



Original Research

Correlation of Reduced Left Ventricular Ejection Fraction with Cognitive Impairment in Heart Failure Patients

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ABSTRACT

Objectives: To determine the correlation between (Left ventricular ejection fraction (LVEF) and cognitive function among patients with Chronic Heart Failure (CHF) attending the tertiary care cardiology unit.

Materials & Methods: The study was conducted in Mardan Medical College and included 245 patients with chronic heart failure included in the study. The patients were selected one after another during the study period. A complete heart examination was performed on each patient. This included a physical exam, heart tracing test, and heart ultrasound. Left ventricular ejection fraction (LVEF) was the parameter used to measure the pumping power of the heart. A simple questionnaire—the Mini-Mental State Examination (MMSE) was used to assess mental ability.

Results: Patients' mean age was approximately 59 years. Out of 245 patients, 158 were male. The most frequent cause of heart failure was the blockage of the blood vessels that supply the heart. The average pumping ability of the heart was approximately 35%. Patients with weaker heart pumping function also had lower mental ability scores. There was a strong correlation between heart pumping power and mental performance. This indicates that the ability of the brain to function declined as the heart's pumping ability weakened. The patients who had more severe heart failure symptoms were also more likely to have poor memory and thinking ability.

Conclusion: Those who had less pumping strength were more likely to have issues with memory, thinking, and understanding. As such, mental functions should be evaluated as a routine part of the evaluation of patients with chronic heart failure.

Keywords: Heart Failure; Left Ventricular Ejection Fraction; Cognitive Impairment; Mini-Mental State Examination; Systolic Dysfunction; Cognitive Function.

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Date of Submission: 01-07-2026

Date of Revision: 01-09-2026

Date of Acceptance: 22-09-2026

Date of Online Publishing: 30-9-2026

Date of Print: 30-9-2026

DOI: 10.36552/pjns.v30i3.1302

INTRODUCTION

Heart failure is a serious condition in which the heart is unable to pump enough blood to meet the needs of the body. It is a significant health issue

worldwide and can result in frequent hospital attendance, morbidity, and mortality. One of the most common ways to measure the pumping power of the heart is using a measurement called left ventricular ejection fraction. This value shows how much blood is pumped out from the main pumping chamber of the heart with each heartbeat. If a person's ejection fraction is low, the heart is weak and is failing to pump enough blood. Doctors use it to assess how serious the heart failure is, to decide which treatment is right for the patient, and to guess what the patient's health may be like in the future. Patients with low ejection fraction are at risk for re-hospitalization and may also be at higher risk of death.¹

Clogged and narrowed blood vessels that feed the heart are one of the most prevalent causes of chronic heart failure. If the heart isn't getting enough blood and oxygen, the heart muscles can grow weak and damaged. Over time, the heart may change in size and shape, and its pumping ability may become worse. The failure of the heart can also cause problems in other parts of the body. When the heart pumps less blood, the brain may not receive an adequate blood supply. The swelling of blood vessels in the body, caused by the changes in body hormones, as well as problems in the smallest blood vessels, can impair the activity of the brain.²⁻⁴

Memory, thinking, attention, and decision-making problems are frequently observed in heart failure patients with long-term heart failure. Patients may not be able to remember the medicines after medical advice they took has worsened, or they are not able to care for themselves properly. They may also have trouble concentrating and performing activities of daily living. These issues can lower the quality of life and could mean a higher risk of re-admission to hospital and poor health. Therefore, problems with memory and thinking should be recognized during the routine care of patients with heart failure.³

Heart failure is an increasingly common condition around the world, and it is estimated

that about 64 million people suffer from heart failure. Many people in Pakistan suffer from high blood pressure, diabetes, high cholesterol, obesity, and clogged heart vessels. These conditions can be risk factors for heart failure. Although treatment of heart failure has improved, mental ability is not usually checked during the routine examination of these patients. That is particularly the case in hospitals with little staff, equipment, and resources, where a lot of focus is placed on managing symptoms and the function of the heart.^{5,6,7}

Research carried out in other countries has demonstrated that people with less heart pumping power may also have poorer memory and thinking power. But there is very little data available on this relationship in Pakistan. Access to healthcare and common heart-related risk factors, differences in education, income, and living conditions, may influence mental performance in the local population. Local research is necessary to fully grasp this issue.⁸⁻¹⁰

The present study was carried out to investigate the association between mental performance and the pumping function of the heart in heart failure patients who come to a major hospital in Pakistan for treatment for a long period. The results could be helpful locally and may be a spur to doctors to incorporate minimal memory and thought assessments into full heart failure evaluations.

MATERIALS AND METHODS

Study Design and Setting

This study was conducted in the Cardiology Department of Mardan Medical College in Mardan. It was conducted from 23 April 2025 to 23 December 2025. Long-term heart failure patients were added sequentially throughout the study period. Patients were selected if they fulfilled the requirements of the study.

Inclusion Criteria

The study included men and women who were at least 40 years old and who had long-term heart failure. The diagnosis was made on clinical examination and by examination of the heart ultrasound when a patient had symptoms of heart failure.

Patients had to be included if the pumping ability of the heart was less than 50 percent. This comprised people with a percentage of heart pumping between 40 percent and 50 percent.

Patients who were unstable and had fluctuating blood pressures were excluded. Patients attending either the hospital wards or outpatient cardiology clinic were considered. All participants provided written informed consent for participation in the study.

Exclusion Criteria

Patients who already had dementia, Alzheimer's disease, Parkinson's disease, stroke, or a severe mental health condition were excluded.

Those who had severe hearing, speech, or eye problems that could impact the memory and thinking test were also not included.

Patients with a recent heart attack, very low blood pressure, very severe heart failure, a serious problem with the chemicals in the body, a serious problem with the kidneys, active infection of the brain, or serious problems with the liver were excluded.

Those who were treated in an intensive care unit or were being treated with sedative medicines during the assessment were also excluded. Patients who refused to participate were excluded from the study.

Operational Definitions

Long-term heart failure was a problem in which the heart was unable to fill with blood or to pump blood because the heart had a problem with its structure or function. Common symptoms were shortness of breath, fatigue, and swelling due to

the fluid buildup. The pumping efficiency of the heart was assessed by the left ventricular ejection fraction. Reduced values were considered to be those below 50 per cent. This was determined using the standard method of measuring a standard heart ultrasound. The NYHA classification was used to determine the severity of heart failure, which was then split into 4 groups. Class I equaled no restriction in normal activities. Mild limitation (Class II). Marked limitation was meant by Class III. A IV classification indicated that symptoms occurred even while the person was resting. The Mini-Mental State Examination was used to measure changes in attention and understanding in memory. This was a straightforward 30-question survey. Poorer mental ability was indicated by a lower score.

Sample Size Calculation

The sample size was determined with the help of a sample size calculator available on the World Health Organization website. This calculation was made at the 95 percent confidence level with a 5 percent margin of error. The number of heart failure patients who have memory and thinking issues was assumed based on previously published research. A total number of patients was established, and eligible patients were added one by one until the required number was met.

Sampling Method

All eligible patients who attended the cardiology ward or clinic over the study period were included. Patients were sequentially recruited until the required number of patients was achieved.

Data Collection Procedure

Information was collected using a specially prepared form. Information on age, sex, medical history, length of time with heart failure, smoking, high blood pressure, diabetes, cholesterol, and whether they had a blockage in their blood vessels

to the heart was collected. Shortness of breath, difficulty breathing while flat, sudden shortness of breath at night, chest discomfort, tiredness, and difficulty performing physical activity were also noted. All patients had a thorough cardiac evaluation. The following were examined: pulse rate, blood pressure, breathing rate, level of oxygen in the blood, swelling of neck veins, and swelling of the legs or feet. A tracing of the heart was done to look for any abnormal heartbeat or any decrease in blood flow to the heart. The heart ultrasound was done by the professional heart specialists using the standard procedure. The pumping ability of the heart was measured. Movement of the heart walls and disorders of the heart valves were also recorded, as was the size of the heart chambers. Memory, thinking, attention, and understanding were checked using the Mini-Mental State Examination. The tests were conducted in a private and quiet clinic. Blood test data were retrieved from hospital records. These included blood count, kidney function, body salts, fasting blood sugar, and cholesterol levels. The tests were employed to detect other medical problems that might impact the patients.

Data Analysis Technique

All the data that was collected was analyzed using SPSS version 26. Numerical information was reported as an average along with the amount of variation. Information such as gender, smoking, and the presence of other diseases was shown as numbers and percentages.

Before the statistical testing, the distribution of the numerical information was evaluated. Two tests were used to examine the relationship between the percentage of pumping and memory and thinking scores.

The mean results for each of the patient groups were also compared. When $p < 0.05$, it was considered to have a meaningful result.

Ethical Considerations

The study was approved by the Institutional Research and Ethical Committee of Mardan Medical College, Mardan (REF: NO. 758/BKMC), on 25 February 2025 before the study was started. The study was carried out in compliance with the Declaration of Helsinki. All participants had given their written informed consent, and confidentiality, anonymity, and data privacy were respected throughout the study.

RESULTS

Patient Demographics and Cardiovascular Risk Profile

A total of 245 patients with chronic heart failure were included in the study. The mean age of the study population was 58.6 ± 11.7 years, with male predominance (158, 64.5%). The mean duration of heart failure was 4.2 ± 2.1 years.

Hypertension was the most common comorbidity (176, 71.8%), followed by dyslipidemia (138, 56.3%) and diabetes mellitus (121, 49.4%). Ischemic heart disease was the leading etiology of heart failure (141, 57.6%), followed by dilated cardiomyopathy (56, 22.9%) and hypertensive heart disease (48, 19.5%).

Clinical Presentation and Functional Status

The most common presenting symptom was dyspnea (214, 87.3%), followed by fatigue (196, 80.0%), orthopnea (162, 66.1%), pedal edema (147, 60.0%), and paroxysmal nocturnal dyspnea (128, 52.2%). Chest discomfort was reported in 103 (42.0%) patients. Most patients were classified as New York Heart Association (NYHA) Class III (128, 52.2%), followed by Class II (74, 30.2%) and Class IV (43, 17.6%).

Echocardiographic Findings

Mean left ventricular ejection fraction (LVEF) was $34.8 \pm 8.9\%$. A large proportion of patients had moderate to severe systolic dysfunction. Structural cardiac abnormalities were frequently observed.

Cognitive Performance

Cognitive assessment using the Mini-Mental State Examination (MMSE) showed progressively lower scores with worsening left ventricular systolic function. Patients with LVEF $<30\%$ had the lowest cognitive scores compared to those with higher EF categories.

A statistically significant positive correlation was observed between left ventricular ejection fraction and cognitive performance scores ($r = 0.61$, $p < 0.001$). NYHA functional class showed a significant negative correlation with cognitive scores ($r = -0.49$, $p < 0.001$).

Table 1: Baseline Demographic, Clinical and Etiological Characteristics.

Variable	Category	Frequency (%)
Age	Mean $\pm$ SD	58.6 ± 11.7
Gender	Male	158 (64.5%)
	Female	87 (35.5%)
Hypertension	Yes	176 (71.8%)
Diabetes mellitus	Yes	121 (49.4%)
Smoking	Yes	104 (42.4%)
Dyslipidemia	Yes	138 (56.3%)
Ischemic heart disease	Yes	141 (57.6%)
Dilated cardiomyopathy	Yes	56 (22.9%)
Hypertensive heart disease	Yes	48 (19.5%)
Heart failure duration	Mean $\pm$ SD	4.2 ± 2.1 years

Table 2: Echocardiographic Characteristics.

Variable	Category	Frequency (%)
LVEF	Mean $\pm$ SD	$34.8 \pm 8.9\%$
LVEF $<30\%$	—	79 (32.2%)
LVEF 30–40%	—	118 (48.2%)
LVEF $>40\%$	—	48 (19.6%)
LV dilatation	Yes	169 (69.0%)
Regional wall motion abnormalities	Yes	144 (58.8%)
Left atrial enlargement	Yes	116 (47.3%)
Pulmonary hypertension	Yes	66 (26.9%)
LVEDD	Mean $\pm$ SD	61.7 ± 6.5 mm

Table 3: Cognitive Scores According to Clinical Variables.

Variable	Mean Cognitive Score
Ischemic heart disease	22.8 ± 3.7
Dilated cardiomyopathy	24.1 ± 3.2
Hypertensive heart disease	24.7 ± 2.9
Hypertension present	22.9 ± 3.5
Diabetes mellitus present	22.5 ± 3.9
EF $<30\%$	21.6 ± 3.8
EF 30–40%	23.8 ± 3.1
EF $>40\%$	26.1 ± 2.4

Table 4: Correlation of Clinical Variables with Cognitive Performance.

Variable	Correlation (r)	p-value
LVEF vs MMSE	0.61	<0.001
NYHA class vs MMSE	-0.49	<0.001
Age vs MMSE	-0.42	<0.001
Duration of HF vs MMSE	-0.37	0.002
Hypertension vs MMSE	-0.29	0.011
Diabetes mellitus vs MMSE	-0.31	0.007

Correlation Analysis

Age ($r = -0.42$, $p < 0.001$), duration of heart failure ($r = -0.37$, $p = 0.002$), hypertension ($r = -0.29$, $p = 0.011$), and diabetes mellitus ($r = -0.31$, $p = 0.007$) were also significantly associated with lower cognitive performance.

Functional Outcomes

Patients with reduced LVEF had worse clinical outcomes. Recurrent hospitalizations, severe fatigue, orthopnea, and advanced NYHA class were more frequent in patients with lower ejection fraction.

The overall analysis demonstrated a strong and consistent association between reduced left ventricular systolic function and impaired cognitive performance. Worsening heart failure severity was associated with declining MMSE scores and poorer functional outcomes.

Table 5: *Functional Outcomes According to LVEF.*

Outcome	EF <30%	EF 30–40%	EF >40%
Recurrent hospitalization	51 (64.5%)	48 (40.7%)	9 (18.7%)
NYHA III/IV	68 (86.1%)	69 (58.5%)	12 (25.0%)
Severe fatigue	59 (74.6%)	63 (53.4%)	11 (22.9%)
Pedal edema	56 (70.8%)	70 (59.3%)	21 (43.7%)
Orthopnea	63 (79.7%)	78 (66.1%)	21 (43.7%)

DISCUSSION

The study was conducted in a big heart care hospital in Mardan, Pakistan. It demonstrated a clear link between the pumping power of the heart and the mental capacity of patients with chronic heart failure. Patients with less vigorous heart pumping function also performed worse on the memory and thinking test. There was also a correlation between the more severe the symptoms of heart failure and the poorer the mental performance. The findings reveal that heart failure is not only limited to the heart. It can also impact brain function and memory, affecting thinking and understanding.¹¹

In other studies, it has been reported that poor mental ability is related to weak heart pumping. Less blood is pumped, and less blood and oxygen reach the brain. Other research has also demonstrated memory and attention difficulties in patients with heart failure who have weaker heart function.¹³ This further suggests that impaired brain blood flow could play a significant role in memory and attention problems experienced by patients with weak heart function.

The difference between this study and the above-mentioned Italian study may be attributed to the different methodologies adopted; the Italian study, including several hospitals and taking age and other diseases into account, found a weak relationship between heart pumping ability and mental impairment.¹⁴ The Italian study was conducted over a period of time and relied on extensive mental examinations. The present study evaluated patients at a single point in time, and

employed a brief memory and thinking test. The results may also have been influenced by variations in culture, education, lifestyle, and preexisting mental ability.

In this study, patients with more severe symptoms of heart failure were also more likely to have poor mental performance scores. Patients with advanced disease were more likely to have difficulty performing activities of daily living (ADLs), and more likely to have symptoms during low- or rest activities. In a study in the U.K., the same conclusions were drawn. From that study, it was found that mental problems and multiple hospitalisations were associated with worse physical limitation, but only in patients with severe heart failure.¹⁵ This indicates that worse physical limitation might be associated with worse cognitive and health effects.

In this study, poor mental performance was also associated with diabetes and high blood pressure. Over time, high blood pressure can lead to damage to the small blood vessels of the brain and abnormal regulation of blood flow. This can, over time, impair memory and thinking.¹⁶ Diabetes can also injure the small blood vessels and nerves. It may lead to adverse effects on body metabolism and worsen effects of fluctuations in blood glucose. Diabetic patients with heart failure may thus be at a higher risk for cognitive impairment.¹⁷

The most frequent cause of heart failure in this study was when blood vessels to the heart became blocked. Found in 57.6 percent of the patients. This is in line with other countries' reports. Heart failure is still one of the most frequent causes of blockage

of heart arteries, given the rising instances of heart disease and associated risk factors in South Asian countries like Pakistan.¹⁸

Many of these patients had an enlarged main pumping chamber of the heart as seen on an ultrasound of the heart. Abnormal movements of portions of the heart wall were also frequent. The changes are generally only seen when the heart has been damaged repeatedly or over a long period of time, as in large European studies of people with heart failure.¹⁹ May signal more severe disease and decreased pumping efficiency.

Patients with poor heart function may have memory and thinking problems for a few reasons. One important factor is decreased delivery of blood to the brain. Inflammation and insufficient blood flow to the brain can also be caused by damage to the blood vessels and changes in the level of hormones in the body. In severe heart failure, fatigue can disrupt sleep and cause a decrease in physical activity, which can also impact mental ability. Patients with a low heart pumping percentage have also been found to have a decrease in blood flow to the brain.²⁰

In this study, the relationship between heart pumping ability and mental performance was greater than in some previous studies. But this discovery needs to be taken with a pinch of salt. The results may have been influenced by differences in the number and kind of patients studied in hospital environments and other unmeasured health or social factors. This relationship needs to be further confirmed using larger studies with multiple hospitals. The influence of age, education, depression medicines, and other diseases should also be taken into account in these studies.²¹⁻²³

This information is relevant to the care of patients. Patients with heart failure frequently do not have documented memory and thinking issues. This is often the case in hospitals with few people and limited resources, with most emphasis on controlling heart symptoms. Being able to identify mental difficulties early can assist patients

to take medicines correctly, recognize that symptoms are getting worse, and look after themselves in the day-to-day. It could also have a beneficial effect on decreasing re-hospitalization and enhancing care management.

This study showed a definite association between poor pumping strength of the heart and poor mental function, but it was not able to establish that poor heart function actually leads to poor mental function. Education level, depression, and medication that could affect mental ability, which are important factors, were not explored. There was also no advanced statistical analysis to distinguish a heart pumping capacity effect from the effects of these other factors. Thus, it could not be determined that low heart pumping ability was a direct cause of poor mental performance.

Limitations

There were some limitations in this study. It was carried out in only one hospital. Thus, the outcomes may not be fully representative of all Pakistani or other countries' heart failure patients.

The patients were assessed at only one point in time. The study was thus able to suggest relationships between heart function and mental performance, but it could not determine if the mental performance problem came first, or if the heart problem triggered the mental performance problem, or if both occurred simultaneously.

Only the Mini-Mental State Examination (MMSE) was used to measure mental ability. This is a simple test that is often performed, but may not pick up mild or early memory, attention, and decision-making issues.

Depression in terms of aspects of education and the use of medicines, which could affect mental performance, was not examined. These factors also had not been adjusted for using advanced statistical methods. So, it was not possible to conclude whether it was only weaker pumping of the heart that led to poorer mental performance.

Patients were not followed up for a prolonged period. In addition, detailed brain scans were not conducted to detect changes or damage to the brain. Further studies should be extended to multiple hospitals to follow patients over longer periods of time, incorporate more detailed mental exams, and consider other factors that could impact brain function.

CONCLUSION

Lower memory and thinking scores were associated with patients having less heart pumping function. Mentally, those who had more severe symptoms of heart failure had worse mental performance.

The results indicate that failure of the heart may be linked to memory, thinking, and comprehension issues. But this study is not able to demonstrate that poor heart function itself leads to these complications because the patients were examined only once.

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Additional Information

Disclosures: Authors report no conflicts of interest.

Conflicts of Interest: In compliance with the ICMJE uniform disclosure form, all authors declare the following:

Financial Relationships: All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work.

Other Relationships: All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

Data Availability Statement: For data sharing, interested researchers can contact the corresponding authors

Funding: None.

AI Statement: No artificial intelligence tools were used in the conception, design, data collection, analysis, interpretation, or writing of this manuscript. All work was performed by the authors.

AUTHORS CONTRIBUTIONS

Role	Contributing Author(s)	Role	Contributing Author(s)
Conceptualization	Kashif Khan	Data Curation	Sajjad Ali
Methodology	Salman Rafi	Writing – Original Draft/Literature Review	Intikhab Khalil