Jurnal Ilmiah **ISLAM FUTURA**
Vol. 25. No. 2, August 2025, 285-304

EFFECTS OF QUR'AN RECITATION ON LEFT VENTRICULAR OUTFLOW TRACT VELOCITY TIME INTEGRAL IN PATIENTS WITH HEART FAILURE WITH REDUCED EJECTION FRACTION

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Abstract

Left ventricular outflow tract velocity time integral (LVOT-VTI) is a noninvasive echocardiographic parameter representing stroke volume. Qur'an recitation has been reported to influence cardiovascular indicators such as heart rate variability and blood pressure, which are indirectly related to cardiac function, although its effect on direct echocardiographic parameters remains unclear. This study aimed to evaluate whether patients with heart failure with reduced ejection fraction (HFrEF) show improvement in cardiac function, as reflected by changes in LVOT-VTI, following Qur'an recitation. A case-control study was conducted involving 30 HFrEF patients divided into three groups: Group 1 recited one juz of the Qur'an daily, Group 2 recited half a juz daily, and Group 3 served as a control. Echocardiographic measurements of LVOT-VTI and ejection fraction (EF) were performed at baseline and after 30 days. Significant improvements in EF were observed in Groups 1 and 2 (p = 0.000), while no significant change was found in the control group (p = 0.260). LVOT-VTI increased significantly in Groups 1 and 2 (p = 0.020) but not in Group 3 (p = 0.090). LVOT-VTI is an independent prognostic marker in HFrEF, and these findings support further well-designed clinical trials to evaluate the clinical benefits of Qur'an recitation.

Keywords: *Left ventricular outflow tract velocity time integral; Heart rate variability; Qur'an; Heart failure with reduced ejection fraction; cardiac function*.

Abstrak

Left ventricular outflow tract velocity time integral (LVOT-VTI) adalah parameter ekokardiografi noninvasif yang mewakili volume sekuncup. Bacaan Al-Qur'an dilaporkan memengaruhi indikator kardiovaskular seperti variabilitas detak jantung dan tekanan darah, yang secara tidak langsung terkait dengan fungsi jantung, meskipun efeknya pada parameter ekokardiografi langsung masih belum jelas. Studi ini bertujuan untuk mengevaluasi apakah pasien dengan heart failure with reduced ejection fraction (HFrEF) menunjukkan perbaikan fungsi jantung, yang tercermin dari perubahan

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Citation: Nurkhalis, Kurnia F Jamil, Imran, Muhammad Yamin. "Effects of Qur'an Recitation on Left Ventricular Outflow Tract Velocity Time Integral in Patients with Heart Failure with Reduced Ejection Fraction" *Jurnal Ilmiah Islam Futura* 25, no. 2 (2025): 285–304.

10.22373/jiif.v25i2.28968

LVOT-VTI setelah membaca Al-Qur'an. Studi kasus-kontrol dilakukan terhadap 30 pasien HFrEF yang dibagi menjadi tiga kelompok: Kelompok 1 membaca satu juz Al-Qur'an setiap hari, kelompok 2 membaca setengah juz setiap hari, dan kelompok 3 berfungsi sebagai kelompok kontrol. Pengukuran ekokardiografi LVOT-VTI dan fraksi ejeksi dilakukan pada awal dan setelah 30 hari membaca Al-Qur'an. Peningkatan signifikan pada EF diamati pada kelompok 1 dan 2 (p = 0,000), sementara tidak ada perubahan signifikan yang ditemukan pada kelompok kontrol (p = 0,260). LVOT-VTI meningkat secara signifikan pada Kelompok 1 dan 2 (p = 0,020) tetapi tidak pada Kelompok 3 (p = 0,090). LVOT-VTI adalah penanda prognostik independen pada HFrEF, dan temuan ini mendukung uji klinis yang dirancang dengan baik untuk mengevaluasi manfaat klinis dari membaca Al-Qur'an.

Kata Kunci: *Left ventricular outflow tract velocity time integral; variabilitas detak jantung; Qur'an; Heart failure with reduced ejection fraction; fungsi jantung.*

مستخلص

يُعدّ تكامل السرعة والزمن في مخرج البطين الأيسر (LVOT-VTI) مؤشراً تخطيطياً غير باضع يعكس حجم الضربة القلبية. وقد أظهرت دراسات سابقة أن تلاوة القرآن الكريم تؤثر في بعض المؤشرات القلبية الوعائية مثل تغاير معدل ضربات القلب وضغط الدم، وهي مؤشرات ترتبط بشكل غير مباشر بوظيفة القلب، إلا أن تأثيرها على المؤشرات التخطيطية المباشرة للقلب ما يزال غير واضح. هدفت هذه الدراسة إلى تقييم ما إذا كان مرضى قصور القلب مع انخفاض الكسر القذفي (HFrEF) يُظهرون تحسناً في وظيفة القلب، كما ينعكس ذلك في التغيرات في قيمةLVOT-VTI ، بعد تلاوة القرآن الكريم
أُجريت دراسة حالة–شاهد شملت 30 مريضاً مصاباً HFrEF قُسّموا إلى ثلاث مجموعات: المجموعة الأولى قامت بتلاوة جزء واحد من القرآن الكريم يومياً، والمجموعة الثانية قامت بتلاوة نصف جزء يومياً، بينما شكّلت المجموعة الثالثة مجموعة ضابطة. أُجريت القياسات التخطيطية للقلب، بما في ذلك LVOT-VTI والكسر القذفي(EF) ، عند خط الأساس وبعد 30 يوماً
أظهرت النتائج تحسناً معنوياً في الكسر القذفي في المجموعتين الأولى والثانية = p) (0.000، في حين لم يُلاحظ تغير معنوي في المجموعة الضابطة .(p = 0.260) كما ازداد LVOT-VTI بشكل معنوي في المجموعتين الأولى والثانية(p = 0.020) ، بينما لم يكن التغير معنوياً في المجموعة الثالثة .(p = 0.090) يُعدّ LVOT-VTI مؤشراً تنبؤياً مستقلاً في مرضى قصور القلب مع انخفاض الكسر القذفي، وتدعم هذه النتائج الحاجة إلى إجراء تجارب سريرية أوسع وأكثر إحكاماً لتقييم الفوائد السريرية لتلاوة القرآن الكريم.

الكلمات الرئيسية: تكامل السرعة والزمن في مخرج البطين الأيسر؛ تغاير معدل ضربات القلب؛ القرآن الكريم؛ قصور القلب مع انخفاض الكسر القذفي؛ وظيفة القلب.

A. Introduction

Heart failure (HF) is a complex clinical syndrome with symptoms and signs resulting from any structural or functional impairment of ventricular filling or ejection of blood. HF poses

a growing health and economic burden for the United States due to the aging population.[1] According to the Global Burden of Disease (GBD) data, the territorial age-standardized rate (ASR) of HF prevalence in the U.S. ranged from 211.86 to 1,032.84 cases per 100,000 individuals. In 2019, the three countries with the highest ASR for HF prevalence were China (1,032.84), Indonesia (900.90), and Malaysia (809.47). The prevalence is expected to increase due to improved survival following an HF diagnosis, driven by the availability of evidence-based, life-saving treatments and the overall increase in life expectancy within the general population.[2]

The findings indicate an important change in HF demography, with HF occurring at an older age but with less traditional cardiovascular risk factors such as alcohol, smoking, blood pressure, and cholesterol and more cardiovascular and noncardiovascular comorbidities. However, there were significant differences between groups of patients with HF. Although some differences have reduced over time, others have persisted or increased, indicating key targets for contemporary tailored prevention programs. The prevalence of diabetes mellitus, obesity, hypertension, chronic kidney disease, and cancer comorbidities at HF onset are increasing.[3]

Heart failure (HF) is classified into three categories based on left ventricular ejection fraction (EF): HF with reduced EF (HFrEF), mildly reduced EF (HFmrEF), and preserved EF (HFpEF), corresponding to EF values of ≤ 40%, 41–49%, and ≥ 50%, respectively. A newer classification, HF with improved EF, has been introduced. This type is defined as HF with a baseline EF ≤ 40%, an increase of ≥ 10 percentage points from baseline, and a subsequent EF measurement >40%.[4]

The left ventricular outflow tract velocity time integral (LVOT-VTI) is a representative and non-invasive echocardiographic parameter for assessing stroke volume. A previous report has demonstrated that lower LVOT-VTI could predict mortality in patients with acute or chronic HF.[5]

[1]Paul A. Heidenreich et al., "2022 AHA/ACC/HFSA Guideline for the Management of Heart Failure: A Report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines," *Circulation* (Lippincott Williams and Wilkins, May 3, 2022), https://doi.org/10.1161/CIR.0000000000001063.

[2] Jiayu Feng, Yuhui Zhang, and Jian Zhang, "Epidemiology and Burden of Heart Failure in Asia," *JACC: Asia* (Elsevier Inc., April 1, 2024), https://doi.org/10.1016/j.jacasi.2024.01.013.

[3] Claire A. Lawson et al., "Risk Factors for Heart Failure," *Circulation: Heart Failure* 13, no. 2 (February 2020), https://doi.org/10.1161/CIRCHEARTFAILURE.119.006472.

[4] Gianluigi Savarese et al., "Global Burden of Heart Failure: A Comprehensive and Updated Review of Epidemiology," *Cardiovascular Research* 118, no. 17 (January 18, 2023): 3272–87, https://doi.org/10.1093/cvr/cvac013.

[5] Kazunori Omote et al., "Left Ventricular Outflow Tract Velocity Time Integral in Hospitalized Heart Failure with Preserved Ejection Fraction," *ESC Heart Failure* 7, no. 1 (February 1, 2020): 167–75, https://doi.org/10.1002/ehf2.12541.

Goldman et al.[6] reported that when heart rate (HR) is within the normal range, the mean LVOT VTI values are approximately 20 ± 3 cm (17–23 cm), indicating a normal stroke volume (SV) and cardiac output (CO). When the HR is below 55 bpm, the LVOT VTI values must exceed 18 cm to reflect adequate SV and CO. Conversely, when HR exceeds 95 bpm, LVOT-VTI values should be below 22 cm; otherwise, elevated SV and CO are implied. [7]

Supportive care, including physical, psychosocial, and spiritual, can be an effective coping resource for HF patients. Nurses may provide individualised supportive care, which includes offering positive emotional support, enhancing the patients' knowledge of self-management, and addressing their physical and psychosocial needs.[8] It has been researched and proven that listening to the Qur'an recitation can reduce stress and psychological disorders. For centuries, Muslims have turned to the Qur'an as a source of healing for those suffering from stress and psychological issues. One notable benefit of listening to Qur'an recitation is its healing effect on the body. Patients who engage with this practice may experience improved physiological responses, such as increased metabolism, body temperature, cardiac output, blood pressure, heart rate, and respiratory rate.[9]

Considering that measurement of LVOT VTI is a dynamic parameter that can change in a very short time and is useful for assessing cardiac output and therapy response, the researchers deemed it important to investigate. This study investigates whether HF patients with reduced ejection fraction (HFrEF) show significant improvement in their condition, measured by changes in LVOT VTI, after receiving Qur'an recitation intervention.

B. Patients and methods

LVOT VTI is used to estimate stroke volume since it reflects the column of blood that moves through the LV outflow tract during each systole, per the following equation. Stroke Volume = ¼ LVOT VTI x Cross Sectional Area of the Left Ventricular Outflow Tract.

LVOT VTI is calculated by placing the pulsed Doppler sample volume in the outflow tract below the aortic valve and recording the velocity (cm/s). When the velocity signal is

[6] Jonathan H. Goldman et al., "Usefulness of Stroke Distance by Echocardiography as a Surrogate Marker of Cardiac Output That Is Independent of Gender and Size in a Normal Population," *The American Journal of Cardiology* 87, no. 4 (February 2001): 499–502, https://doi.org/10.1016/S0002-9149(00)01417-X.

[7] Pablo Blanco, "Rationale for Using the Velocity–Time Integral and the Minute Distance for Assessing the Stroke Volume and Cardiac Output in Point-of-Care Settings," *Ultrasound Journal* (Springer, December 1, 2020), https://doi.org/10.1186/s13089-020-00170-x.

[8] Martha Kyriakou et al., "Supportive Care Interventions to Promote Health-Related Quality of Life in Patients Living With Heart Failure: A Systematic Review and Meta-Analysis," *Heart, Lung and Circulation* 29, no. 11 (November 2020): 1633–47, https://doi.org/10.1016/j.hlc.2020.04.019.

[9] Ali Mansouri et al., "Investigating Aid Effect of Holy Quran Sound on Blood Pressure, Pulse, Respiration and O 2 Sat in ICU Patients," *International Journal of Scientific Study*, 2017, https://doi.org/10.17354/ijssI/2017/1.

integrated with respect to time, the distance blood moves with each systole is calculated in cm/systole (Figure 1). Assuming laminar flow through the LVOT, this has been shown to correlate well with cardiac output, which is equivalent to stroke volume multiplied by heart rate.

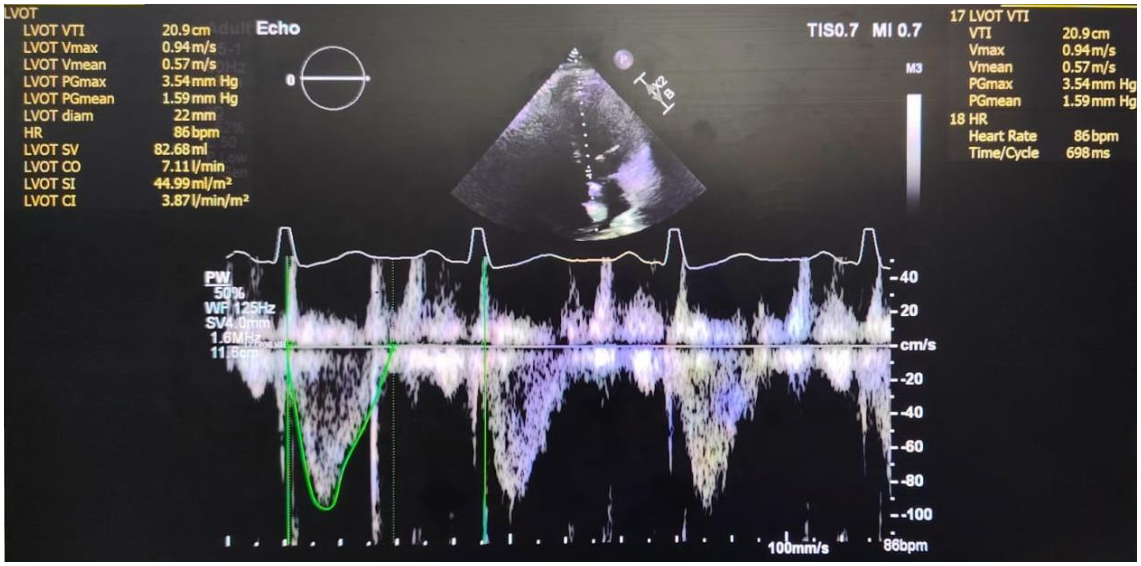

Figure 1. Measurement of LVOT VTI from echocardiography.
LVOT: left ventricular outflow tract, VTI: velocity time integral, Vmax: velocity maximum, Vmean: velocity mean, PGmax: maximum peak gradient, PGmean: pressure gradient, HR: Heart Rate, SV: stroke volume, CO: cardiac output, SI: sphericity index, CI: cardiac index.

Subjects were selected based on inclusion and exclusion criteria at the Echocardiography Polyclinic of dr. Zainoel Abidin Public Hospital from May 2024 - March 2025. The inclusion criteria were as follows: (1) male or female participants aged between 25 and 65 years; (2) diagnosed with stable chronic HFrEF) for a minimum duration of three months; (3) an ejection fraction ranging from 15% to 40%, as determined by echocardiographic assessment and documented in the echocardiography report; (4) no history of coronary intervention within the past three months; and (5) the ability to comply with the research protocol under the supervision of the researcher or research team. Exclusion criteria included any of the following: (1) a history of stroke accompanied by residual limb weakness or slurred speech; (2) the presence of severe valvular stenosis; or (3) atrial or ventricular arrhythmias.

There were 30 patients who met the inclusion and exclusion criteria who were interviewed to collect demographic and clinical characteristic data. They were asked to sign an informed consent form stating their willingness to participate in the study. Each subject undergoes a recitation test to determine group allocation, with each group consisting of 10 subjects. Subjects in Group 1 were instructed to recite one juz per day for 30 consecutive days; those in Group 2 were instructed to recite half a juz per day for 30 days; and subjects in Group

3 were not instructed to recite for the 30 days. After the group assignment, patients were asked to confirm their agreement to participate in the designated intervention group.

All subjects underwent baseline echocardiographic assessment on day 0, which included evaluation of left ventricular outflow tract velocity time integral (LVOT VTI), LVOT velocity maximum (Vmax), left ventricular end-diastolic diameter (LVEDD), left ventricular end-systolic diameter (LVESD), interventricular septum thickness at end-diastole (IVSD), interventricular septum thickness at end-systole (IVSS), ejection fraction using the Teichholz method (EF Teich), tricuspid annular plane systolic excursion (TAPSE), and diastolic dysfunction. After 30 days, subjects returned for a follow-up echocardiographic evaluation. This case-control study was carried out after obtaining the Health Research Ethics Committee of Dr. Zaionel Abidin Public Hospital (No. 049/ETIK–RSUZA/2024). This ethical approval is valid for the period of March 14th, 2024, until March 14th, 2025.

Statistical analysis

Univariate analysis was conducted to describe the characteristics of each research variable. Categorical variables were presented as frequencies (n) and percentages (%), while numerical variables were described in terms of central tendency and dispersion measures. Measures of central tendency included the mean (for normally distributed data) or the median (for non-normally distributed data), and measures of dispersion included the standard deviation (for normally distributed data) or the percentile (for non-normally distributed data).

Bivariate analysis was conducted to test numerical comparative hypotheses across more than two unpaired groups, aiming to determine differences between variables across the Qur'an recitation groups. A one-way ANOVA with Bonferroni post hoc was used if the data were normally distributed and exhibited equal variances. If the data were normally distributed but variances were unequal, a one-way ANOVA with Games-Howell post hoc was applied. For non-normally distributed data, a transformation was performed prior to analysis. The subsequent statistical test depended on the distribution and variance following transformation. If the data remained non-normally distributed, the Kruskal–Wallis test with Mann–Whitney post hoc was used.

C. Results

Table 1 presents the data characteristics of the total sample of 30 cardiac polyclinic patients. We divided them into three groups, each of 10 subjects divided by the amount of their Qur'an recitation.

Table 1. Baseline characteristics.

Variable	Group 1	Group 2	Group 3 (control group)	P
Age (years)	56.00 ± 5.25	50.60 ± 10.55	55.70 ± 5.67	0.360
BMI	26.07 ± 3.92	27.38 ± 4.06	25.10 ± 5.55	0.570
Sex				0.580
Male (n / %)	8 (80.0%)	9 (90.0%)	9 (90.0%)	
Female (n / %)	2 (20.0%)	1 (10.0%)	1 (10.0%)	
Blood pressure:				
Systolic (mmHg)	128.80 ± 29.56	128.50 ± 27.90	116.60 ± 15.77	0.370
Diastolic (mmHg)	87.50 ± 22.84	84.90 ± 16.35	76.10 ± 9.24	0.200
Heart Rate (bpm)	69.90 ± 18.92	72.40 ± 16.34	75.60 ± 13.12	0.730
Risk Factors:				
Hypertension (n/%)	7 (70.0%)	9 (90.0%)	5 (50.0%)	0.330
Diabetes Mellitus (n/%)	3 (30.0%)	2 (20.0%)	3 (30.0%)	1.000
Dyslipidaemia (n/%)	7 (70.0%)	2 (20.0%)	6 (60.0%)	0.660

BMI: Body mass index, mmHg: millimetre of mercury.

Group 1 recited one juz of the Qur'an per day, Group 2 recited half a day, and Group 3 did not recite the Qur'an. The subjects were followed for 30 days. All subjects were diagnosed with heart failure, with a mean age of 56.00 ± 5.25 years in Group 1, 50.60 ± 10.55 years in Group 2, and 55.70 ± 5.67 years in Group 3. Male participants constituted the majority in each group. Blood pressure was relatively stable across all groups, with Group 1 exhibiting the highest mean blood pressure at 129/88 mmHg. Hypertension was the most prevalent risk factor among the subjects, followed by dyslipidaemia and diabetes mellitus. Based on these characteristics, no significant differences were observed among the groups.

Table 2. Baseline echocardiography.

Echocardiography Parameter	Group 1	Group 2	Group 3 (control)	P
LVEDD (mm)	54.00 ± 9.34	55.80 ± 8.59	55.80 ± 7.24	0.870
LVESD (mm)	45.60 ± 8.53	47.80 ± 8.12	48.50 ± 7.23	0.710
IVSD (mm)	9.10 ± 3.35	9.80 ± 2.35	8.80 ± 2.09	0.610
IVSS (mm)	10.40 ± 3.66	11.10 ± 2.88	10.50 ± 2.01	0.840
EF (%)	32.80 ± 4.85	29.30 ± 6.39	26.80 ± 6.49	0.090

LVOT VTI (cm)	17.81 ± 4.81	17.49 ± 5.07	13.59 ± 3.21	0.050
LVOT Vmax (cm/s)	84.75 ± 14.09	100.43 ± 26.54	80.50 ± 13.51	0.150
TAPSE (cm)	1.98 ± 0.33	2.03 ± 0.31	1.81 ± 0.37	0.370
Diastolic dysfunction (n / %)	9 (90.0%)	8 (80.0%)	10 (100.0%)	0.460

LVEDD: left ventricular end-diastolic diameter, LVESD: left ventricular end-systolic diameter, IVSD: interventricular septum thickness at end-diastole, IVSS: interventricular septum thickness at end-systole, EF: ejection fraction, LVOT VTI: left ventricular outflow tract velocity time integral, LVOT Vmax: left ventricular outflow tract velocity maximum, Tapse: tricuspid annular plane systolic excursion.

Before the Qur'an recitation intervention, data were collected from 30 subjects divided into three groups. The average LVEDD indicated ventricular wall thickening, with the highest values observed in Groups 2 and 3 (55.80 ± 8.59 and 55.80 ± 7.24mm), which corresponded to the highest LVESD recorded in Group 3. IVSD and IVSS in Group 2 were the highest (9.80 ± 2.35 mm and 11.10 ± 2.88 mm, respectively). The mean EF in Group 3 was the lowest (26.80 ± 6.49 %). LVOT VTI was the highest in Group 1 (17.81 ± 4.81), while LVOT Vmax was the highest in Group 2 (100.43 ± 26.54 cm/s).

Table 3. Echocardiography data post-intervention.

Echo Parameter	**Group 1**	**Group 2**	**Group 3 (control)**	**P**
LVEDD (mm)	54.10 ± 9.65	56.10 ± 8.33	57.70 ± 11.12	0.750
LVESD (mm)	40.90 ± 11.70	45.70 ± 7.72	49.40 ± 11.69	0.300
IVSD (mm)	7.60 ± 1.71	9.00 ± 1.05	8.10 ±1.73	0.090
IVSS (mm)	9.50 ± 1.27	10.70 ± 1.64	9.90 ± 2.02	0.230
EF (%)	40.10 ± 6.36	37.2 ± 8.27	30.90 ± 9.09	0.060
LVOT VTI (cm)	21.55 ± 6.01	21.35 ± 2.82	15.41 ± 2.43	0.000
LVOT Vmax (cm/s)	101.30 ± 18.80	106.10 ± 13.27	88.10 ± 8.30	0.000
TAPSE (cm)	1.78 ± 0.42	2.01 ± 0.29	1.99 ± 0.29	0.360
Diastolic dysfunction (n / %)	9 (90.0%)	9 (90.0%)	10 (100.0%)	0.370

LVEDD: left ventricular end-diastolic diameter, LVESD: left ventricular end-systolic diameter, IVSD: interventricular septum thickness at end-diastole, IVSS: interventricular septum thickness at end-systole, EF: ejection fraction, LVOT VTI: left ventricular outflow tract velocity time integral, LVOT Vmax: left ventricular outflow tract velocity maximum, Tapse: tricuspid annular plane systolic excursion.

Table 3 shows a significant increase in LVOT VTI and LVOT Vmax across the three groups after one month of intervention. In the pre-and post-intervention evaluation (Table 4), a significant improvement in ejection fraction (EF) was observed in Groups 1 and 2 (p = 0.000),

whereas Group 3 did not exhibit a significant change (p = 0.260). Similarly, the increase in LVOT VTI was statistically significant in Groups 1 and 2 (p = 0.020) but not in the control group (p = 0.090). A significant increase in LVOT Vmax was observed only in Group 1 (p = 0.010).

Table 4. Changes in EF, LVOT VTI, and LVOT Vmax pre and post.

Group	EF			LVOT VTI			LVOT Vmax		
	Pre	post	p	Pre	Post	p	pre	Post	P
Group 1	32.80 ± 4.88	40.10 ± 6.36	0.000	17.81 ± 4.81	21.55 ± 6.01	0.020	84.75 ±14.09	101.30 ±18.80	0.010
Group 2	29.30 ± 6.39	37.20 ± 8.27	0.000	17.49 ± 5.06	21.35 ± 2.81	0.020	100.43 ±26.54	106.10 ±13.27	0.560
Group 3 (control)	26.80 ± 6.49	30.90 ± 9.09	0.260	13.59 ± 3.21	15.41 ± 2.43	0.090	80.50 ±13.51	88.10 ± 8.30	0.170

Statistical analysis employs the paired t-test or Wilcoxon test when data is not normally distributed. EF: ejection fraction, LVOT VTI: left ventricular outflow tract velocity time integral, LVOT Vmax: left ventricular outflow tract velocity maximum.

The follow-up analysis (Figures 1–3) demonstrated differences between the groups following the intervention, with a particularly notable difference in the average post-treatment EF between the group that recited one juz of the Qur'an daily and the control group (p = 0.040). Regarding changes in LVOT VTI, significant differences were observed in both Group 1 (p = 0.030) and Group 2 (p = 0.020) compared to the control group. Similarly, a significant difference in LVOT Vmax was found between Group 2 and the control group (p = 0.010).

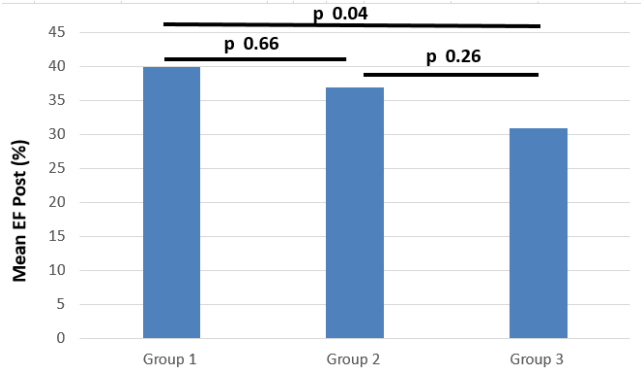

Figure 2. Post Hoc analysis of mean EF post-treatment.

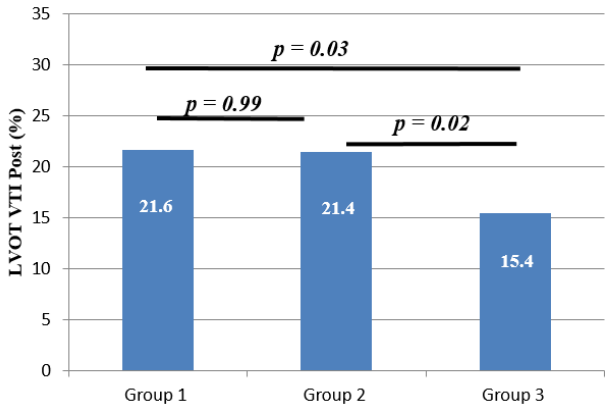

Figure 3. Post Hoc Analysis of LVOT VTI post-treatment.

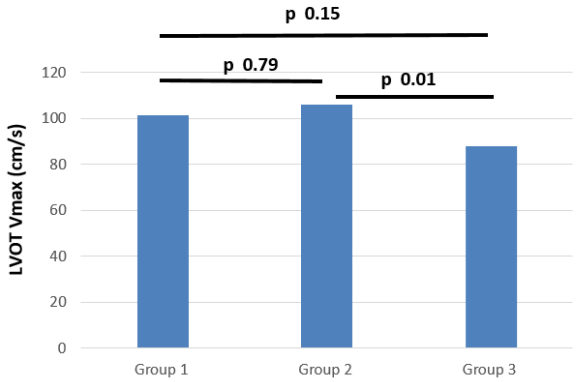

Figure 4. Post Hoc Analysis of LVOT Vmax post-treatment.

Among the groups, a significant increase was observed in the average VTI and Vmax values of LVOT Group 1 (21.55 and 101.30, respectively) following the 30-day Qur'an recitation intervention. Multivariate analysis of changes in LVOT VTI and LVOT Vmax yielded statistically significant results (p= 0.000 for both measures).

D. Discussion

The outlook for heart failure remains unfavourable. Globally, 2% to 17% of patients die upon initial hospital admission, with 17% to 45% dying within one year and over 50% within five years. Considering the substantial burden posed by this morbidity and mortality, a comprehensive understanding of the interconnected pathophysiology and new therapeutic targets needs to be continuously developed.[10]

In addition to ejection fraction, LVOT VTI, or stroke distance, indicates the strength of the left ventricle's contractility, which influences stroke volume and cardiac output. Extremely low LVOT VTI can indicate heart failure patients at elevated risk of mortality. Left ventricular

[10] Christina Tan et al., "Left Ventricular Outflow Tract Velocity Time Integral Outperforms Ejection Fraction and Doppler-Derived Cardiac Output for Predicting Outcomes in a Select Advanced Heart Failure Cohort," *Cardiovascular Ultrasound* 15, no. 1 (July 3, 2017), https://doi.org/10.1186/s12947-017-0109-4.

outflow tract VTI (LVOT VTI) offers superior prognostic insights compared to ejection fraction. A low LVOT VTI is significantly associated with negative clinical outcomes for several reasons. Reduced cardiac output is a prelude to cardiogenic shock, multi-organ failure, and mortality. The precision of cardiac output assessed via Doppler may be compromised by inaccuracies in calculating the cross-sectional area of the LVOT, as dictated by the formula πr^2. Utilising solely the LVOT VTI, without Doppler cardiac output, will eradicate this source of mistake. In individuals with tachycardia resulting from cardiogenic shock and impaired left ventricular function, an elevated heart rate will partially offset the reduction in left ventricular function, thereby sustaining cardiac output; however, LVOT VTI will remain diminished. Consequently, in cases of reduced ventricular output coupled with compensatory tachycardia, LVOT VTI may function as a highly sensitive marker of cardiogenic shock and the impaired ability to meet systemic tissue perfusion and metabolic demands.[11]

The LVOT VTI represents the Doppler-measured distance blood travels through the left ventricular outflow tract during systole. This measurement is multiplied by the LVOT area to calculate stroke volume and forward cardiac output. Several recent cohort studies have demonstrated that a low VTI (<15–17 cm) is a stronger predictor of death or rehospitalisation in HFrEF than the ejection percentage alone.[12]

Four-dimensional flow cardiac magnetic resonance (4D-flow CMR) studies conducted between 2019 and 2022 have shown that patients with HFrEF exhibit significantly lower peak LVOT velocities and pressure gradients than healthy individuals and those with HFpEF. This finding could indicate that they have less heart contraction capacity. Both load and contractility impact LVOT Vmax or peak systolic velocity.[13]

Currently, no studies directly examine the effects of Qur'an recitation on specific echocardiographic parameters such as LVOT VTI and LVOT Vmax. However, several recent studies have explored the impact of Qur'an recitation on cardiovascular health indicators, particularly heart rate variability (HRV) and blood pressure, which are indirectly related to

[11] Bryan Ristow et al., "Left Ventricular Outflow Tract and Pulmonary Artery Stroke Distances Independently Predict Heart Failure Hospitalization and Mortality: The Heart and Soul Study," *Journal of the American Society of Echocardiography* 24, no. 5 (May 2011): 565–72, https://doi.org/10.1016/j.echo.2010.12.024.

[12] Francesco Gentile et al., "Left Ventricular Outflow Tract Velocity-Time Integral Improves Outcome Prediction in Patients with Secondary Mitral Regurgitation," *International Journal of Cardiology* 392 (December 2023): 131272, https://doi.org/10.1016/j.ijcard.2023.131272.

[13] Jiaxuan Guo et al., "The Value of Blood Flow Velocity and Pressure Gradient in Differentiating Patients with Different Types of Heart Failure," *Quantitative Imaging in Medicine and Surgery* 14, no. 10 (October 2024): 7612–24, https://doi.org/10.21037/qims-24-311.

cardiac function. Although no study has yet interrogated VTI or Vmax directly, three mechanistic clusters supported by recent evidence are relevant.

Table 5. Previous research on the influence of Qur'an recitation.

Cluster	Recent evidence (< 7 years)	Relevance to VTI/Vmax
Autonomic shift (↑parasympathetic, ↓sympathetic)	Experimental HRV study in Tahfiz students (students memorising Qur'an): reciting/memorising Qur'an increased SDNN and HF power and lowered LF/HF ratio[14].	Lower sympathetic tone → ↓heart rate & afterload → longer diastolic filling & greater stroke volume → potential rise in VTI
Immediate haemodynamic easing	RCT in 202 uncontrolled hypertensives: 15 min listening to recitation cut SBP by−5.9 mmHg and HR −4 bpm.[12]	Reduced arterial pressure and rate lessen LV wall stress, facilitating higher forward flow without increasing peak velocity burden
Chronic stress buffering & quality-of-life gains	2022 systematic review (20 studies) showed consistent improvements in anxiety, depression and physiologic parameters rom listening to or reciting the Qur'an[15]	Sustained neuro-hormonal down-regulation may improve ventricular–arterial coupling over weeks to months

HRV: heart rate variability, SDNN: Standard deviation of normal-to-normal intervals, HF: High frequency, LF: Low frequency, VTI:Velocity time integral, SBP: Systolic blood pressure.

The results of this study demonstrated a significant difference in the average post-treatment EF between the group that recited one juz of the Qur'an daily and the control group ($p = 0.040$). Regarding changes in LVOT VTI, significant differences were observed in both Group 1 ($p = 0.030$) and Group 2 ($p = 0.020$) compared to the control group. Similarly, for LVOT Vmax, a significant difference was found between Group 2 and the control group ($p = 0.010$).

The relaxing effects of listening to the Qur'an recitation are likely comparable to meditation or music. It has been demonstrated that listening to the Qur'an induces an alpha wave, which promotes relaxation.[16] When one listens to the recitation of the Qur'an and reflects on its content, a contemplative mental state is fostered, directing focus away from the external environment and current events. The outside world and current events are not the focus of the mind. This meditative state cultivates inner stillness and cognitive silence. Furthermore, the decrease in blood pressure following Qur'an recitation was most likely attributable to decreased

[14] Musthika W. Mashitah and Kumoro A. Lenggono, "Quran Recitation Therapy Reduces the Depression Levels of Hemodialysis Patients," *International Journal of Research in Medical Sciences* 8, no. 6 (May 26, 2020): 2222, https://doi.org/10.18203/2320-6012.ijrms20202271.

[15] Wan Nor Atikah Che Wan Mohd Rozali et al., "The Impact of Listening to, Reciting, or Memorizing the Quran on Physical and Mental Health of Muslims: Evidence From Systematic Review," *International Journal of Public Health* 67 (August 31, 2022), https://doi.org/10.3389/ijph.2022.1604998.

[16] Noor -ul-Ain Irfan et al., "Differences in Brain Waves and Blood Pressure by Listening to Quran-e-Kareem and Music," *Journal of Islamabad Medical & Dental College* 8, no. 1 (March 24, 2019): 40–44, https://doi.org/10.35787/jimdc.v8i1.315.

psychological tension or discomfort.[17] Conversely, elevated blood pressure increases afterload, making it more challenging for the left ventricle to eject blood. This increased resistance can decrease stroke volume and LVOT VTI, especially in patients with compromised cardiac function. Blood pressure alterations significantly impact LVOT VTI by influencing afterload and preload conditions.

Neurologically, reading exerts a more significant impact than merely hearing. The thalamus is affected by the superior and inferior colliculi during reading. The colliculi, located in the upper midbrain, comprise two pairs of nerve bundles: the superior colliculi and the inferior colliculi. The superior region processes images received from the eyes prior to their transmission to other areas of the brain. Simultaneously, the inferior region analyses auditory stimuli coming from the brain area primarily responsible for hearing. During auditory processing, the thalamus is solely affected by a single colliculus. Both colliculi impact the thalamus, enhancing the physical experience of reading the Qur'an compared to merely hearing it.[18]

Khan's research demonstrates that interactions with the Qur'an using visualisation and multimedia technology can foster tranquilly and mitigate boredom, fatigue, melancholy, and stress. The effects of daily, consistent, and uninterrupted reading of the Qur'an will be profound and durable. When a person with depression has regained their zest for life and has constructively reinterpreted life circumstances, the hypothalamus will respond properly. The hypothalamus secreted hormones that restored the immunity previously impaired by an endocrine system imbalance. These hormones stimulate the endocrine system, thereby controlling the pituitary gland's function. The controlled pituitary gland will diminish the release of ACTH, thereby inhibiting the target glands from synthesising cortisol. Cortisol has an immunosuppressive effect on the human immune system. Immunodepression or immunosuppressants are techniques employed to restrict or reduce the functionality of the immune system. When stressors are perceived as upsetting, they will reduce the secretion of the hormone cortisol. This hormone later suppresses T cell activity. This symptom signifies that the immune system's efficacy is impaired or hindered.[17]

[17] Daud Norwati et al., "The Effect of Listening to Al-Quran Recitation among Uncontrolled Hypertensive Muslim Patients Attending Primary Care Clinic in Kelantan, Malaysia: A Randomised Control Trial" 22, no. 1 (2023), https://doi.org/10.31436/imjm.v21i4.

[18] Very Julianto, "The Effect of Al Fatihah Reflective Intuitive Reading to Decrease Stress and Increase Immunity," in *Proceedings of the 1st Annual Internatioal Conference on Social Sciences and Humanities (AICOSH 2019)* (Paris, France: Atlantis Press, 2019), https://doi.org/10.2991/aicosh-19.2019.18.

Echocardiographic blood flow assessment, which is non-invasive, widely accessible, and cost-effective, has provided valuable prognostic information in various clinical settings. However, to our knowledge, the prognostic value of LVOT VTI has only been explored in patients with severe heart failure, and these measurements have not previously been studied in patients with reduced LVEF [11]. This study has one limitation. There is a lack of prior research on the effects of Qur'an recitation on LVOT VTI, which poses challenges in identifying comparative references.

E. Conclusion

Recent studies show that regular Qur'an recitation exerts favourable autonomic and hemodynamic effects—lower heart rate, reduced blood pressure, and improved HRV—all of which plausibly translate into higher LVOT VTI and potentially optimized Vmax in patients with heart failure and reduced ejection fraction. Given the strong, contemporary evidence that VTI is an independent prognostic marker in HFrEF, a rigorously designed clinical trial is justified to verify whether this accessible spiritual practice can deliver measurable increments in forward stroke volume and, ultimately, clinical outcomes.

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