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Original article

Relationship Between H2FPEF and SYNTAX Scores in Patients with Chronic Stable Angina

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Abstract:

Background: Both ischemic heart disease and heart failure with preserved ejection fraction (HFpEF) share common metabolic risk factors such as obesity and hypertension. The H_2FPEF score assesses the likelihood of HFpEF, while the SYNTAX score evaluates the severity of coronary artery disease in patients with chronic stable angina. Recent studies have suggested a correlation between elevated H_2FPEF and SYNTAX scores studied in Patients with STEMI and NSTEMI. To our knowledge, no previous studies have researched this correlation in Patients with chronic stable angina. This indicates that there are overlapping pathophysiological mechanisms, such as microvascular dysfunction and myocardial stiffness.This relationship may support earlier detection of HFpEF and guide more personalized treatment strategies. Therefore, our goal was to find out how H2FPEF and SYNTAX scores relate to each other in individuals with chronic stable angina.

Methods: This cross-sectional observational study was carried out at Benha Teaching Hospital and Zagazig University Hospitals' Cardiology Department on 67 Patients presenting with chronic stable angina. In every case, the H_2FPEF score was calculated.

Results: Patients with higher H2FPEF scores demonstrated Statistically significantly elevated echocardiographic parameters such as E/e′ ratio, Tricuspid regurgitation maximal velocity, and ESPAP. Further confirming the H2FPEF score's predictive accuracy was correlation and ROC analyses, surpassing traditional measures like EF%.

Conclusion: In patients having coronary angiography for chronic stable angina, the H2FPEF score is a reliable indicator of the severity of coronary artery disease, as determined by the SYNTAX Score.

The H_2FPEF score is a diagnostic tool originally developed to assess the likelihood of Heart Failure with preserved Ejection Fraction ,might serve as a non-invasive proxy for cardiovascular risk stratification in settings where coronary angiography is not readily available.

In patients with chronic stable angina, a higher H_2FPEF score may indirectly suggest increased coronary burden, guiding clinical decision-making regarding medical therapy vs referral.

Keywords: HFpEF, SYNTAX; heart failure.

INTRODUCTION

All phases of the development of atherosclerotic plaque, including its initiation, advancement, and rupture, are actively influenced by the inflammatory process. A significant portion of coronary artery disease (CAD) is caused by chronic stable angina. The pathobiology of stable angina is well understood, yet it is still very difficult to anticipate when a clinically stable cardiac condition may turn into an acute, life-threatening incident. The number of patients with chronic stable angina is growing as a result of increased survival rates after MI. Therefore, improving the clinical outcome of patients with chronic stable angina requires prompt diagnosis, high-risk group identification, and suitable therapy **[1]**.

Patients with substantial lesions in the left main stem and/or the three epicardial coronary arteries were eligible to participate in the SYNTAX (Synergy between PCI with TAXUSTM and Cardiac Surgery) research. The study offered a method for rating coronary artery atherosclerotic lesions. Originally developed to rate the complexity of coronary artery disease (CAD), the SYNTAX score (SS) is a lesion-based angiographic scoring system. In CAD patients, it can predict mortality and morbidity and help with revascularization decisions **[2]**.

The H2FPEF score is current, however it helps distinguish between non-cardiac reasons and preserved ejection fractional heart failure as the etiological cause of unexplained shortness of breath. Clinical and echocardiographic information (left ventricular (LV) filling and pulmonary artery systolic pressure indicators), including age, obesity, hypertension (HT), and atrial fibrillation (AF), are combined to create the H2FPEF score **[3]**.

According to **Suzuki et al. [4],** in stable patients with cardiovascular risk factors(s), the H2FPEF score may offer valuable information for upcoming HF-related events. The association between H2FPEF and SYNTAX scores in patients with non-ST elevation myocardial infarction (NSTEMI) was examined by **Bayam et al. [5].** They came to the conclusion that a high H2FPEF score could be linked to a high SYNTAX score and could be utilized to gauge the severity and complexity of CAD in patients with NSTEMI.

The association of thrombus burden (TB) with H2FPEF in STEMI patients was examined by **Küçük and Volina [6].** They concluded that the H2FPEF score could be a helpful indicator of High thrombus burden in patients with STEMI. **Turan et al. [7]**

However, the aim of the current study is to find the relationship between both scores in the patients with chronic stable angina, which was not addressed before **.**

METHODS

This cross-sectional observational study was carried out at Benha Teaching Hospital and Zagazig University Hospitals' Cardiology Department on 67 individuals presented with chronic stable angina.

Inclusion Criteria:

- Both male and female adult patients (≥18 years old).
- Patients undergoing coronary angiography due to chronic stable angina with angiographically confirmed atherosclerotic CAD (>50% LM stenosis, >70% in other major vessels, or 30–70% with FFR ≤0.8) **[8].**

Exclusion Criteria:

- Prior history of heart failure.
- Prior history of Myocardial infarction.

- Impaired LV Systolic Function by Echocardiography.
- Atrial fibrillation by ECG.
- Rheumatic heart disease.
- Connective tissue diseases.
- Active malignancies, or patients undergoing chemotherapy/ radiotherapy.
- Pericardial diseases.
- Liver cirrhosis.
- Patient’s refusal.

Methods:

Every patient had their complete medical history taken, which included their age, gender, smoking status, history of Diabetes mellitus (DM), hypertension (HTN), dyslipidemia, heart failure, stroke, peripheral vascular disease, and family history of premature CAD. Vital indicators such as temperature, systolic blood pressure (SBP) and diastolic blood pressure (DBP), heart rate, and respiration rate were recorded throughout the clinical examination. When the patient was admitted to the hospital, random blood sample, were taken in order to determine the complete blood count (CBC), renal function (creatinine, creatinine clearance), liver enzymes (aspartate aminotransferase AST, alanine aminotransferase ALT), International Normalized Ratio (INR), serum electrolytes (Na, K), and lipid profile (cholesterol, Low density lipoprotein LDL, High density lipoprotein HDL, triglycerides). A standard resting 12-lead Electrocardiogram (ECG) was performed on all patients to detect ischemic changes or arrhythmias**.**

Echocardiography:

With a Philips Epic 7C machine, a 5.5 X transducer S5-1 probe, and a simultaneous ECG signal, thorough transthoracic echocardiographic investigations were carried out. The left lateral decubitus position was used to examine the patients. Every echocardiogram was acquired and documented offline. The modified Simpson method was used to measure the Left ventricular Ejection Fraction (EF) **[9–12].** E/e′ ratio, estimated systolic pulmonary artery pressure (ESPAP), tricuspid regurgitation maximal velocity (TR V. max), and left ventricular dimensions (Left Ventricular End-Diastolic Dimension LVEDD, Left Ventricular End-Systolic Dimension were measured LVESD) were measured.

H2FPEF Score Calculation:

The following formula was used to determine the H2FPEF score: obesity, defined as body mass index (BMI) >30 kg/m2, 2 points; presence of atrial fibrillation, 3 points; and all other criteria (age >60 years, therapy with ≥2 antihypertensive medications, E/e′ ratio >9, and PASP >35 mmHg), 1 point each. **(Table 1S).**

Coronary angiography and CAD severity assessment:

The cardiac catheterization lab provided angiographic information for the patients. Standard Judkin's approach was used to do elective coronary angiography. Following angiography, all patients were admitted to the intensive care unit,where they received 100 mg of Asprin and/or 75 mg of clopidogrel were continued in all patients regarding coronary angiography. Whether or not to use glycoprotein IIb/IIIa inhibitors was up to the operator. β-blockers, statins, and angiotensin-converting enzyme inhibitors were used as per indicated or not as a part of concurrent medical treatment in accordance with the American Heart Association/American College of Cardiology guidelines. For each distinct lesion, which was defined as >50% luminal blockage in vessels ≥ 1.5 mm, the SYNTAX score was calculated by adding the individual scores. Dedicated software (available at http://www.syntaxscore.com/calc/start.htm) was used to generate the SYNTAX scores for each patient. The mild-to-moderate group (n = 73) was made up of patients with mild-to-moderate CAD, and the severe group (n = 27) was made up of patients with severe CAD, and Patients are often categorized into two groups based on clinical criteria from the original SYNTAX trial, where patients with scores above this threshold had improved outcomes with CABG compared to PCI,**Farooq V, van Klaveren D, Steyerberg EW, et al. [29]**

which classified regarding SYNTAX score clinical risk to two groups:

Low SYNTAX Score: Typically defined as ≤ 22, indicating less complex disease and potentially favoring PCI.

High SYNTAX Score: Typically defined as > 22, indicating more complex disease and potentially favoring CABG.

Ethical considerations:

The Faculty of Medicine's Research Ethics Committee gave its clearance (IRB number 262/7/April/2024). Prior to participation, all patients or first-degree relatives provided written informed permission that included information about the study's purpose, design, location, time, subject and techniques, and confidentiality. The Dean of the Faculty of Medicine and the University Hospitals management formally approved the study's conduct.

Statistical Analysis:

Using IBM® SPSS statistical software, version 26 (Statistical Package for Social Studies), developed by IBM, Illinois, Chicago, USA, the gathered data were arranged, coded, tabulated, and statistically examined. The parametric data's normality was confirmed using the one-sample Kolmogorov-Smirnov test. The range mean and standard deviations for numerical values were computed. For parametric data, the student t-test was used to determine the differences between the two mean values. The chi square test was used to analyze differences across subcategories and to compute numbers and percentages for categorical variables. To determine the correlation between the variables, Pearson's correlation coefficient (r) was employed. A significance threshold of $p<0.05$ was established.

RESULTS

According to the demographic profile of the study population, the weight ranged from 81 to 120 kg (mean 96.85 ± 10.53 kg), the BMI ranged from 25 to 35 (mean 28.31 ± 2.78), and the age ranged from 40 to 76 years with a mean of 57.67 ± 9.99 years. The baseline characteristics were established using a sex distribution of 43.3% female (n = 29) and 56.7% male (n = 38). Hypertension was present in 67.2% of patients (n = 45) versus 32.8% without hypertension (n = 22); diabetes mellitus was reported in 64.2% (n = 43) compared to 35.8% without (n = 24); all patients (100%) had IHD (n = 67); and smoking status was nearly evenly distributed with 47.8% smokers (n = 32) and 52.2% non-smokers (n = 35). **(Table 1)**

The heart rate ranged from 65 to 105 bpm (mean 85.21 ± 11.31), diastolic blood pressure from 60 to 100 mmHg (mean 78.66 ± 10.86), and systolic blood pressure from 110 to 160 mmHg (mean 130.30 ± 13.92). Laboratory values revealed creatinine levels from 0.70 to 1.50 mg/dL (mean 1.0790 ± 0.2047), creatinine clearance between 65 and 110 mL/min (mean 91.84 ± 23.62), hemoglobin ranging from 11 to 15 g/dL (mean 11.55 ± 1.69), platelets from 230 to 450 × 10^3/µL (mean 333.88 ± 61.06), TLC from 4 to 11 × 10^3/µL (mean 7.70 ± 2.37), and INR from 0.8 to 1.3 (mean 1.003 ± 0.1477). Liver enzymes (AST: 33–89, mean 56.00 ± 18.06; ALT:

13–46, mean 25.75 ± 8.92) and electrolytes (Na: 131–147, mean 139.46 ± 4.19; K: 3.4–5.2, mean 4.122 ± 0.4327) are provided along with lipid profile data (Cholesterol: 156–265, mean 209.24 ± 28.30; LDL: 76–154, mean 119.81 ± 21.09; HDL: 37–84, mean 56.16 ± 11.91; Triglycerides: 112–184, mean 144.73 ± 19.27). **(Table 2S)**

Echocardiography showed an ejection fraction (EF%) between 55% and 70% (mean 62.72 ± 4.11%), an E/e′ ratio ranging from 6 to 16 (mean 9.69 ± 2.88), tricuspid regurgitation maximal velocity from 1.2 to 3.6 m/s (mean 2.478 ± 0.738), an estimated systolic pulmonary artery pressure (ESPAP) between 10 and 54 mmHg (mean 30.30 ± 15.26), LV end-diastolic diameter from 3.8 to 5.5 cm (mean 4.80 ± 0.52), and LV end-systolic diameter from 2.5 to 3.6 cm (mean 3.12 ± 0.37). **(Table 2)**

The mean of the SYNTAX Score was 24.30 ± 14.89, while the range of the H2FPEF score was 1 to 5, with a mean of 2.42 ± 1.27, indicating a moderate distribution of these risk scores among the patients. **(Table 3)**
When stratifying by SYNTAX score, age was similar between groups (57.53 ± 7.63 vs. 57.92 ± 13.41 years, p = 0.882). However, patients with high diastolic blood pressure, higher weight and higher BMI were associated with Statistically significantly higher SYNTAX score (P value: 0.04, 0.003, 0.001 respectively) , While the heart rate and systolic blood pressure were not Statistically significantly different in both groups **(Table 4).**

When comparing both groups, Patients with higher H2FPEF score were found to have Statistically significantly higher SYNTAX score (P value <0.001). Additionally, we have found that patients with higher SYNTAX score (>22) had Statistically significantly higher E/e' ratio, TR V. max and ESPAP (P value <0.001 for all of them). Moreover, we have found that patients with higher SYNTAX score (>22) had significantly lower HB and platelets (P value <0.001, 0.002 respectively) **(Tables 5,6, 7)**

Age had a Statistically non significant link with EF% (r = –0.134, p = 0.280), E/e′ (r = –0.209, p = 0.089), and H2FPEF Score (r = –0.173, p = 0.161), according to correlation analysis, but a slight negative correlation with SYNTAX Score I (r = –0.314, p = 0.010). EF% (r = 0.454, p <0.001), H2FPEF Score (r = 0.615, p <0.001), and SYNTAX Score I (r = 0.564, p <0.001) all showed a significant and positive correlation with BMI. Additionally, there was a strong correlation between E/e′ and both the H2FPEF Score (r = 0.501, p <0.001) and SYNTAX Score I (r = 0.514, p <0.001). Additionally, there were significant positive correlations between TR max.v and ESPAP and the H2FPEF Score (r = 0.381, p = 0.001 and r = 0.425, p <0.001, respectively) and SYNTAX Score I (r = 0.488, p <0.001 and r = 0.510, p <0.001, respectively). Significant relationships were found between H2FPEF Score and SYNTAX Score I (r = 0.916, p <0.001), but not between LVEDD and LVESD. **(Table 3S)**

The E/e′ ratio has an AUC of 0.771 with a cutoff value of >10 to predict higher SYNTAX score >22 according to receiver operating characteristic (ROC) analysis (sensitivity 70.83%, specificity 86.05%, p<0.001), ESPAP achieved an AUC of 0.799 with a cutoff >36 to predict higher SYNTAX score >22 (sensitivity 70.83%, specificity 86.05%, p<0.001), and the H2FPEF Score itself had the highest predictive accuracy with an AUC of 0.893, a cutoff >2 to predict higher SYNTAX score >22 (sensitivity 91.67%, specificity 95.35%, p<0.001). **(Table 4S)**

Table 1: Baseline data among the study population:

		Minimum	Maximum	Mean	SD
Age(years)		40	76	57.67	9.988
BMI (kg/m$^{2)}$		25	35	28.31	2.781
Sex				Frequency	Percent
			Male	38	56.7
			Female	29	43.3
HTN			No	22	32.8
			Yes	45	67.2
DM			No	24	35.8
			Yes	43	64.2
Ischemic Heart Disease			No	0	0
			Yes	67	100
Smokers			No	35	52.2
			Yes	32	47.8

Table 2: Echocardiographic Measurements:

	Minimum	Maximum	Mean	Std. Deviation
EF (%)	55	70	62.72	4.108
E/e`	6	16	9.69	2.877
TR v.max (m/sec)	1.2	3.6	2.478	0.7381
ESPAP (mmhg)	10	54	30.30	15.256
LVEDD (cm)	3.8	5.5	4.796	0.5218
LVESD (cm)	2.5	3.6	3.116	0.3675

Table 3: H2FPEF and SYNTAX Score:

	Minimum	Maximum	Mean	Std. Deviation
H2FPEF Score	1	5	2.42	1.269
SYNTAX Score I	7	55	24.30	14.892

Table 4: Comparison between SYNTAX score groups according to baseline variables:

	Group I (SYNTAX ≤ 22)		**Group II (SYNTAX > 22)**		
	Mean	**Std. Deviation**	**Mean**	**Std. Deviation**	
Age(years)	57.53	7.629	57.92	13.413	0.882
BMI (kg/m$^{2)}$	27.35	1.999	30.04	3.169	**0.001**
HR (beat/minute)	85.84	9.155	84.08	14.551	0.597
DBP (mmhg)	80.70	10.555	75.00	10.632	**0.040**
SBP (mmhg)	132.56	14.158	126.25	12.790	0.068

Table 5: Comparisons between both SYNTAX Score groups according to Laboratory Parameters:

	Group I (SYNTAX ≤ 22)		Group II (SYNTAX > 22)		
	Mean	**Std. Deviation**	**Mean**	**Std. Deviation**	
Creatinine(mg/dl)	1.1007	0.18306	1.0400	0.23782	0.285
Creatinine clearance(ml/min)	93.72	21.636	88.46	26.983	0.417
Hemoglobin(g/dl)	12.09	1.688	10.58	1.213	**<0.001**
Platelets (× 10³/µL)	350.70	56.606	303.75	58.053	**0.002**
Total leukocytes (× 10³/µL)	7.67	2.533	7.75	2.111	0.897
INR	0.977	0.1477	1.050	0.1383	0.051
AST (U/L)	55.12	14.930	57.58	22.917	0.638
ALT(U/L)	23.16	6.436	30.38	10.858	**0.006**
Na (mEq/L)	138.84	4.248	140.58	3.933	0.097
K (mEq/L)	4.160	0.5048	4.054	0.2536	0.256
Cholesterol(mg/dl)	206.12	29.235	214.83	26.203	0.216
LDL(mg/dl)	119.98	19.860	119.50	23.591	0.934
HDL(mg/dl)	57.35	9.973	54.04	14.772	0.334
Triglycerides(mg/dl)	145.37	18.921	143.58	20.238	0.724

Table 6: Comparisons between both SYNTAX Score groups according to Echocardiographic parameters:

	Group I (SYNTAX ≤ 22)		Group II (SYNTAX > 22)		
	Mean	**Std. Deviation**	**Mean**	**Std. Deviation**	
EF (%)	62.19	3.561	63.67	4.878	0.200
E/e`	8.67	2.456	11.50	2.719	**<0.001**
TR max.v(m/sec)	2.216	0.6887	2.946	0.5838	**<0.001**
ESPAP (mmhg)	24.91	13.796	39.96	12.987	**<0.001**
LVEDD (mm)	4.751	0.5488	4.875	0.4702	0.335
LVESD (mm)	3.153	0.3473	3.050	0.4000	0.294

Table 7: Comparison of H2FPEF Score by SYNTAX Score Groups:

	Group I (SYNTAX ≤ 22)		Group II (SYNTAX > 22)		
	Mean	Std. Deviation	Mean	Std. Deviation	
H2FPEF Score	1.60	0.495	3.88	0.850	**<0.001**

Table 1S : H2FPEF score calculation:

	Clinical variable	Values	Points
H_2	**H**eavy	Body mass index (BMI) >30 kg/m^2	2
	Hypertension	Treatment with ≥2 antihypertensive drugs	1
F	Atrial **F**ibrillation	Paroxysmal or Persistent	3
P	**P**ulmonary Hypertension	Doppler Echocardiographic estimated Pulmonary Artery Systolic Pressure > 35 mmHg	1
E	**E**lder	Age > 60 years	1
F	**F**illing pressure	Doppler Echocardiographic E/e' >9	1

Table 2S : Cardiac Vital Signs and Laboratory Parameters:

	Minimum	Maximum	Mean	Std. Deviation
HR (beats/minute)	65	105	85.21	11.306
DBP (mmhg)	60	100	78.66	10.857
SBP (mmhg)	110	160	130.30	13.923
Creatinine(mg/dL)	0.70	1.50	1.0790	0.20468
Creatinine clearance(mL/min)	65	110	91.84	23.624
Hemoglobin(g/dL)	11	15	11.55	1.690
Platelets (× 10^3/µL)	230	450	333.88	61.056
Total leukocyte (× 10^3/µL)	4	11	7.70	2.374
INR	0.8	1.3	1.003	0.1477
AST (U/L)	33	89	56.00	18.064
ALT (U/L)	13	46	25.75	8.921
Na(mEq/L)	131	147	139.46	4.194
K(mEq/L)	3.4	5.2	4.122	0.4327
Cholesterol(mg/dl)	156	265	209.24	28.300
LDL (mg/dl)	76	154	119.81	21.094
HDL (mg/dl)	37	84	56.16	11.912
Triglycerides (mg/dl)	112	184	144.73	19.269

Table 3S: Correlation Matrix Among Key Variables:

		EF%	E/e`	H2FPEF Score	SYNTAX Score I
Age	r	-0.134	-0.209	-0.173	-0.314
	P value	0.280	0.089	0.161	**0.010**
BMI	r	0.454	0.096	0.615	0.564
	P value	**<0.001**	0.441	**<0.001**	**<0.001**
EF%	r	--	-0.109	0.328	0.183
	P value	--	0.380	0.007	0.138
E/e`	r	-0.109	--	0.501	0.514
	P value	0.380	--	**<0.001**	**<0.001**
TR max.v (m/sec)	r	-0.095	0.819	0.381	0.488
	P value	0.446	**<0.001**	0.001	**<0.001**
ESPAP	r	-0.116	0.866	0.425	0.510
	P value	0.350	**<0.001**	**<0.001**	**<0.001**
LVEDD	r	-0.096	0.196	0.110	0.132
	P value	0.439	0.112	0.374	0.287
LVESD	r	-0.402	-0.068	-0.155	-0.045
	P value	**0.001**	0.584	0.211	0.716
H2FPEF Score	r	0.328	0.501	--	0.916
	P value	**0.007**	**<0.001**	--	**<0.001**
SYNTAX Score I	r	0.183	0.514	0.916	--
	P value	0.138	**<0.001**	**<0.001**	--

Table 4S: ROC Curve Analysis for Predicting Outcomes:

	E/e’	EF%	ESPAP	H2FPEF
Area under curve (AUC)	0.771	0.603	0.799	0.893
Cut-off point	>10	>64	>36	>2
Sensitivity	70.83	58.33	70.83	91.67
Specificity	86.05	79.07	86.05	95.35
P value	**<0.001**	0.2079	**<0.001**	**<0.001**

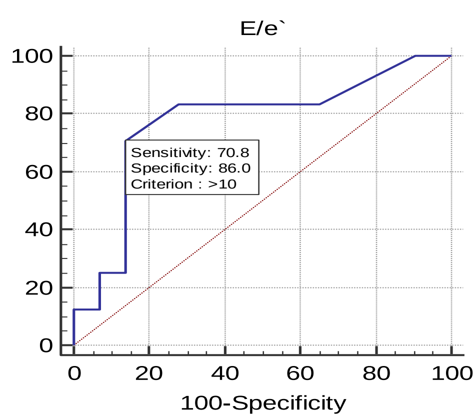

Figure 1S: ROC curve analysis of validity of E/e’ for prediction of high SYNTAX

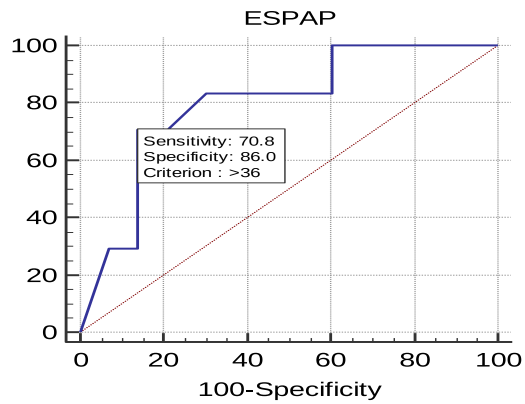

Figure 2S: ROC curve analysis of validity of ESPAP for prediction of high SYNTAX

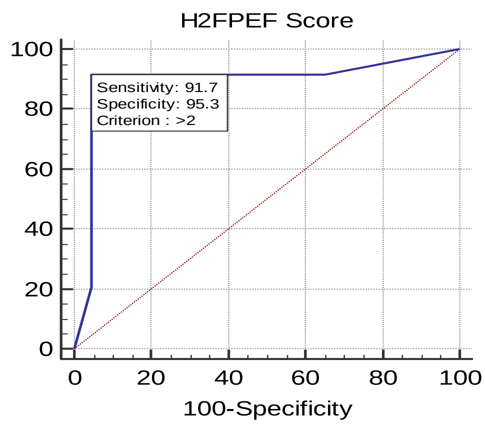

Figure 3S: ROC curve analysis of validity of H2FPEF Score for prediction of high SYNTAX

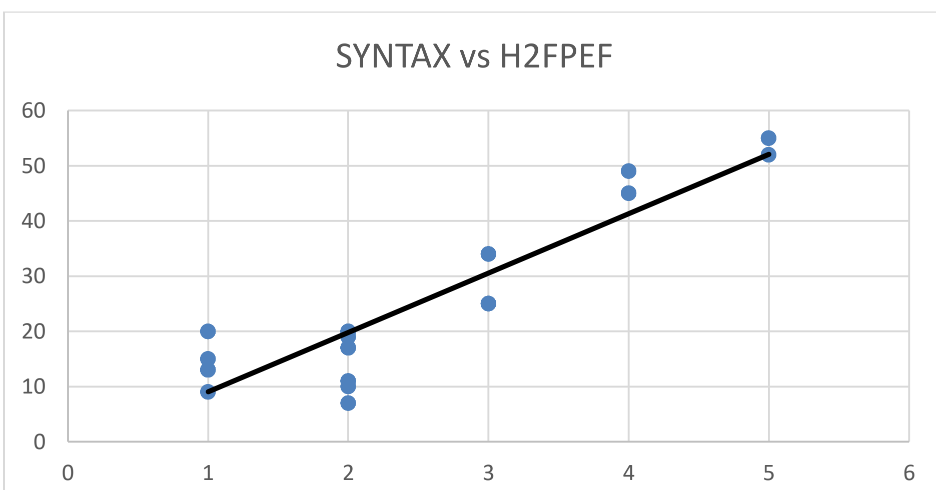

Figure 4S: correlation between SYNTAX Score and H2FPEF Score

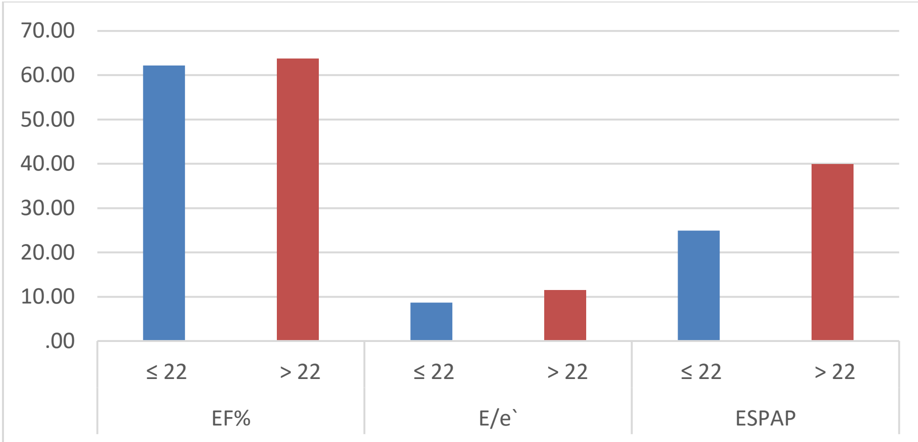

Figure 5S: Comparisons between both SYNTAX Score groups according to Echocardiographic parameters.

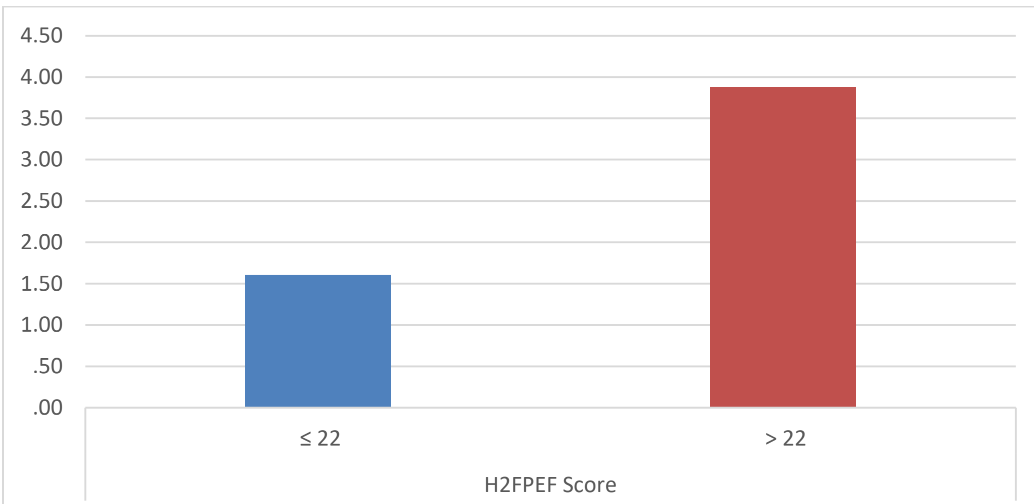

Figure 6S: Comparison of H2FPEF Score by SYNTAX Score Groups

DISCUSSION

H2FPEF score is a tool to help in diagnosis of heart failure with preserved systolic function (HF-PEF) and since it includes risk factors common with CAD, that score was studied earlier in patient with acute coronary syndrome by "**Bayam et al.and Küçük and Volina**" and it could predict the CAD severity and adverse outcomes.

The purpose of this study is to investigate how the H2FPEF score could be related to SYNTAX score in individuals who have chronic stable angina, hence its ability to predict the CAD severity and complexity in such population group.

This cross-sectional study was conducted at the Cardiology Department of the Zagazig universty Hospitals and Benha Teaching Hospital and involved 67 patients who have been diagnosed by invasive coronary angiography to have atherosclerotic CAD, the SYNTAX score was computed retrospectively from angiographic data to evaluate the severity of CAD. To evaluate its prognostic usefulness for CAD severity, the H2FPEF score was also computed for every patient using six clinical and echocardiographic data.

In the current investigation, patients with higher BMI and higher weight were found to have significantly higher SYNTAX score. Compared with the patients' group with SYNTAX score ≤ 22, The patient group with SYNTAX score >22 had significantly higher BMI (27.35±2.00 vs. 30.04±3.17, p = 0.001) and higher weight (93.74± 8.30 vs. 102.42±11.91 kg, p = 0.003).

This is consistent with a study that was conducted by **Abd Elaziz et al. [19]** to determine whether centrally obese patients met metabolic syndrome criteria by forecasting coronary artery disease severity based on coronary angiography (SYNTAX score). One hundred obese patients with CAD symptoms who underwent coronary angiography were included in this cross-sectional investigation. The body mass index and waist circumference of every subject were measured separately. The median waist circumference which is reflective of weight and BMI was higher among individuals with higher syntax scores (P=0.02), suggesting that the two variables have a statistically significant link.

In the current study, the high SYNTAX group had a considerably lower diastolic blood pressure (80.70 ± 10.56 vs. 75.00 ± 10.63 mmHg, p = 0.040).

Supporting our findings, **Amrawy and Zaki [20]** had investigated how DBP and the SYNTAX score relate to one another. The trial comprised 600 stable patients who had elective coronary angiography, When DBP decreased, the authors discovered that the prevalence of high atherosclerotic burden rose considerably for mean SYNTAX scores. According to the scientists, a high SYNTAX score was independently associated with poor DBP.

Furthermore, in 231 stable persons who underwent elective invasive coronary angiography to detect obstructive CAD, **Senthong et al. [21]** examined the relationship between DBP levels and the atherosclerotic burden and severity of CAD. The scientists found that SYNTAX Score (r = -0.61) and SYNTAX Score II (r = -0.73) were inversely correlated with DBP levels. Even after adjusting for traditional risk factors, there was still an independent inverse correlation between DBP levels and a higher terile of SYNTAX Score (adjusted odds ratio [OR] 0.89; 95% confidence interval [CI] 0.85-0.92, p < 0.001) and SYNTAX Score II (adjusted OR 0.75; 95% CI 0.69-0.80, p < 0.001). Intermediate or high SYNTAX Score and SYNTAX Score II suggested a significantly higher likelihood of high atherosclerotic burden in patients with a DBP < 60 mmHg.

We have found also that patients in the group with SYNTAX score >22 had significantly lower levels of hemoglobin when compared with patients in the group with SYNTAX ≤ 22 (12.09 ± 1.69 vs. 10.58 ± 1.21 g/dL, p <0.001)

Our results were corroborated by a study by **Shaikh et al. [22]** that sought to elucidate the connection between hemoglobin levels (anemia) and the degree of coronary artery disease in individuals with STEMI. This prospective cohort study comprised patients aged 20–80 years who presented with STEMI between September 2023 and February 2024.The anemic group's SYNTAX score was substantially higher than the non-anemic group's (27.97±7.15 vs. 24.62±7.04, p<0.01), according to the authors' findings. A one-way ANOVA revealed that the extremely anemic group had the highest mean Syntax Scores across all anemia severity levels ($F(3, 224)$ = 4.310, p = 0.006). ALT levels were higher in the high SYNTAX group (23.16 ± 6.44 vs. 30.38 ± 10.86, p = 0.006), according to logistic regression.

In the current study, patients with SYNTAX > 22 had significantly higher H2FPEF score than those with SYNTAX score ≤22 (3.88 vs. 1.60, p<0.001).

Lindhardsen led a study to investigate if the risk of myocardial infarction in patients with rheumatoid arthritis (RA) is similar to that in individuals with diabetes mellitus (DM) in a nationwide cohort, which supports our findings. The whole Danish population was involved in the study, which ran from January 1, 1997, to December 31, 2006. The authors found patients who developed RA and DM by linking nationwide administrative registers at the person level. A high SYNTAX score may be linked to a high H2FPEF score, as the authors have shown [23].

Age had a little negative link with SYNTAX Score in the current study, according to correlation analysis (r = -0.314, p = 0.010).

On the contrary, **Kersh et al. [24]** conducted a study to use the syntax score to examine the connection between the traditional risk factors for CAD and its complexity. 52 CAD patients who were admitted for elective coronary angiography to the Cardiology Department of Menoufia University Hospitals were included in the study. Age and SYNTAX score were strongly positively correlated (r (50) = 0.639, p < 0.001).

Differences in sample size, patient selection criteria, or the existence of confounding variables like comorbidities and risk factor profiles that could affect the severity and complexity of coronary artery disease could be the cause of the disparity between the two studies. Furthermore, variations in study design, data collection methods, or the population's baseline characteristics (e.g., age distribution, gender ratio, prevalence of diabetes or hypertension) might have contributed to the conflicting outcomes. It's also possible that regional or ethnic differences in disease patterns played a role, as both studies were conducted in distinct settings. To elucidate the nature of this association, more multicenter research with bigger sample sizes and consistent procedures are required **[24].**

BMI and SYNTAX score had a substantial and positive correlation in the current study (r = 0.564, p <0.001).

On the other hand, a study led by **Nabati et al. [25]** looked at the connections between the degree of CAD and various anthropometric markers and obesity indices. A total of 1008 consecutive individuals who had coronary angiography participated in this study. The SYNTAX score and BMI showed a strong inverse correlation (r = -0.110; P < 0.001), according to the investigators.

In order to determine the correlation between BMI, the severity of CAD, and the frequency of high-risk coronary architecture, **Rubinshtein et al. [26]** looked at 928 individuals who had coronary angiography. It was discovered that those who were obese were younger and had a lower incidence of high-risk coronary architecture. The obesity paradox in these participants may be better understood in light of this. Compared to nonobese cases, obese patients were probably referred for angiography sooner. In another study, the BMIs of 842 individuals who underwent coronary angiography and those who did not were compared. Compared to subjects with less severe coronary stenosis, those with more than 50% coronary stenosis were less likely to be obese and more likely to be at appropriate body weight **[27].**

E/e′ showed a significant positive correlation with the H2FPEF Score in this study (r = 0.501, p <0.001).

This conclusion is supported by the performance of the H2FPEF and HFA-PEFF scores in predicting exercise capacity and echocardiographic findings of intracardiac pressures during exercise in subjects with exertion-induced dyspnea referred for bicycle stress echocardiography **[28].** Using simultaneous expired gas analysis, peak oxygen consumption (VO2) was determined. 104 controls without HF and 83 patients with HFpEF were enrolled. The authors found that an H2FPEF score (r = 0.49) was correlated with a higher E/e′ ratio.

There was a strong Positive correlation between the H2FPEF Score and SYNTAX Score in the current study (r = 0.916, p <0.001).

Our results are corroborated by a study conducted by **Bayam et al. [5]** to examine the connection between SYNTAX scores and H2FPEF in patients with non-ST elevation myocardial infarction (NSTEMI). They studied 282 consecutive NSTEMI patients who had Invasive coronary angiography. The scientists discovered that H2FPEF and SYNTAX Scores had a moderately strong positive Correlation (r = 0.694, p <.001).

In the present study, the H2FPEF Score itself had the highest predictive accuracy with an AUC of 0.893, a cutoff >2 to predict CAD severity and complexity as referred to as SYNTAX score >22 (sensitivity 91.67%, specificity 95.35%, p<0.001).

This result is consistent with the **Bayam et al. study [5]**. The authors had found that an H2FPEF score over a cut-off level of 2.5 predicted a high SYNTAX score with a sensitivity of 80% and a specificity of 82.5% (AUC: 0.890; 95%CI: 0.848–0.931; p <.001) on the NSTEMI patients population.

Competing interests

The authors declare that they have no competing interest.

Limitations:

The study was carried out on a small sample size of 67 patients, which may limit the generalizability of the findings to a larger population.

The single-center nature of the study may limit the generalizability of the findings to a broader population

The cross-sectional design precludes assessment of causality or long-term outcomes

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