Original article

Tricuspid Annular Plane Systolic Excursion and Mitral Annular Systolic Excursion: Correlation with Left Ventricular Diastolic Function

Excursão Sistólica do Anel Tricúspide e do Anel Mitral: Correlação com Função Diastólica Ventricular Esquerda

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Abstract

Introduction: Tricuspid annular plane systolic excursion and mitral annular systolic excursion are parameters used to assess the systolic function of the right ventricle and left ventricle, respectively. Little is known about its relationship with left ventricular diastolic function.

Objective: To assess whether the values of mitral annular systolic excursion and tricuspid annular plane systolic excursion correlate with parameters used in the evaluation of left ventricular diastolic function.

Method: Observational cross-sectional study. Two hundred nine individuals were selected, 116 women, with both ventricles normal systolic function. The analyzes were performed for men and women, through Pearson correlation coefficient and Sperman correlation coefficient. Tricuspid annular plane systolic excursion, mitral annular systolic excursion, atrial volumes and left ventricular diastolic function parameters on transthoracic echocardiogram were obtained.

Results: In women, mitral annular systolic excursion was positively correlated with lateral e '(Sperman correlation coefficient of 0.22; p=0.016) and tricuspid annular plane systolic excursion was positively correlated with E / A ratio (Sperman correlation coefficient of 0.23; p=0.037), lateral e' (Sperman correlation coefficient of 0.28; p=0.012), and septal e' (Sperman correlation coefficient of 0.28; p=0.012), and negatively with the E/e' ratio (Pearson correlation coefficient of -0.27; p=0.018), and A wave (Pearson correlation coefficient of -0.29; p=0.009). In men, only mitral annular systolic excursion correlated positively with E wave (Pearson correlation coefficient of 0.21; p=0.037), lateral e' (Sperman correlation coefficient of 0.34; p <0.001) and the septal e' (Sperman correlation coefficient of 0.26; p=0.008). There was no correlation between mitral annular systolic excursion and tricuspid annular plane systolic excursion and atrial volumes. Hypertension and diabetes mellitus influenced tricuspid annular plane systolic excursion and mitral annular systolic excursion values correlated to E and A waves, E/A ratio, septal and lateral e' waves, and E/e' ratio.

Conclusion: In the present study, mitral annular systolic excursion and tricuspid annular plane systolic excursion values showed a significant correlation with some parameters of left ventricular diastolic function, with stronger evidence on female sex.

Keywords: Cardiac function; Cardiovascular disease; COVID-19; Echocardiography; SARS-CoV-2

Resumo

Introdução: *A excursão sistólica do anel tricúspide e a do anel mitral são parâmetros utilizados para se avaliar a função contrátil do ventrículo direito e do ventrículo esquerdo, respectivamente. Pouco se conhece sobre sua relação com a função diastólica ventricular esquerda.*

Objetivo: *Avaliar se os valores de excursão sistólica do anel tricúspide e do anel mitral se correlacionam com parâmetros utilizados na avaliação da função diastólica ventricular esquerda.*

Métodos: *Estudo observacional transversal. Foram selecionados 219 indivíduos, sendo 116 mulheres, com função sistólica preservada de ambos os ventrículos. As análises foram feitas separadamente para os sexos masculino e feminino, por meio dos coeficientes de correlação de Pearson e de Sperman. Foram obtidos: excursão sistólica do anel tricúspide, excursão sistólica do anel mitral, volumes atriais e medidas relacionadas à avaliação da função diastólica do ventrículo esquerdo ao ecocardiograma transtorácico.*

Resultados: *No sexo feminino, a excursão sistólica do anel mitral se correlacionou positivamente com o e' lateral (coeficiente de correlação de*

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Sperman de 0,22; p=0,016) e a excursão sistólica do anel tricúspide se correlacionou positivamente com a relação E/A (coeficiente de correlação de Sperman de 0,23, p=0,037), com o e' lateral (coeficiente de correlação de Sperman de 0,28; p=0,012), com o e' septal (coeficiente de correlação de Sperman de 0,28; p=0,012) e negativamente com a relação E/e' (coeficiente de correlação de Pearson de -0,27; p=0,018) e onda A (coeficiente de correlação de Pearson de -0,29; p= 0,009). No sexo masculino, apenas a excursão sistólica do anel mitral se correlacionou positivamente com a onda E (coeficiente de correlação de Pearson de 0,21; p=0,037), e' lateral (coeficiente de correlação de Sperman de 0,34; p <0,001) e e' septal (coeficiente de correlação de Sperman de 0,26; p=0,008). Não houve correlação entre excursão sistólica do anel mitral e do anel tricúspide e volumes atriais. A presença de hipertensão arterial sistêmica e diabetes melito influenciou nos valores de excursão sistólica do anel tricúspide e do anel mitral correlacionados a ondas E e A, relação E/A, ondas e' septal e lateral e relação E/e'.

Conclusão: *No presente estudo, os valores da excursão sistólica do anel mitral e do anel tricúspide apresentaram correlação significativa com algumas variáveis da função diastólica ventricular esquerda com maior evidência no sexo feminino.*

Palavras-chave: *Ecocardiografia; Ventrículos do coração; Função ventricular.*

Introduction

The cardiac cycle encompasses several phases and corresponds to interdependent movements between several cardiac structures that determine its efficiency. A quick and accurate analysis is not possible.[1] Therefore, cardiac assessment by transthoracic echocardiography (TTE) is based on the acquisition of static and dynamic images associated with measurements and comparisons predetermined in uni- and multicentric studies and arranged in tables to define normality.[1,2]

In particular, two measurements stand out due to their correlation with and dependence on cardiac structures, the tricuspid annular plane systolic excursion (TAPSE) and the mitral annular plane systolic excursion (MAPSE), which are used to assess right ventricular (RV) and left ventricular (LV) contractile function, respectively.[3,4] Both TAPSE and MAPSE are evaluated in the apical four-chamber window by placing the M-mode on the lateral tricuspid or mitral annulus, respectively, and measuring the distance from the "lowest" to the "highest" point it reaches (Figure 1).[5] Thus, the M-mode angulation with other adjacent cardiac structures, especially the left and right atria, may interfere with these two measurements.[6,7]

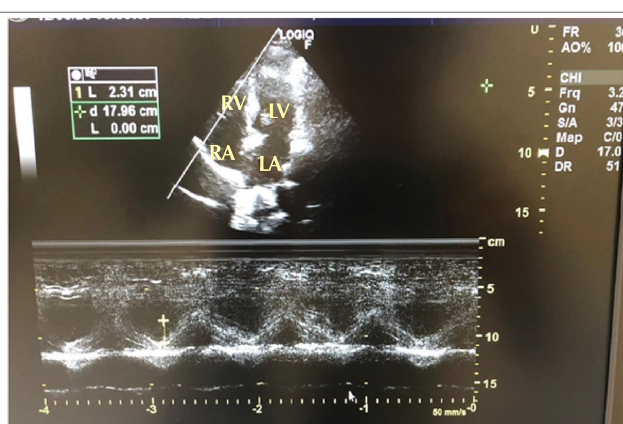
Myocardial performance is directly related to ventricular architecture. Circumferential and longitudinal myocardial fibers, in addition to improving systole and diastole through shortening/widening, help displace the mitral and tricuspid annuli in the cardiac cycle.[8,9] Thus, any systolic or diastolic dysfunction would theoretically change these movements, which could be quantitatively assessed by MAPSE and TAPSE measurements. Previous studies confirmed the relationship between MAPSE and LV systolic function[5] even with sensitivity similar to the longitudinal strain[8]; however, little is known about its relationship with left ventricular diastolic function (LVDF). The same happens with TAPSE.[3,4]

Therefore, the present study aimed to assess whether MAPSE and TAPSE correlate with parameters used to assess LVDF and whether the behaviors of these variables differ between the sexes.[10-12]

Methods

Study population

This observational cross-sectional study enrolled a total of 219 patients (116 women [53%], 103 men [47%]) regardless of ethnicity who were referred by the assistant physician for TTE for any clinical indication from the cardiology outpatient clinic of the Red Cross Hospital of Curitiba, PR, Brazil. The patients were selected by convenience without statistical criteria



RV, right ventricle; LV, left ventricle; RA, right atrium; LA, left atrium.

Figure 1 – *Tricuspid annular plane systolic excursion image.*

according to each subject's availability to participate in the research. A protocol form with clinical and echocardiographic parameters was completed for each patient. The clinical data collected included age, sex, weight, height, body mass index (BMI), and the presence of systemic arterial hypertension (SAH), diabetes mellitus (DM), coronary artery disease (CAD), smoking (current or previous), and dyslipidemia. Information on SAH, DM, dyslipidemia, and smoking were collected from the patients' medical records and/or reported by them (referred information). CAD was confirmed by the medical record and the patient through a reported history of non-fatal myocardial infarction and surgical or percutaneous myocardial revascularization. Regularly used medications were also recorded.

The exclusion criteria were a) significant valvular disease (moderate and severe); b) valve prostheses; c) segmental LV contraction changes due to ischemic heart disease or other cardiomyopathies; d) declared pulmonary emphysema or chronic obstructive pulmonary disease;,,,,, e) moderate to severe pulmonary arterial hypertension (pulmonary artery systolic pressure [PASP] > 50 mmHg); f) LV contractile dysfunction (ejection fraction < 52% for men and < 54% for women); g) infiltrative and pericardial diseases; h) congenital heart disease with increased pulmonary blood flow with or without surgical correction; i) pacemakers or atrial fibrillation; and j) advanced-degree (II and III) LV diastolic dysfunction. Patients with any of the conditions described above were automatically excluded from the study. Only patients who met the selection criteria were invited to participate.

The patients underwent a complete two-dimensional TTE using Phillips IE 33, Envisor, or General Electric Vivid E echocardiography equipment. All acoustic windows and all standard echocardiographic measurements and analyses were performed on each patient. Sonographic measurements were performed by two experienced echocardiographers qualified in echocardiography by the Department of Cardiovascular Imaging of the Brazilian Society of Cardiology.

All patients signed an informed consent form. The study was approved by the institution's research ethics committee.

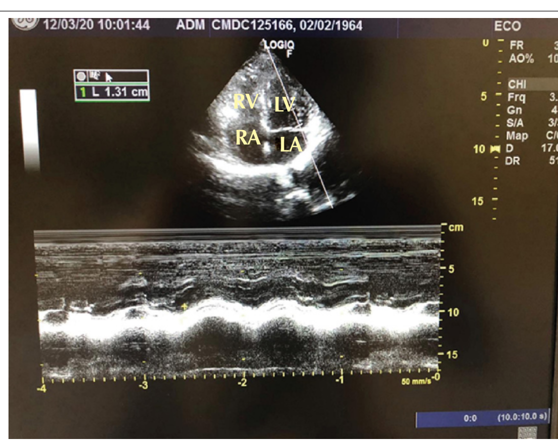
Main echocardiographic parameters analyzed in this study

The analyzed parameters included: RA indexed volume (normal up to 27 mL/m^2 in women, up to 32 mL/m^2 in men) measured in the apical four-chamber window; TAPSE measured in the apical four-chamber window (normal, ≥17 mm) (Figure 1); LA indexed volume (normal up to 34 mL/m^2 for women and men) measured in the apical four-chamber window; MAPSE measured in the apical four-chamber window (normal, ≥12 mm) on the lateral wall of the valve annulus. Measurements of the anterior, posterior, and septal walls of the annulus were excluded due to a greater possibility of errors and changes caused by pressure overload, ischemia, necrosis, and ventricular interdependence through the interventricular septum (Figure 2)[3]; E wave velocity, A wave velocity, and E/A ratio on transmitral spectral Doppler; e' septal wave velocity, e' lateral wave velocity, mean e' septal and e' lateral velocity, E/e' ratio (E wave velocity/mean e' septal and e' lateral velocity) on tissue Doppler of the mitral annulus; and PASP (mmHg) through the maximum tricuspid regurgitation velocity (m/s), when present, on continuous spectral wave Doppler, and inferior vena cava diameter (mm).

All quantifications and values considered in the present study were based on American Society of Echocardiography and the European Society of Cardiovascular Imaging guidelines.[13,16]

Statistical analysis

The results of this study are described as means, medians, minimum and maximum values, and standard deviations (quantitative variables) or as frequencies and percentages (categorical variables). The association between two quantitative variables was estimated by the Pearson (PCC) or Spearman (SCC) correlation coefficient. Quantitative variables were compared between two groups using the Student's t-test for independent samples or the non-parametric Mann-Whitney test. More than two groups were compared using one-way analysis of variance and the least significant difference test for multiple comparisons or the non-parametric Kruskal-Wallis test. The association between MAPSE (or TAPSE) and



RV, right ventricle; LV, left ventricle; RA, right atrium; LA, left atrium.

Figure 2 – *Mitral annular plane systolic excursion image.*

diastolic function variables was assessed thought three linear regression models adjusted for MAPSE (or TAPSE) regardless of SAH, DM, BMI, and DSLP. The first included SAH and the diastolic function variable, the second included DM and the diastolic function variable, and the third included SAH, DM, BMI, DSLP, and the diastolic function variable. The normality of the variables was evaluated by the Kolmogorov-Smirnov test. P values < 0.05 were considered statistically significant.

The data were analyzed using SPSS Statistics software v.20.0 (IBM Corp., Armonk, NY, USA)

Results

A total of 140 patients were excluded from the final analysis for not meeting the inclusion criteria. Table 1 shows the clinical characteristics of the studied 116 women (62.8 ± 13.4 years; BMI, 28.8 ± 5.4 kg/m²) and 101 men (60.9 ± 16.5 years; BMI, 27.4 ± 5.5 kg/m²). The prevalence of cardiovascular comorbidities was similar between the sexes, with a predominance of SAH and grade I diastolic dysfunction (75% of women vs 70% of men) over the other studied comorbidities, with women having a higher incidence of SAH. Table 2 shows the baseline echocardiographic parameters of the studied population by sex.

In women (Table 3), MAPSE was positively correlated with lateral e′ (SCC, 0.22; p = 0.016), while TAPSE was positively correlated with E/A ratio (SCC, 0.23; p = 0.037), lateral e′ (SCC, 0.28; p = 0.012), and septal e′ (SCC, 0.28; p = 0.012) and negatively correlated with E/e′ ratio (PCC, -0.27; p = 0.018) and A wave (PCC, -0.29; p = 0.009). In men (Table 3), only MAPSE was positively correlated with E wave (PCC, 0.21; p = 0.037), lateral e′ wave (SCC, 0.34; p < 0.001), and septal e′ wave (SCC, 0.26; p = 0.008). TAPSE did not correlate with any variables in men. There was no correlation between MAPSE and TAPSE and atrial volumes in either sex (Table 3). There was no significant difference in TAPSE and/or MAPSE values by classification of grade I diastolic dysfunction and preserved LVDF (considered a categorical variable) (data not shown). Age showed a negative correlation with A wave, E/A ratio, septal e′, and lateral e′ wave and a positive correlation with A wave, E wave deceleration, and left atrial volume (LAV) in both sexes (Table 4). There was no correlation between age and TAPSE or MAPSE for either sex (Table 4). In women with SAH, MAPSE was positively and significantly correlated with E/A ratio, septal e′ wave, and lateral e′ wave when analyzed alone or with the other categorical variables. Likewise, in women, TAPSE was positively correlated with E/A ratio, septal e′ wave, and lateral e′ wave and negatively correlated with A wave and E/e′ ratio. In women with DM, MAPSE was positively correlated with the septal and lateral e′ waves, while TAPSE was negatively correlated with A wave and E/e′ ratio and positively correlated with the septal and lateral e′ waves (Tables 5 and 6).

In men with SAH and/or DM, MAPSE was positively correlated with E wave, septal e′ wave, and lateral e′ wave (Table 7). However, TAPSE values were not influenced by the presence of SAH and/or DM (data not shown). The presence of dyslipidemia, CAD, smoking, and BMI did not influence TAPSE or MAPSE values for either sex (data not shown).

Table 1 – Clinical characteristics of the study population.

Variable	Classification	Women		Men	
		n	%	n	%
Systemic arterial hypertension	No	31	26.7%	43	42.6%
	Yes	85	73.3%	58	57.4%
Diabetes mellitus	No	89	76.7%	73	72.3%
	Yes	27	23.3%	28	27.7%
Dyslipidemia	No	70	60.3%	68	67.3%
	Yes	46	39.7%	33	32.7%
Smoking	No	28	71.8%	27	79.4%
	Yes	11	28.2%	7	20.6%
Coronary artery disease	No	101	87.1%	70	69.3%
	Yes	15	12.9%	31	30.7%
Degree of diastolic dysfunction	No	9	24.3%	10	29.4%
	Grade I	28	75.7%	24	70.6%

Table 2 – Baseline echocardiographic parameters of the studied population.

	n	Women Mean ± SD	n	Men Mean ± SD
E wave (m/s)	116	0.69 ± 0.18	103	0.65 ± 0.21
A wave (m/s)	116	0.79 ± 0.20	103	0.77 ± 0.19
E/A ratio	116	0.94 ± 0.40	103	0.90 ± 0.41
Septal e' (m/s)	116	0.08 ± 0.03	102	0.08 ± 0.03
Lateral e' (m/s)	116	0.10 ± 0.04	102	0.10 ± 0.04
E/e' ratio	116	8.58 ± 2.74	102	7.6 ± 2.2
PASP (mmHg)	77	28.2 ± 6.7	46	26.8 ± 5.8
Left atrial volume (mL/m²)	116	30.9 ± 10.7	102	31.2 ± 9.2
MAPSE (mm)	116	15.6 ± 2.5	103	16.3 ± 2.8
Tricuspid velocity (m/s)	77	2.34 ± 0.41	45	2.3 ± 0.3
TAPSE (mm)	79	23.8 ± 3.0	70	23.5 ± 3.0
Right atrial volume (mL/m²)	79	21.2 ± 7.0	69	21.4 ± 7.6

MAPSE, mitral annular plane systolic excursion; PASP, pulmonary artery systolic pressure; TAPSE, tricuspid annular plane systolic excursion NOTE: p non-significant for all variables.

Discussion

In the present study, a significant correlation was found between TAPSE and MAPSE and some of the main LVDF parameters. Women presented a greater correlation, especially in the TAPSE assessment. Modin D et al.[17] demonstrated that TAPSE has an inverse correlation with age, hypertension, and E/e′ ratio and that lower TAPSE values are associated with higher cardiovascular mortality regardless of sex. The studied population demonstrated a higher prevalence of SAH in women (73%) than in men (57%), and the E/e′ ratio (corroborating the study findings of Modin D et al.[17]) and A wave increased as TAPSE decreased. Concomitantly, the E/A ratio and lateral and septal e′ waves showed a positive correlation with TAPSE, with

Table 3 – Correlation between MAPSE and TAPSE and LV diastolic function indices.

Variable	Women			Men		
	n	r	p	n	r	p
MAPSE × LA volume	116	0.04	0.686	102	0.09	0.378
MAPSE × RA volume	79	-0.05	0.684	69	0.13	0.293
TAPSE × LA volume	79	-0.06	0.621	70	0.18	0.130
TAPSE × RA volume	79	0.10	0.383	69	0.06	0.608
MAPSE × E wave (m/s)	116	0.16	0.086	103	0.21	0.037
MAPSE × A wave (m/s)	116	-0.04	0.671	103	0.15	0.131
MAPSE × E/A ratio	116	0.13	0.164	103	0.10	0.303
MAPSE × septal e' (m/s)	116	0.10	0.310	102	0.26	0.008
MPASE × lateral e' (m/s)	116	0.22	0.016	102	0.34	<0.001
MAPSE × E/e'	116	-0.07	0.475	102	-0.11	0.257
TAPSE × E wave (m/s)	79	0.10	0.395	70	0.04	0.738
TAPSE × A wave (m/s)	79	-0.29	0.009	70	0.09	0.455
TAPSE × E/A ratio	79	0.23	0.037	70	-0.04	0.743
TAPSE × septal e' (m/s)	79	0.28	0.012	69	0.01	0.957
TAPSE × lateral e' (m/s)	79	0.28	0.012	69	-0.13	0.291
TAPSE × E/e'	79	-0.27	0.018	69	0.17	0.161

LA, left atrium; LV, left ventricle; MAPSE, mitral annular plane systolic excursion; RA, right atrium; TAPSE, tricuspid annular plane systolic excursion.

Table 4 – Correlation between age (years) and echocardiographic variables.

Variable	Women			Men		
	n	r	p	n	r	p
Age × E wave (m/s)	116	-0,39	<0,001	101	-0,49	<0,001
Age × A wave (m/s)	116	0,56	<0,001	101	0,45	<0,001
Age × E/A ratio	116	-0,63	<0,001	101	-0,51	<0,001
Age × septal e' (m/s)	116	-0,33	<0,001	101	-0,37	<0,001
Age × lateral e' (m/s)	116	-0,46	<0,001	101	-0,52	<0,001
Age × E/e'	116	0,17	0,070	101	0,18	0,069
Age × E decel T (s)	116	0,23	0,012	100	0,28	0,005
Age × PASP (mmHg)	77	0,34	0,003	45	-0,01	0,970
Age × LA volume (mL/m2)	116	0,28	0,002	100	0,33	0,001
Age × MAPSE (mm)	116	-0,15	0,102	101	-0,05	0,608
Age × Tric R vel (m/s)	77	0,28	0,015	45	0,10	0,533
Age × TAPSE	79	-0,15	0,194	68	0,06	0,630
Age × RA volume	79	0,19	0,101	67	0,23	0,064
Age × RV baseline s'	79	-0,11	0,314	67	-0,21	0,081

r, Pearson correlation coefficient (E wave, A wave, E/e', E accel T, E decel T, PASP, LA volume, MAPSE, Tric R Vel, IVC, TAPSE, RA volume, RA area); Spearman correlation coefficient (E/A ratio, septal e', lateral e', RV lateral s', RV baseline s'). E decel T, E wave deceleration time; IVC, inferior vena cava; LA, left atrium; MAPSE, mitral annular plane systolic excursion; PASP, pulmonary arterial systolic pressure; RA, right atrium; RV, right ventricle; TAPSE, tricuspid annular plane systolic excursion; Tric R vel, tricuspid regurgitation velocity.

lower TAPSE values corresponding to lower E/A ratio, lateral e', and septal e' values. These findings indicate progressive or worsened LVDF associated with a lower TAPSE value, i.e., RV systolic dysfunction is associated with progressive LV diastolic dysfunction, especially in women. However, previous studies[10-12] demonstrated a more pronounced effect and higher prevalence of SAH in women. In addition, the data presented here show more evident independent correlations between SAH, TAPSE, MAPSE, and diastolic variables in women, with only MAPSE being influenced by SAH in men. Therefore, we cannot rule out that the higher prevalence of SAH in the female population studied here influenced the results. As for DM, a correlation was also observed between MAPSE and septal and lateral e' waves in both sexes and with E wave in men only. DM was correlated with preclinical LV diastolic dysfunction, which significantly worsens over the years regardless of the presence of SAH or CAD.

Other studies[18-20] demonstrated significant ventricular structural and functional differences between men and women, which are mainly related to the RV and have greater impact on the prognosis of cardiovascular morbidity and mortality in women. In addition, women have a higher prevalence of heart failure (HF) with preserved LV ejection fraction (HFpEF) than men, indicating diastolic dysfunction as the predominant cause of HF in women.[21-22] Lundorff et al.[20] identified higher E/e' ratios in women and lower lateral and septal e' waves on tissue Doppler of the mitral annulus in a population of patients with HF with reduced LV ejection

Table 5 – Association between categorical variables and MAPSE in women.

	Independent variable (n=116)	Estimated coefficient	95% CI	p*
Model 1	SAH	0.80	-0.26; 1.87	0.140
	E/A ratio	1.39	0.20; 2.58	0.024
Model 2	DM	-0.32	-1.39; 0.76	0.565
	E/A ratio	1.01	-0.14; 2.16	0.087
Model 3	DM	-0.48	-1.60; 0.64	0.404
	SAH	0.84	-0.28; 1.96	0.144
	E/A ratio	1.34	0.11; 2.58	0.035
Model 1	SAH	0.48	-0.52; 1.48	0.347
	Septal e' (m/s)	20.53	4.39; 36.7	0.014
Model 2	DM	-0.29	-1.35; 0.77	0.595
	Septal e' (m/s)	19.15	2.78; 35.5	0.024
Model 3	DM	-0.42	-1.54; 0.70	0.460
	SAH	0.54	-0.53; 1.60	0.325
	Septal e' (m/s)	20.60	3.54; 37.6	0.020
Model 1	SAH	0.86	-0.17; 1.88	0.104
	Lateral e' (m/s)	20.03	7.42; 32.6	0.002
Model 2	DM	-0.14	-1.22; 0.93	0.793
	Lateral e' (m/s)	16.52	3.90; 29.1	0.012
Model 3	DM	-0.33	-1.44; 0.78	0.560
	SAH	0.84	-0.24; 1.91	0.130
	Lateral e' (m/s)	20.02	6.69; 33.3	0.004

*CI, confidence interval; DM, diabetes mellitus; MAPSE, mitral annular plane systolic excursion; SAH, systemic arterial hypertension. *Linear regression model, p < 0.05.*

Table 6 – Association between categorical variables and TAPSE in women.

	Independent variable (n=79)	Estimated coefficient	95% CI	p*
Model 1	SAH	0.35	-1.13; 1.84	0.641
	A wave (m/s)	-4.91	-8.5; -1.33	0.009
Model 2	DM	-0.14	-1.78; 1.49	0.864
	A wave (m/s)	-4.66	-8.25; -1.07	0.013
Model 3	DM	-0.14	-1.89; 1.62	0.879
	SAH	0.42	-1.15; 1.99	0.599
	A wave (m/s)	-4.43	-8.43; -0.43	0.033
Model 1	SAH	0.35	-1.19; 1.89	0.657
	E/A ratio	1.80	0.05; 3.54	0.047
Model 2	DM	-0.28	-1.94; 1.39	0.746
	E/A ratio	1.63	-0.09; 3.35	0.067
Model 3	DM	-0.24	-2.01; 1.53	0.791
	SAH	0.42	-1.19; 2.03	0.611
	Rel. E/A	1.56	-0.31; 3.42	0.107
Model 1	SAH	-0.07	-1.5; 1.37	0.929
	Septal e' (m/s)	34.79	11.87; 57.7	0.004
Model 2	DM	-0.18	-1.79; 1.42	0.826
	Septal e' (m/s)	34.32	11.0; 57.6	0.005
Model 3	DM	-0.13	-1.85; 1.60	0.886
	SAH	0.06	-1.46; 1.58	0.942
	Septal e' (m/s)	34.02	8.94; 59.1	0.010
Model 1	SAH	0.41	-1.08; 1.91	0.590
	Lateral e' (m/s)	26.50	6.87; 46.1	0.010
Model 2	DM	-0.05	-1.71; 1.61	0.952
	Lateral e' (m/s)	25.01	5.23; 44.8	0.015
Model 3	DM	-0.05	-1.80; 1.70	0.955
	SAH	0.48	-1.08; 2.05	0.547
	Lateral e' (m/s)	25.76	4.55; 47.0	0.020
Model 1	SAH	0.08	-1.39; 1.55	0.916
	E/e'	-0.27	-0.49; -0.05	0.018
Model 2	DM	-0.30	-1.93; 1.33	0.720
	E/e'	-0.26	-0.48; -0.04	0.023
Model 3	DM	-0.24	-1.99; 1.50	0.784
	SAH	0.18	-1.37; 1.73	0.820
	E/e'	-0.25	-0.48; -0.02	0.038

*CI, confidence interval; DM, diabetes mellitus; SAH, systemic arterial hypertension; TAPSE, tricuspid annular plane systolic excursion. *Linear regression model, p < 0.05.*

Table 7 – Association between categorical variables and MAPSE in men.

	Independent variable (n=101)	Estimated coefficient	95% CI	p*
Model 1	SAH	0.28	-0.84; 1.41	0.625
	E wave (m/s)	2.85	0.23; 5.46	0.036
Model 2	DM	1.01	-0.20; 2.23	0.105
	E wave (m/s)	2.91	0.35; 5.47	0.028
Model 3	DM	0.12	-1.28; 1.51	0.872
	SAH	-0.63	-1.89; 0.62	0.324
	E wave (m/s)	2.82	0.28; 5.36	0.032
Model 1	SAH	0.37	-0.77; 1.51	0.526
	Septal e' (m/s)	21.57	1.85; 41.3	0.034
Model 2	DM	1.12	-0.11; 2.34	0.076
	Septal e' (m/s)	22.65	3.55; 41.8	0.022
Model 3	DM	0.13	-1.25; 1.50	0.855
	SAH	-0.58	-1.82; 0.66	0.361
	Septal e' (m/s)	26.26	7.19; 45.33	0.008
Model 1	SAH	0.42	-0.72; 1.56	0.472
	Lateral e' (m/s)	16.42	3.00; 29.8	0.018
Model 2	DM	1.13	-0.09; 2.34	0.072
	Lateral e' (m/s)	16.91	3.95; 29.9	0.012
Model 3	DM	0.20	-1.17; 1.58	0.772
	SAH	-0.48	-1.73; 0.77	0.451
	Lateral e' (m/s)	18.34	5.33; 31.3	0.007

*CI, confidence interval; DM, diabetes mellitus; MAPSE, mitral annular plane systolic excursion; SAH, systemic arterial hypertension. *Linear regression model, p < 0.05.*

fraction (HFrEF), with TAPSE and LV isovolumetric relaxation time (IVRT) indicating a worse cardiovascular prognosis. Therefore, the findings of this study corroborate those in the current literature, which identifies a strong correlation between RV systolic function, assessed mainly through TAPSE, and LVDF in women. Corroborating these findings, uni- and multivariate analyses identified that the presence of SAH influenced TAPSE in women only.

The MAPSE analysis evidenced a positive correlation with lateral e′ values in both sexes and a positive correlation with septal e′ and E wave in men. MAPSE values correlate with better LVDF. However, atrioventricular annulus plane motion has a well-known correlation with LV systolic function. Lower MAPSE values are associated with adverse events in several cardiovascular diseases.[23] However, no studies significantly and definitively correlating MAPSE values with LVDF indices were found in the current literature. On the contrary, the few existing studies failed to find such an association,[24,25] unanimously identifying the need for further studies in this area.

Another relevant finding presented here was the association between LVDF parameters with age, with TAPSE and MAPSE values not being influenced by age. The prevalence of LV diastolic dysfunction increases with age, especially in hypertensive women,[26-28] indicating progressive LV relaxation worsening. However, no study has consistently correlated TAPSE and MAPSE values with advancing age. Once again, the findings of the present study corroborate those of the current literature.

Some limitations should be mentioned. First, the relatively small number of participants and the higher prevalence of SAH in women may have influenced the results. The small number of participants may also have corroborated the fact that no significant differences were found in TAPSE and MAPSE when the diastolic function was classified as a categorical variable. Finally, the exclusion criteria were strict, excluding patients with advanced degrees (II and III) of diastolic and LV systolic dysfunction, making it impossible to assess the behaviors of the MAPSE and TAPSE values in these cases.

Conclusions

In the present study, MAPSE and TAPSE values showed a significant correlation with some LVDF variables, especially in women. More studies are needed in this area to validate our findings.

Authors' contributions

Data collection: Baroncini LAV, Martins AAB, Osaku LY, Camarozano AC, Carmo DC, Sá CRF, Fortunato JA, Darwich RZ; Data analysis: Baroncini LAV, Martins AAB, Osaku LY, Camarozano AC, Carmo DC; Data design: Baroncini LAV, Martins AAB, Osaku LY, Camarozano AC; Manuscript writing: Baroncini LAV, Martins AAB, Osaku LY, Camarozano AC, Carmo DC, Sá CRF, Fortunato JA, Darwich RZ; Critical review of the manuscript for important intellectual content: Baroncini LAV, Martins AAB, Osaku LY, Camarozano AC.

Conflict of interest

The authors have declared that they have no conflict of interest.

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