMI) as a prognostic risk factor for outcomes following revascularization procedures such as PCI.[12] A number of studies have shown that lean patients (<20 kg/m^2) and those with normal BMI (20–24.9 kg/m^2) are at a higher risk for adverse in-hospital outcomes and post-PCI complications than overweight (25–29.9 kg/m^2) and obese (≥30 kg/m^2) patients.[12–14]. This unexpected phenomenon was explained by "obesity paradox".[12]

Methods

In the Department of Cardiology, National Institute of Cardiovascular Diseases and Hospital, Dhaka, this cross sectional observational study was conducted during the period from November 2015 to October 2016. By purposive sampling technique total 100 patients who underwent PCI in NICVD during this period were selected. Study subjects were divided on the basis of their BMI in accordance with Asian ethnicity into two equal groups each containing 50 patients: Group I (BMI < 23 kg/m^2) and Group II (BMI ≥23.0 kg/m-^{2}). Patients with chronic kidney diseases, chronic liver disease, chronic obstructive pulmonary disease, valvular heart disease, congenital heart disease, cardiomyopathy, previous history of revascularization (PCI or CABG) were excluded from the study. Patients undergoing primary PCI, transradial interventions were not included, also. No ethical violation was made in conducting the study.

After having matched the inclusion and exclusion criteria the patients were selected for this study. Weight and height were measured and recorded in all participants by a standard medical scale and stadiometer, respectively. Self-reported weight or height was not accepted. BMI was calculated, categorized and recorded accordingly. PCI was done by transfemoral approach. Following PCI patients were monitored at Coronary Care Unit for at least 24 hours. Post-PCI development of in-hospital left ventricular failure along with common adverse outcomes were observed and recorded, i.e., bleeding, stroke, vascular access site complications, post-PCI ischemic chest pain, myocardial infarction with PCI, significant arrhythmia, acute stent thrombosis, repeat revascularization, contrast induced nephropathy, cardiogenic shock, cardiovascular death.

To adjust for the potential confounders in predicting the association between BMI and in-hospital outcomes, logistic regression analysis was performed. Univariate logistic regression analysis was performed to specify the odds ratio (OR) for overall adverse in-hospital outcomes. Multivariate logistic regression analysis was then performed by using SPSS 23.0 to investigate independent predictors for adverse in-hospital outcomes. Variables yielding p values ≤0.05 in univariate analysis were selected for multivariate model. Statistical significance was assumed if $p \leq 0.05$ throughout the study.

Results:

Out of 100 studied patients 84% were male and 16% were female. Male to female ratio was 4.5:1. No significant association (p>0.05) was found between the groups in terms of sex distribution. The mean age of the patients was 51.1 ± 9.57 years and the mean age difference between two groups was not statistically significant (p>0.05). In both of the groups the highest percentages of patients were in the age range of 41-50 years (Table-I).

Table II shows that among the different risk factors dyslipidemia, hypertension and diabetes mellitus were significantly more in group II (<0.05). The other risk factors i.e., smoking and family history of CAD were not significantly different between the groups (p >0.05).

The difference of means of height was insignificant (p>0.05) across the groups. But that of weight was found to be significant (p=0.001). BMI was significantly (p=0.001) higher in group II than group I. The breakdown of total patient would be 81 in Group I and 19 in Group II with statistically significant difference

($p = 0.001$) of mean BMI across the group had their conventional non-Asian BMI cut-off value be used (Table III).

The difference of means of height between the two sex groups was significant (p=0.001). The difference of means of weight across these groups was also significant (p<0.01). BMI was higher in female patients than in male but the difference between them was not statistically significant in any group (p>0.05) (Table IV).

Table V compares the distribution of clinical presentations between the groups. The percentage of STEMI was the highest in both groups. No statistically significant difference was noted between the two groups ($p > 0.05$).

Table - I

Comparison of the study groups by their demographic characteristics (N = 100).

Age in years	BMI				Total (N =100)		*p*-value
	Group I (n = 50)		Group II (n = 50)				
	Number	%	Number	%	Number	%	
d" 40	4	8.0	5	10.0	9	9.0	[a]0.11[NS]
41-50	23	46.0	25	50.0	48	48.0	
51-60	17	34.0	14	28.0	31	31.0	
> 60	6	12.0	6	12.0	12	12.0	
Mean ± SD	51.2 ± 11.4		50.9 ± 9.1		51.1 ± 9.57		[b]0.91[NS]
Sex							
Male	43	86.0	41	82.0	84	84.0	[a]0.92[NS]
Female	7	14.0	9	18.0	16	16.0	

Group I = Patients with BMI <23 kg/m^2
Group II = Patients with BMI ≥ 23 kg/m^2
NS= Not Significant (p>0.05)
[a]p-value reached from chi-square test and Fisher exact test
[b]p-value reached from unpaired t-test

Table-II

Comparison of the study groups according to their risk factors (N = 100)

Risk factors	BMI				Total (N =100)		*p*-value
	Group I (n = 50)		Group II (n = 50)				
	Number	%	Number	%	Number	%	
Smoking	20	40.0	24	48.0	44	44.0	0.587[NS]
DM	9	18.0	21	42.0	30	30.0	0.038[S]
Hypertension	11	22.0	23	46.0	34	34.0	0.048[S]
Dyslipidemia	7	14.0	20	40.0	27	27.0	0.022[S]
Family history of CAD	14	28.0	14	28.0	28	28.0	0.931[NS]

Group I = Patients with BMI < 23 kg/m^2
Group II = Patients with BMI ≥23 kg/m^2
DM = Diabetes mellitus
CAD = Coronary Artery Disease
S = Significant ($p < 0.05$)
NS = Not Significant ($p > 0.05$)
p-value reached from chi-square test

Table-III

Comparison of the study groups by their height, weight and BMI (N=100).

Parameters	BMI		Total(N =100)	*p*- value
	Group I (n = 50) Mean ± SD	Group II (n = 50) Mean ± SD	Mean ± SD	
Height(in meter)	1.61 ± 0.07	1.63 ± 0.06	1.62 ± 0.06	0.26^{NS}
Weight(in kilogram)	55.5 ± 5.5	65.7 ± 5.9	63.4 ± 7.2	0.001^{S}
BMI cutoff value 23 kg/m^2	21.3 ± 1.4	24.7 ± 1.4	23.9 ± 1.9	0.001^{S}
	*Group I (n=81)	*Group II (n= 19)		
BMI cutoff value 25 kg/m^2	23.3 ± 1.5	26.7 ± 1.3	23.9 ± 1.9	0.001^{S}

Group I = Patients with BMI <23 kg/m^2
Group II = Patients with BMI ≥23 kg/m^2
* = Had non-Asian BMI category been used in this study
S= Significant (*p*<0.05)
NS= Not Significant (*p*>0.05)
p-value reached from unpaired t-test

Table-IV

Comparison of height, weight and BMI within each study groups by sex of the patients (N = 100).

Study group	Male (n= 84)		Female (n= 16)		Mean±SD(N =100)	*p*-value
	Number	Mean ± SD	Number	Mean ± SD		
Height in meter	84	1.64 ± 0.04	16	1.51 ± 0.06	1.62 ± 0.06	0.001^{S}
Weight in kilogram	84	64.5 ± 6.3	16	56.4 ± 8.6	63.4 ± 7.2	0.006^{S}
Group I(n = 50)	43	21.2 ± 1.4	7	21.9 ± 0.8		0.436^{NS}
Group II(n = 50)	41	24.6 ± 1.3	9	25.3 ± 1.9		0.169^{NS}
	84	23.9 ± 1.9	16	24.5 ± 2.3	23.9 ± 1.9	0.294^{NS}

Group I = Patients with BMI <23 kg/m^2, Group II = Patients with BMI ≥23 kg/m^2.
S= Significant (*p*<0.05)
NS= Not Significant (*p*>0.05)
p-value reached from unpaired t-test

Table - V

Comparison of the study population by clinical presentations (N = 100)

Diagnosis	BMI				Total (N =100)		*p*-value
	Group I (n = 50)		Group II (n = 50)				
	Number	%	Number	%	Number	%	
CSA	6	12.0	5	10.0	11	11.0	0.27^{NS}
UA	6	12.0	7	14.0	13	13.0	
NSTEMI	9	18.0	11	22.0	20	20.0	
STEMI	29	58.0	27	54.0	56	56.0	

Group I = Patients with BMI < 23 kg/m^2
Group II = Patients with BMI ≥ 23 kg/m^2
CSA = Chronic Stable Angina
UA = Unstable Angina
NSTEMI = Non-ST-segment Elevation Myocardial Infarction
STEMI = ST-segment Elevation Myocardial Infarction
NS = Not Significant (*p* > 0.05)
p-value reached from chi-square test

Table VI shows that the baseline LV function measured by echocardiography between the two study groups was not statistically significant (p > 0.05). The difference of mean LVEF was also insignificant statistically (p > 0.05) between the groups. Post-PCI echocardiography to assess LV function was not done routinely.

Table VII compares the involvement of vessels between the groups. There was no statistical significance of difference between the two groups ($p > 0.05$).

Table VIII compares the types of stent used between the groups. DES outnumbers BMS in each groups. No significant difference was found between the groups ($p > 0.05$).

The adverse in-hospital outcomes were significantly ($p<0.01$) higher in Group I than Group II. Among all adverse in-hospital outcomes, only acute LVF was found to be statistically significant between the two study groups ($p< 0.01$) (Table IX).

Smoking and family history of CAD were not included in multivariate model as univariate analysis yielded them as statistically insignificant in the current study (OR = 1.29 and 1.10; 95% CI = 0.82– 1.78 and 0.46 – 1.75; p=0.273 and 0.087, respectively). Hypertension and left ventricular ejection fraction (LVEF) that were significant (OR = 1.51 and 1.53;95% CI = 1.05 – 2.10 and 1.32 – 1.78; p=0.026 and 0.049, respectively) in univariate analysis were found to be insignificant (OR = 1.36 and 1.15; 95% CI = 0.92 – 1.95 and 0.98 – 1.35; p=0.114 and 0.087, respectively) in multivariate regression analysis. Diabetes mellitus and dyslipidemia were found to be the independent predictors for developing adverse in-hospital outcome after PCIs (OR= 1.68 and 1.46; 95% CI = 1.25 – 2.24 and 1.16 – 1.83; p=0.018 and 0.040, respectively). BMI was inversely associated with adverse in-hospital outcome after adjustment by multivariate logistic regression analysis (OR = 0.95; 95%CI = 0.91–0.98; p=0.007) (Table X).

Table - VI

Comparison of the study groups according to their LVEF (N = 100)

LVEF	BMI				Total		*p*-value
	Group I (n = 50)		Group II (n = 50)		(N =100)		
	Number	%	Number	%	Number	%	
<50	23	46.0	29	58.0	52	52.0	[a]0.79[NS]
>50	27	54.0	31	62.0	58	58.0	
Mean ± SD	53.4 ± 8.2		52.1 ± 8.1		53.3 ± 8.1		[b]0.69[NS]

Group I = Patients with BMI < 23 kg/m^2
Group II = Patients with BMI ≥23 kg/m^2
LVEF = Left Ventricular Ejection Fraction
NS = Not Significant ($p > 0.05$)
[a]*p*-value reached from chi-square test
[b]*p*-value reached from unpaired t-test

Table-VII

Comparison of the study groups by involvement of vessels (N = 100)

Vessels involved	BMI				Total		*p*-value
	Group I (n = 50)		Group II (n = 50)		(N =100)		
	Number	%	Number	%	Number	%	
LAD	16	32.0	12	24.0	28	28.0	0.07[NS]
RCA	19	38.0	21	42.0	40	40.0	
LCX	7	14.0	10	20.0	17	17.0	
LAD & RCA	5	10.0	6	12.0	11	11.0	
RCA & LCX	1	2.0	0	0.0	1	1.0	
LAD & LCX	2	4.0	1	2.0	3	3.0	

Group I = Patients with BMI < 23 kg/m^2
Group II = Patients with BMI ≥ 23 kg/m^2
LAD = Left Anterior Descending Artery
RCA = Right Coronary Artery
LCX = Left Circumflex Artery
NS = Not Significant ($p > 0.05$)
p-value reached from chi-square test and Fisher exact test

Table-VIII

Comparison of the study groups according to the types of stent used (N = 100)

Types of stent used	BMI				Total (N =100)		*p*-value
	Group I (n = 50)		Group II (n = 50)				
	Number	%	Number	%	Number	%	
DES	27	54.0	29	58.0	56	56.0	0.07^{NS}
BMS	16	32.0	15	30.0	31	31.0	
DES & BMS	7	14.0	6	12.0	13	13.0	

Group I = Patients with BMI < 23 kg/m^2
Group II = Patients with BMI ≥23 kg/m^2
DES = Drug Eluting Stent
BMS = Bare Metal Stent
NS = Not Significant (*p* > 0.05)
p-value reached from chi-square test

Table - IX

Comparison of the study groups by in-hospital outcomes after PCI (N=100).

Types of stent used	BMI				Total (N =100)		*p*-value
	Group I (n = 50)		Group II (n = 50)				
	Number	%	Number	%	Number	%	
Adverse outcomes	11	22.0	3	6.0	14	14.0	0.006^{S}
Chest pain	2	4.0	1	2.0	3	3.0	0.630^{NS}
Arrhythmia	2	4.0	0	0.0	2	2.0	0.058^{NS}
Access site complications	1	2.0	1	2.0	2	2.0	0.630^{NS}
Acute LVF	4	8.0	0	0.0	4	4.0	0.007^{S}
Shock	2	4.0	0	0.0	2	2.0	0.058^{NS}
Death	0	0.0	1	2.0	1	1.0	0.594^{NS}

Group I = Patients with BMI < 23 kg/m^2
Group II = Patients with BMI ≥23 kg/m^2
S = Significant (*p* <0.05)
NS = Not Significant (*p* > 0.05)
p-value reached from chi-square test and Fisher exact test

Table - X

Univariate and multivariate logistic regression analyses of variables associated with adverse in-hospital outcomes.

Variables of interest	Univariate analysis		*p*- value	Multivariate analysis		*p*- value
	OR	95% CI of OR		OR	95% CI of OR	
Smoking	1.29	0.82 - 1.78	0.273			
Hypertension	1.51	1.05–2.10	0.026	1.36	0.92 – 1.95	0.114
Diabetes	1.97	1.61 – 2.41	0.011	1.68	1.25 – 2.24	0.018
Dyslipidemia	1.54	1.11 – 1.72	0.034	1.46	1.16 – 1.83	0.040
Family history	1.10	0.46 – 1.75	0.087			
LVEF	1.53	1.32 – 1.78	0.049	1.15	0.98 – 1.35	0.087
BMI	0.89	0.87 – 0.92	0.004	0.95	0.91 – 0.98	0.007

Discussions:

Obesity measured on the basis of BMI is an independent cardiovascular risk factor. A number of studies have shown that the lean patients and those with normal BMI are at a higher risk for adverse in-hospital outcomes and post-PCI complications than overweight and obese patients. This is contrary to the common clinical perception that overweight and obese patients would be at a higher risk of adverse outcomes following PCI. To date, there is not a complete understanding of this complex effect.

The age distribution of the studied patients was very close to the other relevant studies.[15,16] The sex distribution of this study population is not comparable to the overall population of Bangladesh because there were fewer females in this study. In Bangladesh, almost all of the studies reported an overwhelming majority of male patients.[17–19] Females were found to be more obese than male in the current study as well as in the other studies.[20-21] In comparison with Europeans, the mean stature of Bangladeshi counterparts is 1.3 cm to 11.8 cm shorter.[22] BMI tends to be higher among shorter adults, especially women.[23]

In-hospital adverse outcomes after PCI was significantly higher in Group I. Compared with normal-weight individuals, overweight and obese patients had lower in-hospital adverse outcomes after PCI.[24] Among all the adverse in-hospital outcomes, only LVF was found to be significantly more in Group-I. A study on 1,203 individuals with class IV heart failure found that higher BMI was associated with better survival, and multivariate analysis showed an inverse association between BMI and mortality.[25] BMI was inversely associated with post-PCI adverse in-hospital outcome after adjustment by multivariate logistic regression analysis in this study. Gruberg et al.[12] noticed that very lean patients (BMI <18.5) and those with normal BMI are at the highest risk for in-hospital complications and cardiac death. Patients at the extremes of BMI (<18.5 and >40kg/m^2) were also at increased risk of adverse outcomes after PCI.[26] Park et al. found that low BMI was associated with increased risks of adverse in-hospital outcomes and death.[27] They also found no excess risks of these events to be associated with a high BMI. A Japanese real-world multicenter registry analysis reported that lean patients, rather than obese patients were at greater risk for in-hospital complications during and after PCI.[27] Although obesity via its negative impact on systolic and diastolic function predisposes to overt heart failure, clinical evidence suggests that overweight/obese patients with heart failure paradoxically seem to have a better clinical prognosis than do their lean counterparts with clinical heart failure. In essence, obesity is a risk factor for developing heart failure, but after the onset of heart failure, obesity is a positive predictor for survival. The existence of this obesity paradox has led physicians to question whether obesity should be treated when associated with heart failure.[25]

Conclusion:

BMI was inversely associated with in-hospital left ventricular failure after PCI in this study. The underweight and normal weight people were at greater risk to experience in-hospital adverse outcomes than overweight and obese people following PCI. Though obesity is a recognized risk factor for cardiovascular diseases, once cardiovascular disease is developed, this obesity seems to play protective roles and provide some benefits. This 'Obesity Paradox' leads us to reshuffle and reorganize our plans whether we should take aggressive attempts or schemes to lose weight of an obese patient once he or she develops coronary artery disease. Verily it calls for more research and observations.

Limitations of the study

There are some facts to be considered which might have affected the result of the current study.

- The study population was heterogeneous, including patients with different severities of CAD, ranging from chronic stable angina to myocardial infarction.
- The complexity of the lesions, procedural complications, use of anticoagulants and antiplatelets were not recorded which might have affected the incidence of complications in each of the BMI groups.

Conflict of interest- None.

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