| **Table (1): Patients' gender in relation to GLS groups** | | | | | |
| --- | --- | --- | --- | --- | --- |
| **Variable** | **Overall, N = 441** | **GLS higher than -10 & less than -16, N = 171** | **GLS higher than -16, N = 151** | **GLS less than -10, N = 121** | **p-value2** |
| **Gender** |  |  |  |  | **0.004** |
| female | 12 (27%) | 6 (35%) | 0 (0%) | 6 (50%) |  |
| male | 32 (73%) | 11 (65%) | 15 (100%) | 6 (50%) |  |
| 1n (%) | | | | | |
| 2Fisher's exact test | | | | | |

73% of the patients in the study were male, 27% were female. There was a statistically significant difference in gender across GLS groups (P= 0.004).

Chart, bar chart, box and whisker chart

Description automatically generated

**Figure (1): Distribution of patients according to gender**

| **Table (2): Difference in patients’ age across GLS groups** | | | | | |
| --- | --- | --- | --- | --- | --- |
| **Variable** | **Overall, N = 441** | **GLS higher than -10 & less than -16, N = 17** | **GLS higher than -16, N = 15** | **GLS less than -10, N = 12** | **p-value2** |
| **Patient age** |  |  |  |  | **0.020** |
| Mean ± SD | 50.32 ± 10.73 | 50.41 ± 10.53 | 45.53 ± 11.17 | 56.17 ± 7.85 |  |
| Median (IQR) | 50.50 (15.00) | 49.00 (7.00) | 43.00 (17.50) | 56.50 (11.00) |  |
| 1Mean ± SD, Median (IQR) | | | | | |
| 2Kruskal-Wallis rank sum test | | | | | |

Mean patient age was 50.32±10.73 years old. There was a statistically significant difference in age across GLS groups (P= 0.02).

Chart, box and whisker chart

Description automatically generated

**Figure (2): Distribution of patients’ age across GLS groups**

| **Table (3): Distribution of hypertension in relation to GLS groups** | | | | | |
| --- | --- | --- | --- | --- | --- |
| **Variable** | **Overall, N = 441** | **GLS higher than -10 & less than -16, N = 171** | **GLS higher than -16, N = 151** | **GLS less than -10, N = 121** | **p-value2** |
| **Hypertension** |  |  |  |  | 0.14 |
| No | 30 (68%) | 11 (65%) | 13 (87%) | 6 (50%) |  |
| Yes | 14 (32%) | 6 (35%) | 2 (13%) | 6 (50%) |  |
| 1n (%) | | | | | |
| 2Fisher's exact test | | | | | |

32% of patients had hypertension. No statistically significant association was found between presence of hypertension and GLS score (P= 0.14).

Chart, box and whisker chart

Description automatically generated

**Figure (3): Distribution of patients according to presence of hypertension in relation to GLS score**

| **Table (4): Distribution of diabetes mellitus and HbA1c in relation to GLS groups** | | | | | |
| --- | --- | --- | --- | --- | --- |
| **Variable** | **Overall, N = 441** | **GLS higher than -10 & less than -16, N = 17** | **GLS higher than -16, N = 15** | **GLS less than -10, N = 12** | **p-value2** |
| **Diabetes Mellitus** |  |  |  |  | **<0.001** |
| No | 28 (64%) | 9 (53%) | 15 (100%) | 4 (33%) |  |
| Yes | 16 (36%) | 8 (47%) | 0 (0%) | 8 (67%) |  |
| **HbA1c** |  |  |  |  | 0.10 |
| Mean ± SD | 8.19 ± 1.14 | 8.60 ± 1.07 | NA ± NA | 7.68 ± 1.05 |  |
| Median (IQR) | 8.20 (2.00) | 9.00 (1.00) | NA (NA) | 7.60 (1.52) |  |
| 1n (%); Mean ± SD, Median (IQR) | | | | | |
| 2Fisher's exact test; Kruskal-Wallis rank sum test | | | | | |

36% of patients had diabetes mellitus, and a statistically significant association was found between presence of diabetes and GLS score (P< 0.001). Mean HbA1c in diabetic patients was 8.19±1.14 %.

Chart, box and whisker chart

Description automatically generated

**Figure (4): Distribution of patients according to presence of diabetes mellitus in relation to GLS score**

| **Table (5): Distribution of smoking history in relation to GLS groups** | | | | | |
| --- | --- | --- | --- | --- | --- |
| **Variable** | **Overall, N = 441** | **GLS higher than -10 & less than -16, N = 171** | **GLS higher than -16, N = 151** | **GLS less than -10, N = 121** | **p-value2** |
| **History of smoking** |  |  |  |  | **<0.001** |
| Ex-smoker | 8 (18%) | 0 (0%) | 6 (40%) | 2 (17%) |  |
| No | 24 (55%) | 12 (71%) | 2 (13%) | 10 (83%) |  |
| Smoker | 12 (27%) | 5 (29%) | 7 (47%) | 0 (0%) |  |
| 1n (%) | | | | | |
| 2Fisher's exact test | | | | | |

27% of patients were smoker, 18% were ex-smokers, and 55% were non-smokers. A statistically significant association was found between smoking and GLS score (P< 0.001).

Chart, box and whisker chart

Description automatically generated

**Figure (5): Distribution of patients according to smoking status in relation to GLS score**

| **Table (6): Difference in patients' hemoglobin levels across GLS groups** | | | | | |
| --- | --- | --- | --- | --- | --- |
| **Variable** | **Overall, N = 441** | **GLS higher than -10 & less than -16, N = 17** | **GLS higher than -16, N = 15** | **GLS less than -10, N = 12** | **p-value2** |
| **Hemoglobin level** |  |  |  |  | **0.044** |
| Mean ± SD | 13.43 ± 1.29 | 13.11 ± 1.28 | 14.13 ± 1.13 | 13.00 ± 1.21 |  |
| Median (IQR) | 13.00 (2.00) | 13.00 (2.00) | 14.00 (2.00) | 12.50 (2.00) |  |
| 1Mean ± SD, Median (IQR) | | | | | |
| 2Kruskal-Wallis rank sum test | | | | | |

Mean hemoglobin level was 13.43±1.29 g/dl. A statistically significant difference was found between hemoglobin level across GLS groups (P= 0.044).

Chart, box and whisker chart

Description automatically generated

**Figure (6): Distribution of hemoglobin level across GLS groups**

| **Table (7): Distribution of lipid profile in relation to GLS groups** | | | | | |
| --- | --- | --- | --- | --- | --- |
| **Variable** | **Overall, N = 441** | **GLS higher than -10 & less than -16, N = 171** | **GLS higher than -16, N = 151** | **GLS less than -10, N = 121** | **p-value2** |
| **Lipid profile** |  |  |  |  | 0.25 |
| high | 25 (57%) | 7 (41%) | 10 (67%) | 8 (67%) |  |
| normal | 19 (43%) | 10 (59%) | 5 (33%) | 4 (33%) |  |
| 1n (%) | | | | | |
| 2Pearson's Chi-squared test | | | | | |

57% of patients had a high lipid profile, but no statistically significant association was found between lipid profile and GLS score (P= 0.25).

Chart, box and whisker chart

Description automatically generated

**Figure (7): Distribution of patients’ lipid profile in relation to GLS groups**

| **Table (8): Difference in patients' systolic blood pressure across GLS groups** | | | | | |
| --- | --- | --- | --- | --- | --- |
| **Variable** | **Overall, N = 441** | **GLS higher than -10 & less than -16, N = 17** | **GLS higher than -16, N = 15** | **GLS less than -10, N = 12** | **p-value2** |
| **Systolic blood pressure** |  |  |  |  | 0.17 |
| Mean ± SD | 122.05 ± 18.37 | 127.65 ± 20.16 | 121.33 ± 8.34 | 115.00 ± 23.16 |  |
| Median (IQR) | 120.00 (30.00) | 120.00 (30.00) | 120.00 (0.00) | 105.00 (40.00) |  |
| 1Mean ± SD, Median (IQR) | | | | | |
| 2Kruskal-Wallis rank sum test | | | | | |

Mean systolic blood pressure was 122.05±18.37 mmHg. No statistically significant difference in systolic blood pressure was found across GLS groups (P= 0.17).

Chart, box and whisker chart

Description automatically generated

**Figure (8): Distribution of systolic blood pressure across GLS groups**

| **Table (9): Difference in patients' diastolic blood pressure across GLS groups** | | | | | |
| --- | --- | --- | --- | --- | --- |
| **Variable** | **Overall, N = 441** | **GLS higher than -10 & less than -16, N = 17** | **GLS higher than -16, N = 15** | **GLS less than -10, N = 12** | **p-value2** |
| **Diastolic blood pressure** |  |  |  |  | 0.35 |
| Mean ± SD | 73.41 ± 12.00 | 73.53 ± 13.20 | 76.00 ± 10.56 | 70.00 ± 12.06 |  |
| Median (IQR) | 70.00 (20.00) | 70.00 (20.00) | 70.00 (10.00) | 65.00 (20.00) |  |
| 1Mean ± SD, Median (IQR) | | | | | |
| 2Kruskal-Wallis rank sum test | | | | | |

Mean diastolic blood pressure was 73.41±12.00 mmHg. No statistically significant difference in diastolic blood pressure was found across GLS groups (P= 0.35).

Chart, box and whisker chart

Description automatically generated

**Figure (9): Distribution of diastolic blood pressure across GLS groups**

| **Table (10): Difference in patients' heart rate across GLS groups** | | | | | |
| --- | --- | --- | --- | --- | --- |
| **Variable** | **Overall, N = 441** | **GLS higher than -10 & less than -16, N = 17** | **GLS higher than -16, N = 15** | **GLS less than -10, N = 12** | **p-value2** |
| **Heart rate** |  |  |  |  | **0.039** |
| Mean ± SD | 68.84 ± 7.13 | 70.06 ± 8.33 | 65.07 ± 3.71 | 71.83 ± 6.99 |  |
| Median (IQR) | 68.50 (10.00) | 70.00 (11.00) | 65.00 (5.00) | 71.50 (14.00) |  |
| 1Mean ± SD, Median (IQR) | | | | | |
| 2Kruskal-Wallis rank sum test | | | | | |

Mean heart rate was 68.84±7.13 bpm, and a statistically significant difference was found in heart rate across GLS groups (P= 0.039).

Chart, box and whisker chart

Description automatically generated

**Figure (10): Distribution of heart rate across GLS groups**

| **Table (11): Difference in patients' troponin level across GLS groups** | | | | | |
| --- | --- | --- | --- | --- | --- |
| **Variable** | **Overall, N = 441** | **GLS higher than -10 & less than -16, N = 17** | **GLS higher than -16, N = 15** | **GLS less than -10, N = 12** | **p-value2** |
| **Troponin** |  |  |  |  | 0.14 |
| Mean ± SD | 1,524.95 ± 1,226.81 | 1,394.12 ± 877.12 | 1,571.87 ± 856.42 | 1,651.67 ± 1,945.24 |  |
| Median (IQR) | 1,054.00 (1,244.00) | 1,000.00 (1,600.00) | 1,450.00 (896.00) | 878.00 (243.00) |  |
| 1Mean ± SD, Median (IQR) | | | | | |
| 2Kruskal-Wallis rank sum test | | | | | |

Mean troponin level was 1524.95±1226.81 pg/ml. No statistically significant difference was found in troponin level across GLS groups (P= 0.14).

Chart, box and whisker chart

Description automatically generated

**Figure (11): Distribution of troponin across GLS groups**

| **Table (12): Difference in patients' left ventricular end systolic volume across GLS groups** | | | | | |
| --- | --- | --- | --- | --- | --- |
| **Variable** | **Overall, N = 441** | **GLS higher than -10 & less than -16, N = 17** | **GLS higher than -16, N = 15** | **GLS less than -10, N = 12** | **p-value2** |
| **LVESV** |  |  |  |  | 0.63 |
| Mean ± SD | 64.10 ± 35.45 | 68.17 ± 44.33 | 55.31 ± 16.86 | 69.32 ± 39.14 |  |
| Median (IQR) | 56.00 (29.40) | 44.00 (26.70) | 47.00 (29.50) | 63.50 (15.90) |  |
| 1Mean ± SD, Median (IQR) | | | | | |
| 2Kruskal-Wallis rank sum test | | | | | |

| **Table (13): Difference in patients' left ventricular end diastolic volume across GLS groups** | | | | | |
| --- | --- | --- | --- | --- | --- |
| **Variable** | **Overall, N = 441** | **GLS higher than -10 & less than -16, N = 17** | **GLS higher than -16, N = 15** | **GLS less than -10, N = 12** | **p-value2** |
| **LVEDV** |  |  |  |  | 0.62 |
| Mean ± SD | 122.94 ± 45.96 | 126.91 ± 63.90 | 125.26 ± 27.76 | 114.39 ± 35.04 |  |
| Median (IQR) | 103.00 (36.60) | 100.00 (50.03) | 112.00 (37.40) | 103.00 (18.00) |  |
| 1Mean ± SD, Median (IQR) | | | | | |
| 2Kruskal-Wallis rank sum test | | | | | |

| **Table (14): Difference in patients' left ventricular ejection fraction across GLS groups** | | | | | |
| --- | --- | --- | --- | --- | --- |
| **Variable** | **Overall, N = 441** | **GLS higher than -10 & less than -16, N = 17** | **GLS higher than -16, N = 15** | **GLS less than -10, N = 12** | **p-value2** |
| **LVEF** |  |  |  |  | **<0.001** |
| Mean ± SD | 48.78 ± 11.30 | 48.83 ± 7.42 | 57.94 ± 6.42 | 37.26 ± 10.35 |  |
| Median (IQR) | 50.60 (16.25) | 50.30 (7.06) | 57.00 (12.20) | 35.23 (17.63) |  |
| 1Mean ± SD, Median (IQR) | | | | | |
| 2Kruskal-Wallis rank sum test | | | | | |

Mean left ventricular end systolic volume was 64.10±35.45 ml. No statistically significant difference was found in left ventricular end systolic volume across GLS groups (P= 0.63). Mean left ventricular end systolic volume was 122.94±45.96 ml. No statistically significant difference was found in left ventricular end systolic volume across GLS groups (P= 0.62).

Mean left ventricular ejection fraction was 48.78±11.30 %. A statistically significant difference was found in left ventricular ejection fraction across GLS groups (P< 0.001).

Chart, box and whisker chart

Description automatically generated

**Figure (12): Distribution of left ventricular ejection fraction across GLS groups**

| **Table (15): Distribution of follow up results in relation to GLS groups** | | | | | |
| --- | --- | --- | --- | --- | --- |
| **Variable** | **Overall, N = 441** | **GLS higher than -10 & less than -16, N = 171** | **GLS higher than -16, N = 151** | **GLS less than -10, N = 121** | **p-value2** |
| **Follow up during in-hospital stay** |  |  |  |  | **<0.001** |
| developed symptoms of heart failure | 16 (36%) | 4 (24%) | 0 (0%) | 12 (100%) |  |
| discharged with good general condition | 28 (64%) | 13 (76%) | 15 (100%) | 0 (0%) |  |
| 1n (%) | | | | | |
| 2Fisher's exact test | | | | | |

36% of patients developed symptoms of heart failure, including 100% of those were classified as having important reduced GLS score (less than -10%) and 24% of those classified as having reduced GLS score (less than -16% and higher than -10%). A statistically significant difference was found in follow up results across GLS groups (P< 0.001).

Chart, box and whisker chart

Description automatically generated

**Figure (13): Results of patients’ follow up in relation to GLS score**

Chart, scatter chart

Description automatically generated

**Figure (14): GLS score in relation to left ventricular ejection fraction**

A statistically significant correlation was found between the results of left ventricular ejection fraction and GLS score (r= 0.82, P< 0.001)

| **Table (2): Differentiation of patients according to Simpson's LVEF in relation to follow up** | | | | |
| --- | --- | --- | --- | --- |
|  | **Simpson's LVEF** | |  | |
| **Characteristic** | **Diseased** | **Normal** | **Total** | **p-value1** |
| **Follow up** |  |  |  | **<0.001** |
| Diseased | 10 | 4 | 14 |  |
| Normal | 0 | 26 | 26 |  |
| **Total** | 10 | 30 | 40 |  |
| 1Fisher's exact test | | | | |
| **Table (3): Differentiation of patients according to GLS score in relation to follow up** | | | | |
|  | **GLS** | |  | |
| **Characteristic** | **Diseased** | **Normal** | **Total** | **p-value1** |
| **Follow up** |  |  |  | **<0.001** |
| Diseased | 12 | 4 | 16 |  |
| Normal | 0 | 28 | 28 |  |
| **Total** | 12 | 32 | 44 |  |
| 1Fisher's exact test | | | | |
| **Table (4): Differentiation of patients according to GLS score in relation to Simpson's LVEF** | | | | |
|  | **GLS** | |  | |
| **Characteristic** | **Diseased** | **Normal** | **Total** | **p-value1** |
| **Simpson's LVEF** |  |  |  | **0.007** |
| Diseased | 6 | 4 | 10 |  |
| Normal | 4 | 26 | 30 |  |
| **Total** | 10 | 30 | 40 |  |
| **1Fisher's exact test** | | | | |
| **Kappa = 0.47, P value = 0.004** | | | | |

Statistically significant associations were found between patients’ classification according to left ventricular ejection fraction and their follow up results (P< 0.001), between patients’ classification according to GLS score and their follow up results (P< 0.001), and between patients’ classification according to left ventricular ejection fraction and GLS score (P= 0.007).

Inter-rater reliability between Simpson’s left ventricular ejection fraction and GLS score was 0.46 and was statistically significant (P= 0.004).

| **Table (19): Validity: Simpson's LVEF** | |
| --- | --- |
| **Item** | **Value** |
| **Sensitivity** | 71 % |
| **Specificity** | 100 % |
| **PPV** | 100 % |
| **NPV** | 87 % |
| **Accuracy** | 90 % |
| **Table (20): Validity: GLS** | |
| **Item** | **Value** |
| **Sensitivity** | 75 % |
| **Specificity** | 100 % |
| **PPV** | 100 % |
| **NPV** | 88 % |
| **Accuracy** | 91 % |

The table shows high sensitivity and specificity of both Simpson’s left ventricular ejection fraction and GLS score in identifying patients with heart failure, with Simpson’s left ventricular ejection fraction reaching 90% accuracy and GLS score reaching 91% accuracy.

Chart, waterfall chart

Description automatically generated

**Figure (15): Sensitivity and Specificity of Simpson’s LVEF versus follow up**

Chart, waterfall chart

Description automatically generated

**Figure (16): Sensitivity and Specificity of GLS versus follow up**

Chart

Description automatically generated

**Figure (17): ROC (receiver operating characteristic) curve of Simpson’s LVEF**

Chart

Description automatically generated

**Figure (18): ROC (receiver operating characteristic) curve of GLS score**

Both Simpson’s left ventricular ejection fraction and GLS score reached the optimum area under the curve (AUC) of 100%.