DOI: https://doi.org/10.3329/cardio.v13i1.50560

Original Article

Impact of Body Mass Index on In-Hospital Length of Stay after Percutaneous Coronary Interventions

Mohammad Khalilur Rahman Siddiqui[1], Md. Mizanur Rahman[1], Borhanuddin Ahmed[1], Abdul Latif Molla[1], Md. Iftekhar Uddin[1], Md. Belal Hossain[1], Pranob Karmaker[2], Mohammad Morshedul Ahsan[3]

[1]Department of Cardiology, Cumilla Medical College, Cumilla, [2]Department of Cardiology, National Institute of Cardiovascular Diseases, Dhaka, [3]Department of Cardiology, Shaheed Ziaur Rahman Medical College, Bogura

Key words:
Body mass index, Length of hospital stay, Percutaneous coronary interventions

Abstract:

Background: *In-hospital length of stay (LOS) is an important metric for assessing the quality of care and planning capacity within a hospital. Percutaneous Coronary Interventions (PCI) merit short LOS following an uncomplicated procedure. Various factors have been studied that may influence LOS. The relationship between BMI and LOS 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 outcomes and LOS were observed and recorded after PCI.*

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 LOS 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 adverse in-hospital outcome after PCI (OR = 0.95; 95% CI = 0.91 – 0.98; p = 0.007).*

Conclusion: *BMI is inversely associated with adverse in-hospital outcome after PCI. The underweight people are likely to experience longer LOS following PCI.*

(Cardiovasc. j. 2020; 13(1): 19-26)

Introduction:

Length of hospital stay (LOS) is an important indicator of the use of medical services that is used to assess the efficiency of hospital management, patient quality of care, and functional evaluation. Decreased LOS has been associated with decreased risks of opportunistic infections and side effects of medication, and with improvements in treatment outcome and lower mortality rates. Furthermore, shorter hospital stays reduce the burden of medical fees and increase the bed turnover rate, which in turn increases the profit margin of hospitals, while lowering the overall social costs.[1,2]

Overweight and obesity are established risk factors for major debilitating chronic diseases including hypertension, type II diabetes mellitus, dyslipidemia, stroke, and CAD.[3–6] There are limited data, however, on the relationship of body mass index (BMI) as a prognostic risk factor for outcomes following revascularization procedures

Address of Correspondence: Dr. Mohammad Khalilur Rahman Siddiqui, Department of Cardiology, Cumilla Medical College, Cumilla, Bangladesh. Email: drmkrs@gmail.com

such as PCI.[7] 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.[7–9].

A good number of factors such as age, sex, marital status, place of residence, socioeconomic status, the month, day and time of patient admission, patients' physical and functional status, patients' status at discharge time, hospitalizing physician's academic degree, types and severity of illnesses, malignancy, complications, hospital infections, and delay in laboratory exams and in surgical interventions, education status and increased severity of illness have been shown to affect the average LOS in the hospital. Different aspects, variables, impacts and implications of LOS have been studied worldwide with none of this kind so far in our country. The present study was conducted on 100 patients in the National Institute of Cardiovascular Diseases (NICVD), Dhaka to ascertain BMI and its impacts on various in-hospital outcomes after percutaneous coronary interventions (PCI); especially, how BMI is associated with post-PCI prolonged or reduced LOS.[10]

Methods:

This cross-sectional observational study was conducted at the Department of Cardiology, National Institute of Cardiovascular Diseases and Hospital, Dhaka, 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.

Patients were selected after having matched the inclusion and exclusion criteria. Date and time of interventions and discharging the patients were recorded for calculating LOS. 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. The following in-hospital outcomes were observed and recorded after PCI: bleeding, stroke, vascular access site complications, post-PCI ischemic chest pain, myocardial infarction with PCI, significant arrhythmia, acute stent thrombosis, repeat revascularization, acute heart failure, contrast induced nephropathy, cardiogenic shock, cardiovascular death.

Logistic regression analysis was performed to adjust for the potential confounders in predicting the association between BMI and in-hospital outcomes. 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 ≤0.05in univariate analysis were selected for multivariate model. Statistical significance was assumed if p ≤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).

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 IX).

Table-I

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

Age in years	BMI				Total		*p*-value
	Group I (n = 50)		Group II (n = 50)		(N =100)		
	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-squared (χ^2) 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		*p*-value
	Group I (n = 50)		Group II (n = 50)		(N =100)		
	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-squared (χ^2) test

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).

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)	Group II (n = 50)		
	Mean ± SD	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

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 been used (Table III).

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	*p*-value
	Number	Mean ± SD	Number	Mean ± SD	(N =100)	
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

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

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-squared (χ^2) test

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-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-squared (χ^2) test
^{b}*p*-value reached from unpaired t-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

Comparison of the study groups by length of hospital stay after PCI (N = 100)

Length of stay	BMI				Total		p- value
	Group I (n=50)		Group II (n=50)		(N = 100)		
	Number	%	Number	%	Number	%	
< 72 hours	27	54.0	36	72.0	63	63.0	$^{a}0.036^{S}$
72 - 96 hours	11	22.0	12	24.0	23	23.0	
> 96 hours	12	24.0	2	4.0	14	14.0	
Mean ± SD	70.9 ± 34.3		56.0 ± 16.7		59.3 ± 22.5		$^{b}0.005^{S}$

Group I = Patients with BMI < 23 kg/m^2
Group II = Patients with BMI ≥23 kg/m^2
S = Significant ($p < 0.05$)
^{a}*p*-value reached from chi-squared (χ^2) test and Fisher exact test
^{b}*p*-value reached from unpaired t-test

Table VII shows that the difference of mean length of hospital stay was statistically significant ($p < 0.01$). The difference of frequency distributions of the patients in this two study groups according to hospital stay time was also significant ($p < 0.05$).

Table - VIII

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

	BMI				Total		p- value
	Group I (n=50)		Group II (n=50)		(N = 100)		
	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-squared (χ^2) test and Fisher exact test

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 VIII).

Table-IX

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:

Percutaneous coronary intervention (PCI) is the most common method of coronary revascularization. Over time, as operator skills and technical advances have improved procedural outcomes, the length of stay (LOS) has decreased. However, standardization in the definition of LOS following PCI has been challenging due to significant physician, procedural, and patient variables.[11] Length of hospital stay (LOS) is one of the important postprocedural outcomes. LOS in particular is an index of patient safety and is a driver of health care expenditure. LOS is likely to be influenced by both patient presenting features and procedural complications; therefore, it is logical to assess the performance of postprocedural risk classification models with respect to LOS.[12]

Underweight patients with cardiovascular disease have been relatively understudied, with attention generally focused on the obese people.[13,14] In the current study, the mean length of hospital stay (LOS) after PCI was significantly (p < 0.01) longer in lower BMI groups. In-hospital overall adverse outcomes after PCI were also significantly higher in this group. Compared with normal-weight individuals, overweight and obese patients had lower in-hospital adverse outcomes after PCI.[15] Compared with normal BMI patients, obese and overweight patients did not have longer LOS in different studies.[16] [12] In-hospital mortality was higher and length of hospital stay was longer in the normal BMI group despite similar procedural success.[17] A study ascertaining the association of BMI and LOS in ICD recipients found that both in unadjusted and multivariable adjusted analyses, underweight patients had an increased odds of a longer hospital stay, whether compared with normal weight patients or compared with everyone else in the cohort (OR, 1.61; 95% CI, 1.38 to 1.89; P<0.0001). Obese patients in both unadjusted and multivariable adjusted analyses had a similar odds of a hospital stay compared with normal weight patients.[18]

BMI was inversely associated with post-PCI adverse in-hospital outcome after adjustment by multivariate logistic regression analysis in this study. Gruberg et al. 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.[7] Patients at the extremes of BMI (<18.5 and >40kg/m^2) were also at increased risk of adverse outcomes after PCI.[19] 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.[20] It is relevant to cite that patients with an obese BMI are not at greater risk for morbidity or mortality after CABG, rather, underweight body mass index group have the greatest risk of mortality, prolonged ventilation, reoperation for bleeding, and renal failure. Length of hospital stay and intensive care unit stay after surgery are the longest for patients with an underweight BMI. [21]

Length of stay for underweight patients was more than double that of normal weight patients resulting in nearly 50% higher costs for underweight patients. Morbidly obese patients had a slightly longer length of stay and higher costs compared to normal weight patients ($p<0.01$).[22] Being underweight, and not overweight, has the higher mortality, cost, length of stay, and readmission rate for those undergoing cardiac catheterization, according to an analysis of more than one million patients presented at ESC Congress.[22] Despite a poor clinical profile, obese patients had fewer in-hospital groin bleeds, shorter length of hospital stay, and lower incidence of mortality in the hospital.[17]

Conclusion

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. Underweight patients are more likely to experience longer LOS. 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 viz. 'Obesity Paradox'. It calls for more investigations for better understanding and explanations which are essential to formulate strategy to deal with BMI and its various implications.

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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