Original Article

Association of Waist-Hip Ratio with Angiographic Severity of Coronary Artery Disease in Patients with Acute ST- Segment Elevation Myocardial Infarction

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Abstract

Objective: Coronary artery disease (CAD) is rising in South Asia and is taking a more malignant proportion in South Asians than in Caucasians. Having a similar socioeconomic and cultural background, the scenario is same in Bangladesh. Obesity, especially abdominal is concerned as an important and modifiable risk factor for CAD which is now also raising both in developed and under developed countries. Waist-Hip ratio (WHR) is considered as an important tool for assessing abdominal obesity. The aim of this study is to evaluate the association between WHR and the severity of CAD of acute ST-segment elevation myocardial infarction (STEMI) patients so that primary prevention, early detection and proper management strategy can be taken to reduce the disease burden, morbidity and mortality.

Methods: This cross sectional observational study was carried out among 105 patients with acute STEMI who received thrombolytic and underwent coronary angiography (CAG) at National Institute of Cardiovascular Diseases (NICVD), Dhaka from May, 2016 to November, 2016. They were divided into two groups, Group I (normal WHR) = 51 and group II (increased WHR) = 54, according to WHR level. Angiographic severity of coronary artery disease was assessed by vessel score and Genseni's score.

Results: Significant positive correlation was found between WHR and vessel score (r= 0.62, p=0.003). Moderate to severe CAD patients were significantly higher in increased WHR group than in normal WHR group (77.8% vs. 29.4%, p=<0.001). Significant positive correlation was also found between WHR and Genseni's score (r= 0.71, p=0.001). Logistic regression analysis showed that a patient with increased WHR had 2.75 times higher risk of having significant CAD compared with those with the normal WHR.

Conclusions: Increased WHR group had more significant coronary artery disease in terms of vessel score and Genseni's score and can be considered as a predictor of the severity of the CAD disease in acute STEMI patients.

Keywords: Myocardial infarction, Waist-Hip ratio, Coronary Angiography.

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Introduction:

CAD is a common and leading cause of death throughout the world.

In Bangladesh it is also an increasingly important medical and public health problem, and is the leading cause of mortality. National data on incidence and mortality of CAD are few in Bangladesh. More recent data indicates the CAD prevalence is 1.85% to 3.4% in rural population and it is 19.6% in an urban population[1]. Obesity has an association with cardiovascular disease (CVD), diabetes and is an important component of metabolic syndrome[2]. Central obesity is more strongly associated with CVD risk than general obesity[3].

The deposition of adipose tissue is associated with systemic inflammation which has a direct effect on CAD risk[3]. Visceral adipocytes have high lipolytic activity and produce free fatty acids and glycerol, which are drained by the portal vein into the liver, where they increase triglyceride and glucose production, decrease insulin clearance and may cause hepatic steatosis[4]. Moreover, visceral adipocytes differ from subcutenaeous adipocytes in their release of secrotory proteins potentially protective for diabetes and CAD (adiponectin, leptin,glycogen synthase and peroxisome proliferator activated receptor-gamma) show lower expression levels in visceral than subcutaneous tissue[5]. Currently used general and central obesity anthropometric measures for assessing adiposity related risk include body mass index (BMI), waist circumference (WC), hip circumference (HC), waist-hip ratio (WHR) and waist-height ratio (WHtR)[3]. BMI is often used to reflect total obesity, whereas the WC, WHR and WHtR are used as surrogates for intra abdominal adiposity[6]. BMI does not differentiate between fat and fat free mass so for is inadequate for identifying individuals at increased risk of CAD[3]. Waist and hip circumferences measures different aspects of body composition and fat distribution and have independent and often opposite effects of CVD risk factors[7]. The larger waist circumference may be associated with a higher risk of developing CVD or cardiovascular mortality. Interestingly, larger hip circumferences, suggesting peripheral fat deposition, have been associated with less severe CVD risk factors or a lower risk of incident CVD. Because of the opposing effects of waist and hip circumferences, the WHR has become a popular method of assessing atherogenic risk[8]. But the choice to use WC or WHR as an indices of abdominal obesity may depend on the setting, as in a physicians' office it is more feasible to measure WC, whereas in research studies, it appears to be more informative to measure WHR[9]. Based on a number of studies, it is clearly suggested that indices of abdominal obesity is more consistently and strongly predictive of coronary heart disease than BMI[10-13].

Computed tomography scan (CT scan) and Magnetic resonance imaging (MRI) are accurate for measuring body composition but they are too expensive to be performed for this alone[14]. Moreover, sonographically based obesity measurement are not superior to anthropometric indices in predicting the presence CAD[15]. Coronary angiography is undoubtedly the most sensitive and specific method available for assessing CAD. It also has the advantage that even minor atherosclerotic lesions at a subclinical stage can be detected and may become a target for preventive and therapeutic interventions[16]. Several studies also demonstrated that WHR had strong relation with angiographic severity CAD both in men and women[16-21].Methods

This cross sectional observational study was carried out among 105 patients with acute STEMI who received thrombolytic and underwent CAG at NICVD, Dhaka from May, 2016 to November, 2016. Acute STEMI patients who were not thrombolysed, not subjected to do CAG, with previous H/O percutaneous coronary intervention (PCI), coronary artery bypass grafting (CABG), systemic infection and non-cardiovascular diseases (like hepatic dysfunction, CKD, malignancy) and who had participated in weight-reducing programs (including diets) or received related medications were excluded from the study. Data collection was done after taking informed written consent from each patient or from legal guardian who fulfilled the criteria. They were divided into two groups, group I (normal WHR, Male < 0.90, Female < 0.80) = 51 and group II (increased WHR, Male >0.90, Female >0.80) = 54 according to inclusion and exclusion criteria.

Acute STEMI was diagnosed by third universal definition of Myocardial Infarction[22]. Demographic profile (age, sex, occupation and risk factors of myocardial infarction like diabetes, hypertension, dyslipidaemia, smoking, family history of CAD), drug history, pulse, BP and other vital parameters were recorded and routine laboratory investigations were done during admission. Base line investigations for CAG, height, weight, waist circumference and hip circumference were measured day before CAG. Height was measured while standing with four parts (heels, buttocks, back and head) touching the mechanical beam balance on the backing board heels together without shoes and head in Frankfurt plane wearing light clothing only. Weight was measured by a standard medical scale after removal of shoes and wearing light clothing only. Waist circumference was measured at the midpoint between the lower margin of the least palpable rib and the top of the iliac crest, using a stretch resistant tape at the end of a normal

expiration. Hip circumference was measured around the widest portion of the buttocks, with the tape parallel to the floor. World Health Organization (WHO) definition of central obesity (for Asians) as measured by WHR was used for defining the abdominal obesity[23]. CAG was done during same hospital stay. Angiographic severity of CAD was assessed by vessel score and Gensini's score. Gensini's score 36 points was regarded as cut-off value for CAD severity (Gensini's score < 36 points – absent or mild coronary atherosclerosis, Gensini's score > 36 points – medium to severe coronary atherosclerosis)[24].

Ethical clearance was taken from ethical review committee, NICVD, Dhaka. Data were analyzed by using statistical package for Continuous data was expressed as median or mean ± SD. Dichotomous data was expressed as percentage. Comparison of continuous variables was done by unpaired t-test, as appropriate. Categorical data was analyzed with Chi-square test. Fisher's exact test and ANOVA tests were used as applicable. The significance of the results as determined in 95% confidence interval and a value of P < 0.05 was considered to be statistically significant. Spearman's rank correlation coefficient test, Pearson's correlation coefficient test and logistic regression analysis were used as appropriate.

Results:

The mean age of the studied patients were 50.9±8.7 years ranging from 28 to 75 years. The mean age of group II was more than group I (52.37±9.64 vs. 47.80±9.83 years; p=0.11). Male patients were predominant in both groups. Male female ratio was 6:1. Among the risk factors hypertension, dyslipidaemia, diabetes mellitus were significantly higher in group II than group I (p=0.03, 0.001, 0.02). The mean WHR of group II and group I was 0.98±0.05 and 0.86±0.04 (0.99±0.034 and 0.88±0.008 was in male and 0.92±0.033and 0.78±0.007 was in female). Mean BMI of group II and group I was 26.17±1.75 (kg/m^2) and 24.02±1.97 (kg/m^2). Mean Waist circumference was found in group II and group I was 92.61±7.12 and 81.33±4.80 cm. The mean WHR was increased in proportion with the number of vessel involved from no vessel involvement to triple vessel involvement (0.86±0.005, 0.88±0.06, 0.94±0.05 and 0.99±0.07 respectively, p=<0.001). Significant positive correlation was found between WHR and vessel score (r= 0.62, p=0.003). Moderate to severe CAD patients were significantly higher in increased WHR group than in normal WHR group (77.8% vs. 29.4%, p=<0.001). The mean WHR in moderate to severe CAD was 0.96±0.07 and normal to mild CAD was 0.88±0.05 (p=<0.001). The mean Genseni's score was found 57.55±28.8 and 26.20±.13.96 in group II group and I. The difference of mean Genseni's score between two groups was statistically significant (p=<0.001). Significant positive correlation was also found between WHR and Genseni's score (r= 0.71, p=0.001). Logistic regression analysis showed that patient with increased WHR had 2.75 times higher risk of having significant CAD compared with those with the normal WHR.

Table - I

Demographic profile of study population (n=105)

	Group I (n= 51)	Group II (n=54)	p value
Age in years(Mean ±	49.5±8.9	52.2±8.3	0.11^{NS}
SD)	(28-70)	(35-75)	
(Range)			
Gender			
Male	43(84.3%)	47(87.0%)	0.69^{NS}
Female	8(15.7%)	7(13%)	
Risk factorsSmoking	29(56.9%)	34(63.0%)	0.52^{NS}
Hypertension	17(33.3%)	24(44.4%)	0.03^{S}
Diabetes mellitus	11(21.6%)	28(51.9%)	0.001^{S}
Dyslipidaemia	18(35.3%)	31(57.4%)	0.02^{S}
Family H/O of CAD	6(11.8%)	9(16.7%)	0.74^{NS}
Anthropometric status			
(Mean ± SD)	0.86±0.04	0.98±0.05	<0.001^{S}
Waist-hip ratio	0.88±0.008	0.99±0.034	<0.001^{S}
Male	0.78±0.007	0.92±0.033	<0.001^{S}
Female	24.02±1.97	26.17±1.75	<0.001^{S}
Body Mass Index (kg/m^2)	81.33±4.80	92.61±7.12	<0.001^{S}
Waist circumference (cm)			

SD – Standard deviation, NS - Not significant, S - significant

Table - II

Distribution of the study population according to vessel score (n=105)

Vessel Score	Group I (n=51)	Group II(n=54)	p value
Score – 0	5.9%(3)	0.0%(0)	0.07^{NS}
Score – 1	56.9%(29)	22.2%(12)	<0.001 ^{S}
Score – 2	31.4%(16)	50.0%(27)	0.04^{S}
Score – 3	5.9%(3)	27.8%(15)	0.003 ^{S}

Table - III

Association between WHR and number of vessels involvement (n=105)

No. of vessel involved	Waist-hip Ratio (WHR)		p value
	Mean	SD	
No vessel involvement (n=3)	0.86	0.005	
Single (n=41)	0.88	0.06	
Double (n=43)	0.94	0.05	<0.001 ^{S}
Triple (n=18)	0.99	0.07	

Table - IV

Distribution of the study population according to CAD severity by Genseni's score (n=105)

CAD severity by Genseni's score	Group I	Group II	p value
Moderate to severe (≥36 points)	29.4%(15)	77.8%(42)	<0.001 ^{S}
Normal to mild (<36 points)	70.6%(36)	22.2%(12)	
Mean ± SD	26.20±.13.96	57.55±28.82	<0.001 ^{S}

Table -V

Mean status of WHR of the study population according to significant coronary artery disease defined by Genseni's Score (n=105)

WHR	Moderate to severe CAD (n=57) (GS≥36)	Normal to mild CAD (n=48) (GS<36)	p value
Mean±SD	0.96±.07	0.88±0.05	<0.001^{S}

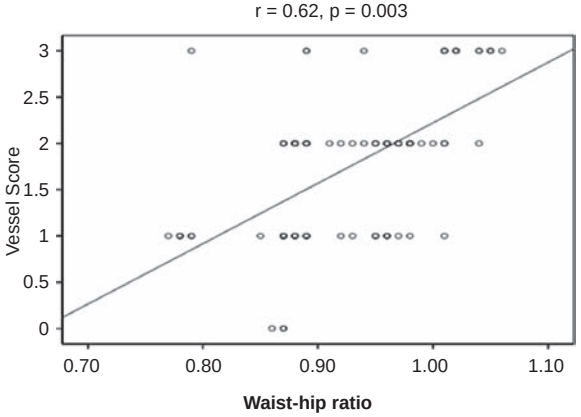

Fig.- 1: *Correlation between WHR and vessel score*

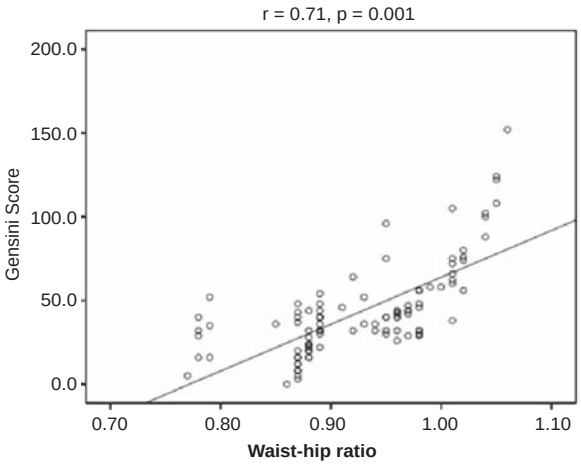

Fig.- 2: *Correlation between WHR and Genseni's score*

Table -VI

Multivariate logistic regression of determinants of significant CAD (by Genseni's Score).

Variables of interest	β	S.E.	p value	OR	95% CI
Age (>50yrs)	0.141	0.034	0.10^{NS}	1.17	0.109 -1.921
Smoking	0.099	0.017	0.49^{NS}	0.61	0.220 – 1.414
Diabetes mellitus	0.666	0.350	0.03^{S}	2.49	1.55 – 5.201
Hypertension	0.489	0.299	0.04^{S}	2.31	1.241 – 4.724
Dyslipidaemia	0.600	0.401	0.04^{S}	2.25	1.405 – 3.112
Increased WC	0.233	0.147	0.04^{S}	1.20	1.123 – 2.190
Increased BMI	0.458	0.239	0.03^{S}	1.47	1.099 – 3.912
Increased WHR	0.534	0.366	0.03^{S}	2.75	1.200 – 4.979

Dependent Variable: Genseni's Score;
Independent Variables: Age, smoking, diabetes mellitus, hypertension, dyslipidemia, increased WC, increased BMI, increased WHR
S.E.- Standard Error, OR- Odds Ratio. CI- Confidence Interval.

Discussion:

The age and sex distribution of the studied patients were very close to other relevant studies[25-27]. Majority of them were in the range of 41-50 and 51-60 years. The mean age of the studied patients was 50.9±8.7 years ranging from 28 to 75 years. The mean age of group II was more than group I (52.37±9.64 vs. 47.80±9.83 years) but the difference between two groups was not statistically significant (p=0.11). In group I, 43 (84.3%) patients were male and 8 (15.7%) patients were female. In group II, 47 (87%) patients were male and 7 (13%) were female. Male female ratio was 6:1 which indicates male patients were predominant in this study. No significant association (p=0.69) was found between the groups in terms of sex distribution. As females were given less attention and access for them to health care facilities was limited particularly in low socioeconomic population like our country may contribute this male predominance.

Among the study population, highest percentage had history of smoking (60%) followed by dyslipidaemia (46.7%), hypertension (39.0%), diabetes mellitus (37.1%) and family history of CAD (14.3%). It was found that hypertension, diabetes mellitus and dyslipidaemia were significantly higher in group II than group I (p=0.03, 0.001, 0.02). The rest of the risk factors had no significant association between study groups (p>0.05). Akanda, et al. [25] found most prevalent risk factors were smoking (60%) and dyslipidaemia (60%) followed by hypertension (35%) and diabetes mellitus (10%) in Bangladeshi population having CAD. Kumar, et al. [28] found 40.40% were diabetic, 45.72% were hypertensive and family history of CAD were present 14.54% in Indian population having AMI. These differences might be due to variation in the life style, degree of motivation and level of education.

The mean WHR was observed 0.98±0.05 and 0.86±0.04 in group II and group I respectively. In case of male and female of the studied patients in group I it was observed 0.88±0.008 and 0.78±0.007 and in group II it was 0.99±0.034 and 0.92±0.033. The differences between them were statistically significant (p<0.05). Mean BMI of group II was 26.17±1.75 (kg/m^2) and that of group I was 24.02±1.97 (kg/m^2). Mean WC of group II and group I was 92.61±7.12 cm and 81.33±4.80 cm.

Vessel score 1 was significantly higher (56.9% vs. 22.2%) in group I than group II (p=<0.001) where vessel score 2 and vessel score 3 were significantly higher in group II than in group I (50.0% vs. 31.4% and 27.8% vs. 5.9%; p=0.04, 0.003) respectively.

The mean WHR of subjects with angiographically normal, single, double and triple vessel disease were 0.86±0.005, 0.88±0.06, 0.94±0.05 and 0.99±0.07 respectively. It was increased in proportion with the number of vessel involved from no vessel involvement to triple vessel involvement and the differences were statistically significant (p=<0.001). Ahmad, Khan and Khan found that the WHR was abnormally increased in 65% of patients with CAD[2].

Moderate to severe CAD in terms of Genseni's score was significantly higher (77.8% vs 29.4%) in group II than in group I (p=<0.001). It was also found that the relative risk of CAD was approximately twice in the group with increased WHR than among normal WHR (RR= 3.06, CI=1.831 – 5.122, p=<0.001). It was almost similar to another study[2].

The mean Genseni's score was found 57.55±28.8 and 26.20±.13.96 in group II group and I respectively. The difference of mean Genseni's score between two groups was statistically significant (p=<0.001). Bakhoum, et al. [29] found that the mean Genseni's score was 85.1±38.5 vs. 60.4 ± 43.6 in patients with or without abdominal obesity in terms of WC respectively that indicated that Genseni's score was higher in abdominal obese than normal population.

The mean WHR was found 0.96±0.07 and 0.88±0.05 in moderate to severe and normal to mild CAD respectively and was statistically significant (p=<0.001). Similar finding was evaluated by Parsa and Jahanshahi[21].

Regarding correlation coefficient between WHR and the severity of CAD as assessed by Genseni's score, it was found that WHR(r=0.71) had the significant positive correlation. It was supported by another study[2].

Multivariate analysis revealed that diabetes mellitus, hypertension, dyslipidaemia, increased WC, increased BMI and increased WHR were found to be the significant predictors of severe CAD with ORs being 2.49, 2.31, 2.25, 1.20, 1.47 and 2.75 respectively. Thus the WHR was found to be more strong predictor of the severity of CAD. This result was comparable with the study of Parsa and Jahanshahi[21].

Conclusions:

Increased WHR was significantly associated with the angiographic severity of coronary artery disease in patients with acute STEMI. Significant positive correlation was observed between the vessel score and WHR. Similarly WHR levels were found to be higher in patients with high degree of angiographic stenosis in terms of Genseni's score. Logistic regression analysis showed that a patient with increased WHR had 2.75 times higher risk of having significant CAD compared with those with the normal WHR. So, abdominal obesity, as evidenced by increased WHR, may be considered as a predictor of the severity of CAD in patients with acute STEMI.

Limitations of the study:

This was non-randomized study. The sample size was small and the study was carried out in one centre. Angiography was evaluated by visual estimation, so there was chance of inter observer and intra observer variation of interpretation of the severity of the stenosis.

Disclouser:

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References:

1. Islam AKMM, Majumder AAS. Coronary artery disease in Bangladesh: A review. Indian Heart J. 2013;65(4):424-35.
2. Ahmad M, Khan AR, Khan MU. Waist to hip ratio as a risk factor for coronary artery disease. Pakistan Heart Journal. 2004; 37(1-2):11-15.
3. Kaur S, Sharma A, Singh HJ. Waist–related anthropometric measures: simple and useful predictors of coronary heart disease in women. Natl J Physiol Pharm Pharmacol. 2015; 5:60-4.
4. Lakka HM, Lakka TA, Tuomilehto J, Salonen JT. Abdominal obesity is associated with increased risk of acute coronary events in men. Eur Heart J. 2002; 23:706-13.
5. Nicklas BJ, Penninx BWJH, Cesari M, Kritchevsky SB, Newman AB, Kanaya AM, et al. Association of visceral adipose tissue with incident myocardial infarction in older men and women. Am J Epidemiol. 2004;160(8):741-49.
6. Bhowmik B, Munir SB, Diep LM, Siddiquee T, Habib SH, Samad MA, et al. Anthropometric indicators of obesity for identifying cardiometabolic risk factors in a rural Bangladeshi population. J Diabetes Invest. 2013; 4(4): 361-68.
7. Seidell JC, Perusse L, Despres JP, Bouchard C. Waist and hip circumferences have independent and opposite effects on cardiovascular disease risk factors: the Quebec family study. Am J Clin Nutr. 2001;74: 315-21.
8. Litwin SE. Which measures of obesity best predict cardiovascular risk? J Am Coll Cardiol. 2008; 52(8):616-19.
9. de Koning L, Merchant AT, Pogue J, Anand SS. Waist circumference and waist-to-hip ratio as predictors of cardiovascular events: meta-regression analysis of prospective studies. Eur Heart J. 2007; 28:850-56.
10. Dalton M, Cameron AJ, Zimmet PZ, Shaw JE, Jolley D, Dunstan DW, et al. Waist circumference, waist-hip ratio and body mass index and their correlation with cardiovascular disease risk factors in Australian adults. J Internal Medicine. 2003; 254:555-63.
11. Canoy D, Boekholdt SM, Wareham N, Luben R, Welch A, Bingham S, et al. Body fat distribution and risk of coronary heart disease in men and women in the European prospective investigation into cancer and nutrition in Norfolk cohort: a population-based prospective study. Circulation. 2007;116: 2933-43.
12. Yusuf S, Hawken S, Ounpuu S, Bautista L, Franzosi MG, Commerford P, et al. Obesity and the risk of myocardial infarction in 27,000 participants from 52 countries: a case-control study. Lancet. 2005; 366:1640–49.
13. Hussain A., Khan AK, Bhowmik B. Anthropometric indicators of obesity for identifying cardiometabolic risks in a rural Bangladeshi population- Chandra diabetes study. Diabetes Voice. 2013;58(2):46-48.

14. Rahmani A, Ahmadi MHA, Misgavam S, Farhadi F, Shariatpanahi ZV. Body composition and abdominal obesity in patients with and without coronary heart disease. Cardiol Res. 2014; 5(2):68- 71.

15. Shabestari MAA, Motlagh MHB, Hosseinpanch F, Heidari K. Abdominal fat sonographic measurement compared to anthropometric indices for predicting the presence of coronary artery disease. J Ultrasound Med. 2013*;* 32:1957-65.

16. Hauner H, Stangl K., Schmatz C, Burger K, Blomer H, Pfeiffer EF. Body fat distribution in men with angiographically confirmed coronary artery disease. Atherosclerosis. 1990*;* 85: 203-10.

17. Hartz A, Grubb B, Wild R, Nort JJV, Kuhn E, Freedman D, et al. The association of waist hip ratio and angiographically determined coronary artery disease. International J Obesity. 1990;14:657-65.

18. Hodgson JM, Wahlqvist ML, Balazs NDH, Boxall JA. Coronary atherosclerosis in relation to body fatness and its distribution. International J Obesity. 1994;18: 41-46.

19. Zen V, Fuchs FD, Wainstein MV, Goncalves SC, BiavattiK, Riender CE et al. Neck circumference and central obesity are independent predictors of coronary artery disease in patients undergoing coronary angiography. Am J Cardiovasc Disc. 2012; 2(4): 323-30.

20. Lewandowski A., Dluzniewski M., Chmielewski M, Zielinski L, Pietkiewicz WP, Burbicka E, et al. Evaluation of the relations between the presence of the metabolic syndrome and the degree of visceral obesity and the severity of coronary artery disease by coronary angiography. Kardiol Pol. 2013;71(9): 937-44.

21. Parsa AFZ, Jahanshahi B. Is the relationship of body mass index to severity of coronary artery disease different from that of waist-to-hip ratio and severity of coronary artery disease? Paradoxical findings. CVJ Africa. 2015;26(1):13-6.

22. Thygesen K, Alpert JS, Jaffe AS, Simmons ML, Chaitman BR, White HD. Third universal definition of myocardial infarction. Circulation. 2012;126: 2020-35.

23. World Health Organization. Waist circumference and waist – hip ratio: report of a WHO expert consultation. Geneva: WHO. 2008.

24. Ling S, Zheng LS. Association between non-alcoholic fatty liver disease and coronary artery disease severity. Chin Med J. 2011;124(6):867-72.

25. Akanda MAK, Ali SY, Islam AEMM, Rahman MM, Parveen A., Kabir MK., et al. Demographic profile, clinical presentation & angiographic findings in 637 patients with coronary heart disease. Faridpur Med Coll J. 2011;6(2):82-85.

26. Gupta S, Gupta VK., Gupta R, Arora S, Gupta V. Demographic profile and prevalence of risk factors and their correlation with STEMI, NSTEMI and premature CAD in documented CAD patients. J. Preventive Cardiology. 2012; 1(4):164-72.

27. Jabeen S,Haque M. Risk factors for cardiovascular diseases: a study at National Institute of Cardiovascular disease(NICVD). Bangladesh Medical J. 2010; 39(2):16-21.

28. Kumar N, Sharma S, Mohan B, Beri A, Aslam N, Sood N, et al. Clinical and angiographic profile of patients presenting with first acute myocardial infarction in a tertiary care center in northern India. Indian Heart J. 2008; 60:210-4.

29. Bakhoum SWG, Sorour SM, Elraml MZ, Raslan HZ, Salama II. Impact of waist circumference on hospital outcome and coronary angiographic findings of patients with acute ST-segment elevation myocardial infarction. Egyptian Heart J. 2015; 67:159-65.