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Approval Sheet

The Relationship of Health Literacy with Heart Failure Symptoms and Quality of Life

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Abstract Cover sheet

The Relationship of Health Literacy with Heart Failure Symptoms and Quality of Life

By

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[Bachelors of Science in Nursing]
[Georgia State University]
[2018]

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An abstract of
A thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University
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[Master of Public Health]
in [Epidemiology]
[2023]

Abstract

The Relationship of Health Literacy with Heart Failure Symptoms and Quality of Life

By [Shifa Bhamani]

Study Objective: To examine the association between health literacy and heart failure symptoms and quality of life in patients hospitalized for heart failure.
Study Design: This study explored the relationships between health literacy and heart failure symptoms and quality of life using data from the study, "Predicting Readmissions with mHealth Technologies" (PRemHealth). The analysis examined the relationship between exposures (health literacy, functional subjective literacy, and numeracy understanding or NUMI-S) with the baseline KCCQ-12 score(Kansas City Cardiomyopathy Questionnaire scores) as the outcome, which measures heart failure symptoms and quality of life. We considered covariates including age, sex, race, education, and heart failure descriptors using linear regression models. We also examined the determinants of health literacy.
Results: The cohort (n=87) had a median age of 64, was majority black or African American (60.9%), male (57.8%), at the time of enrollment. We found a significant negative correlation with heart failure and communicative subjective literacy, and no relationships with functional subjective literacy. Inotrope use, coronary artery disease history, and implantable cardiac defibrillator presence associated with health literacy. Education also associated with higher literacy, especially numeracy. White race was also associated with higher health literacy.
Conclusions: In this cohort of hospitalized patients with heart failure symptoms, we observed a significant negative correlation with communicative skills and heart failure symptoms severity as measured by the KCCQ-12. Factors like inotropes, CAD history, and ICD presence are important contributing factors to health literacy. White race and education are particularly important sociodemographic exposures of increased health literacy. These relationships warrant additional research and may contribute to future research on prevention efforts in heart failure.

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Cover page

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Introduction:

Heart failure is a highly prevalent disease affecting approximately 6.5 million people in the United States and projected to increase by 46% by 2023 (Mock and Sethares, 2019). Hospitalization due to heart failure is common, and its management requires complex skills such as monitoring weight and blood pressure, tracking sodium and fluid intake, controlling glycemia, and adhering to prescribed medications and dietary recommendations (Fabbri et al., 2020). Therefore, it is crucial to pay greater attention to health literacy in order to effectively manage the symptoms and care of heart failure patients (Fabbri et al., 2020). Unfortunately, health literacy is often overlooked as a contributing factor to health outcomes, despite its importance.

Personal health literacy has been defined as "the degree to which individuals have the ability to find, understand, and use information and services to inform health-related decisions and actions for themselves and others" ("What is health literacy? Take action. Find out," 2022). Organizational health literacy, on the other hand, is defined as "the degree to which organizations equitably enable individuals to find, understand, and use information and services to inform health-related decisions and actions for themselves and others" ("What is health literacy? Take action. Find out," 2022).

Several studies have suggested that poor literacy may be associated with adverse heart failure outcomes, including higher risk of mortality, hospitalizations, and emergency department visits (Fabbri et al., 2020). Other studies have also indicated that treating heart failure requires a multimodal approach, with patient self-care being an important component (Kuhn et al., 2021). Self-care is influenced by health literacy, which refers to patients' ability to obtain, process, and

understand basic health information. This enables patients to comprehend important details such as calculating their sodium and fluid intake, monitoring weight fluctuations, and recognizing the significance of consistent adherence to a complex medication regimen (Kuhn et al., 2021).

The primary goal of the PRemHealth (Predicting Readmissions with mHealth Technologies) study was to collect physiological and behavioral data using a combination of low-burden, noninvasive mobile health technologies and a variety of validated behavioral questionnaires. The aim was to use this data to develop and train a risk prediction algorithm capable of predicting worsening health statuses in patients with heart failure. The secondary goal was to compare three questionnaires – the Kansas City Cardiomyopathy Questionnaire (KCCQ-12), the Duke Activity Status Index (DASI), and the Veterans Specific Activity Questionnaire (VSAQ) – to determine if they were similarly correlated with thirty-day events and deaths in patients with heart failure. The study aimed to assess whether these questionnaires could reliably substitute for one another in a predictive model. One key focus of the PRemHealth study was to address a gap in the health literacy literature and further examine the association between health literacy and the management of heart failure symptoms. This paper aims to explore the relationship between health literacy and heart failure symptoms and quality of life, as well as exposures associated with higher health literacy.

Background and literature review:

Heart failure, a complex clinical condition predominantly affecting older individuals, is associated with poor health outcomes; readmissions specifically due to low health literacy in heart failure are common, and likely in part attributed to inadequate self-care. Achieving adequate self-care is intertwined with factors such as self-efficacy, self-confidence, and health literacy. To promote improved comprehension, active participation, and favorable outcomes

among heart failure patients, it becomes imperative to enhance their health literacy (Deek et al., 2020). Within clinical practice, it becomes crucial to assess, measure, and identify individuals with insufficient health literacy in order to tailor therapies and interventions accordingly, leading to enhanced health outcomes. This necessitates the utilization of reliable and valid techniques and methodologies for comprehensive assessment and effective intervention implementation (Deek et al., 2020).

Furthermore, Swiatoniowska et al. (2020) discuss despite advancements in diagnosis and treatment, research indicates that 50% of patients worldwide require readmission to the hospital within six months of discharge, with non-adherence to therapy being a primary contributing factor to mortality and readmission in HF patients. Effective education programs for HF patients have shown promise in increasing patient knowledge, enhancing self-care capabilities, reducing hospitalizations, and improving outcomes and quality of life. However, traditional patient education methods that focus solely on imparting knowledge have often proven insufficient in changing patients' behavior regarding their own treatment. The existing research findings on the impact of education on HF patient outcomes remain limited, suggesting that education alone may have little influence on improving outcomes for HF patients. It is crucial for future studies to explore and develop more comprehensive and innovative education strategies that go beyond knowledge transfer, addressing the behavioral aspects of self-care and empowering patients to actively participate in their treatment and management of HF.

According to Oscalices *et al.* (2019), a negative correlation was found between lower literacy rates and the rehospitalization of patients with heart failure (HF). The study revealed that lower literacy levels were associated with decreased medication adherence and the presence of barriers to adherence. Additionally, individuals with poor reading skills had higher rates of

mortality and rehospitalization. The study focused on heart failure patients who had been admitted to the emergency room. The researchers utilized the Newest Vital Sign test to assess the patients' literacy skills, and the Morisky-Green test and Brief Medical Questionnaire were used to evaluate their adherence to pharmaceutical treatment within 90 days after discharge.

In other analysis, Fabbri *et al.* (2020) also highlight the relationship between these two variables. A comprehensive search was conducted in databases such as Embase, MEDLINE, PsycINFO, and EBSCO CINAHL, with the assistance of a medical librarian. The search included studies that assessed the level of health literacy among heart failure patients and examined outcomes such as death, hospitalizations, and emergency room visit for any reason, without excluding patients based on language, location, or time of day. Two reviewers independently selected the relevant papers, extracted data, and evaluated the quality of the included studies. The study discussed poor health literacy among heart failure patients, which was associated with an increased risk of death and hospitalization. These findings have important implications for both clinical practice and public health, emphasizing the importance of assessing health literacy and implementing interventions to improve outcomes.

The research conducted by Wu and Moser (2022) indicates that individuals with low health literacy are at a heightened risk of experiencing a cardiac incident. In order to effectively address this risk, interventions should be specifically tailored to high-risk patients who have health literacy, particularly among the elderly and those with low incomes. By implementing targeted therapies for these individuals, it is expected that adverse effects in heart failure patients can be reduced.

According to Chen *et al.* (2011), health literacy skills are crucial for patients to effectively understand and utilize health information, navigate the healthcare system, and adhere to self-care guidelines. However, approximately 90 million Americans lack the necessary health literacy skills

to properly care for themselves within the complexities of the healthcare system and self-care routines. Surprisingly, there is a lack of data on how health literacy specifically impacts self-care among individuals with heart failure, despite the belief that a strong grasp of self-care can improve heart failure symptoms and patient outcomes. The primary objective of Chen et al.'s (2011) pilot study was to examine the relationship between health literacy and self-care behaviors among patients with heart failure. Participants were recruited from various community settings and had a confirmed diagnosis of heart failure. The study employed measures such as the Short-Form Test of Functional Health Literacy, the Self-care Index of Heart Failure (which assesses self-care maintenance, management, and confidence), as well as a demographic survey. Spearman correlations were used to evaluate the strength of the link between self-care ratings and health literacy levels. Preliminary findings from this study shed light on the relationship between health literacy and self-care among individuals with heart failure. The results indicate that patients with higher levels of health literacy are more likely to engage in self-care maintenance, which has been associated with improved patient outcomes in heart failure. Additionally, patients with higher health literacy tend to exhibit greater self-confidence, which may enhance their adherence to self-care routines. However, it is important to note that this conclusion did not reach statistical significance. Contrary to initial expectations, patients with lower health literacy demonstrated a better level of self-care management. This warrants more studies.

Indeed, it is important to consider the perspective presented by Nesbitt et al. (2022). Their research findings indicate that although health literacy can contribute to patients with heart failure acquiring knowledge about their condition, but it also requires health care providers to explain the conditions in detailed way. This highlights the significance of healthcare providers prioritizing the translation of knowledge into actual behavioral changes when addressing self-care among this

specific patient population. In other words, simply providing patients with information and increasing their health literacy may not be sufficient for promoting effective self-care in individuals with heart failure. Healthcare providers should focus on supporting patients in translating their knowledge into actionable behaviors that contribute to better self-care management. This may involve tailored interventions, ongoing support, and strategies to empower patients in implementing and maintaining self-care practices. By recognizing the importance of behavioral changes in addition to knowledge acquisition, healthcare providers can develop more comprehensive approaches to improve self-care outcomes for patients with heart failure.

In the study conducted by Dennison et al. (2011), it was found that individuals with sufficient health literacy were generally younger, more educated, and had higher knowledge scores regarding heart failure (HF). They also displayed greater confidence in their ability to manage their own care. However, the study did not identify any significant impact of health literacy on self-care maintenance and management ratings, as well as the 30-day KCCQ scores. These findings highlight the prevalence of inadequate health literacy and underscore the importance of addressing health literacy to enhance HF knowledge and self-care confidence, especially among older adults and individuals with lower educational attainment. This indicates that there are other factors than literacy contributing to heart failure management such as social determinants of health (access, socioeconomic status, neighborhood, and environment).

Methods:

Data sources:

The data source for this study was the PRemHealth study, which aimed to collect physiological and behavioral data using noninvasive mobile health technologies and validated behavioral questionnaires. The primary objective of the parent study was to develop and train a

risk prediction algorithm capable of predicting worsening health statuses in patients with heart failure. This is the second ancillary analysis. We previously compared the correlations of three questionnaires—the Kansas City Cardiomyopathy Questionnaire (KCCQ-12), the Duke Activity Status Index (DASI), and the Veterans Specific Activity Questionnaire (VSAQ)—with thirty-day events and deaths in heart failure patients, with the secondary goal of determining their substitutability in predictive models (PRemHealth Data Analysis Write-Up, 2022).

In this thesis, which is an ancillary study to the main study, we examine the relationship between the KCCQ-12 scores and health literacy, functional subjective literacy, and numeracy, taking into account covariates such as age, sex, race, education, and heart failure descriptors (ejection fraction). We also examine which factors are associated with higher health literacy outcomes.

Data collection:

Data for the study was collected from the PRemHealth study, focusing on individuals who were admitted to the hospital with a possible diagnosis of acute decompensated heart failure (ADHF) or exhibited symptoms indicative of ADHF, such as lower extremity edema, abdominal fullness, dyspnea, or orthopnea. The eligibility criteria for the study included being 18 years or older, English-speaking, and able to provide informed consent (PRemHealth Data Analysis Write-Up, 2022).

However, individuals who were prisoners, required intravenous inotropic therapy, had a history of an implanted ventricular assist device (VAD) or heart transplant, or had a history of cognitive impairment were excluded from participation (PRemHealth Data Analysis Write-Up, 2022).

The PRemHealth study utilized the electronic medical record (EMR) system to screen a total of 633 inpatients. From this pool, 208 eligible individuals were approached to participate, and ultimately, 90 participants were enrolled in the study over an eight-month period. Participants were asked to complete a series of questionnaires (with the quantity varying based on the study phase), wear a non-invasive continuous ECG monitor during their inpatient stay and for a duration of up to thirty days after discharge (duration varied depending on the study phase), and provide outcomes data for up to 30 days post-discharge. Compensation for participation was provided to participants on a pro-rated basis based on the amount of data they provided.

Study Subjects:

In the study, certain participants were excluded for various reasons. Firstly, participants who had missing thirty-day outcome data were excluded. This means that the researchers were unable to reach these participants to confirm their outcomes data, and there were no available post-hospitalization medical records to review for this information (PRemHealth Data Analysis Write-Up, 2022).

Secondly, participants who were initiated on continuous intravenous (IV) inotropic therapy during the initial hospitalization, at the time of discharge, or during the thirty-day post-discharge period were also excluded from the analysis (PRemHealth Data Analysis Write-Up, 2022).

Thirdly, participants who presented with symptoms suggestive of acute decompensated heart failure (ADHF) but were ultimately not diagnosed with ADHF during their hospitalization were excluded as well (PRemHealth Data Analysis Write-Up, 2022).

For this analysis, 87 participants were examined. However, 61 of these participants had missing data for cumulative functional subjective literacy, and NUMI-S scores (a health literacy

assessment tool). To handle the missing values for this analysis, we replaced them with the median values from the respective questionnaires.

Measurements:

In the PRemHealth study, a total of sixteen questionnaires were administered to collect comprehensive information on various aspects of participants' functional capacity, symptom burden, quality of life, mood, attitudes and beliefs, and life experiences. During the first phase, participants completed all sixteen questionnaires at the time of enrollment. The KCCQ-12, DASI, and VSAQ questionnaires were repeated at fourteen days and thirty days after discharge to assess changes in functional capacity, symptom burden, and quality of life over time(PRemHealth Data Analysis Write-Up, 2022).

In the second phase, participants completed the same sixteen questionnaires at the time of hospital discharge, and the KCCQ-12, DASI, and VSAQ questionnaires were repeated at thirty days after discharge. To streamline the enrollment process, participants were given the option to complete the initial sixteen questionnaires at the time of hospital discharge or within seven days after discharge. However, many participants opted out, resulting in reduced data collection and potentially impacting the statistical power of the analysis PRemHealth Data Analysis Write-Up, 2022).

The KCCQ-12 (Kansas City Cardiomyopathy Questionnaire-12) was assessed for equivalence and correlation with outcomes data in line with the research question of the PRemHealth study. It is a 12-item questionnaire specifically designed to measure symptom burden, physical and social limitations, and quality of life among individuals with heart failure. The questionnaire yields numerical results that are transformed into four domain scores: physical

limitation, symptom frequency, quality of life, and social limitation. Additionally, a summary score, which is the average of the four domain scores, is calculated. This summary score is strongly associated with NYHA class, as well as all-cause hospitalization and death.

Scores on the KCCQ-12 range from 0 to 100, with lower scores indicating more severe symptoms, greater limitations, and a lower quality of life.

According to Spitzer, R (1999), PHQ-9 stands for Patient Health Questionnaire-9. It is a self-report questionnaire commonly used to assess and screen for symptoms of depression. The PHQ-9 consists of nine items that correspond to the nine diagnostic criteria for major depressive disorder listed in the Diagnostic and Statistical Manual of Mental Disorders (DSM-5).

According to the National Institute for Health and Care Excellence (NICE) guidelines from 2018, the PHQ-9 (Patient Health Questionnaire-9) is a self-report questionnaire used to assess and screen for symptoms of depression. Each item in the PHQ-9 asks the individual to rate the frequency of specific depressive symptoms experienced over the past two weeks. These symptoms include feelings of sadness, loss of interest or pleasure, changes in sleep patterns, changes in appetite, difficulty concentrating, and thoughts of self-harm or suicide. The individual responds to each item on a scale ranging from 0 to 3, indicating the frequency of the symptom from "not at all" to "nearly every day." The scores for each item are then added up to obtain a total score that ranges from 0 to 27. Higher scores on the PHQ-9 indicate a higher severity of depressive symptoms.

The PHQ-9 is widely utilized in healthcare settings, research studies, and clinical practice to screen for and monitor depression, evaluate the response to treatment, and assist in making

diagnostic decisions. Its standardized and structured approach makes it a valuable tool in assessing depressive symptoms and aiding in the management of depression (Kroenke, K, 2001).

In this thesis, several questionnaires were employed to examine the relationship between health literacy and 30-day heart failure events, as well as changes in self-reported quality of life over time. The specific questionnaires used include: Functional Subjective Literacy, NUMI-S, demographics, psychological factors (PHQ-9 score), and EF (Ejection fraction- this measures the percentage of blood ejected from the heart during each contraction and provides information about the heart's pumping ability), and KCCQ-12 score. By utilizing these questionnaires, the thesis aims to explore how health literacy relates to heart failure symptoms and self-reported quality of life. This comprehensive approach allows for a comprehensive understanding of the impact of health literacy on heart failure management and patient outcomes.

Data analysis:

The focus is to explore the relationship of health literacy self-reported quality of life. Linear regression analysis using the lm function in R is used to analysis this data. An a priori value of $\alpha = .05$ was set for statistical significance. Several linear and logistics regression models are created to present the relationship between dependent and independent variables. Outcome (Dependent variable) is KCCQ- score. Independent variable are Health literacy, Functional subjective literacy, and NUMI-S. Covariates which can affect the relationship between exposure and outcomes are as follows: age, sex, race, hx of ICD, hx of pacemaker, hx of CAD, and Education, HF descriptors (EF) and psychological factors (PHQ9 score). Missing value is replaced with the median value to generate the relationship.

Results:

The final cohort (n=87) had a median age of 64, was majority black or African American (60.9%), male (57.8%), at the time of enrollment. Education level followed a right skew distribution, with the majority of participants reporting either high school, some college, or college level of education. The education is categorize into 10 levels. Which are as follows:1- Elementary/Middle, 2- High school, 3- some college, 4- Trade/Vocational, 5- Associates Degree, 6- Bachelor's degree, 7- Master's degree, 8- Doctoral degree, 9- Juris Doctor Degree, and 10- Medical Doctor degree. Similarly race was divided into categories as follows: 1- American Indian or Alaska Native, 2- Asian, 3- Black or African Amercian, 4- Native Hawaiian or other pacific Islander, 5- White or Caucasian, and 6- Other. And sex was divided into two categories: 1- male and 0- Female. Other demographics of the patient data is shown in the Table 1.

Each model examines the relationship between the "KCCQ score" variable (dependent variable) and exposures. The tables and graphs provide information about the coefficients, their statistical significance.

Based on the analysis of correlations and associated p-values, it is observed that there is a significant negative correlation between being admitted with heart failure (HF) and communicative subjective literacy, indicating that individuals admitted with HF tend to have lower levels of communicative subjective literacy. Additionally, there is a weak positive correlation between being admitted with HF and functional subjective literacy, though this correlation is not statistically significant at the conventional significance level. Age shows weak correlations with both functional subjective literacy and communicative subjective literacy, but these correlations are also not statistically significant. Finally, a positive correlation between being admitted with HF and NUMI-S is noted, but the interpretation of this correlation is limited

due to the lack of context for NUMI-S, and the correlation is not statistically significant at the conventional significance level. As shown in Table 2 which provides correlations and p-values related to being admitted with heart failure (HF), age, and various literacy measures.

Correlation of Admitted with Heart Failure (HF) with Functional Subjective Literacy:

There is a positive correlation of 0.06 between being admitted with heart failure (HF) and functional subjective literacy. This suggests that individuals admitted with HF tend to have slightly higher levels of functional subjective literacy.

The associated p-value of 0.18 indicates that this correlation is not statistically significant at the conventional significance level of 0.05. Therefore, we cannot conclude that this correlation is reliable.

Correlation of Admitted with Heart Failure (HF) with Communicative Subjective Literacy:

There is a negative correlation of -0.15 between being admitted with heart failure (HF) and communicative subjective literacy. This implies that individuals admitted with HF tend to have lower levels of communicative subjective literacy.

The associated p-value of 0.01 suggests that this correlation is statistically significant at the 0.05 level. Therefore, we can conclude that there is a significant negative correlation between being admitted with HF and communicative subjective literacy.

Correlation of Admitted with Heart Failure (HF) with NUMI-S:

There is a positive correlation of 0.11 between being admitted with heart failure (HF) and NUMI-S. However, without context or a description of NUMI-S, it is challenging to interpret the practical implications of this correlation.

The associated p-value of 0.07 indicates that this correlation is not statistically significant at the conventional significance level of 0.05. Whether this correlation is meaningful would depend on the specific characteristics of NUMI-S and the research objectives.

Correlation of Age with Functional Subjective Literacy:

There is a negative correlation of -0.08 between age and functional subjective literacy, implying that as age increases, functional subjective literacy tends to decrease slightly.

The associated p-value of 0.18 suggests that this correlation is not statistically significant.

Correlation of Age with Communicative Subjective Literacy:

There is a positive correlation of 0.07 between age and communicative subjective literacy, suggesting that as age increases, communicative subjective literacy tends to increase slightly.

The associated p-value of 0.29 indicates that this correlation is not statistically significant.

Correlation of Age with NUMI-S:

There is a negative correlation of -0.04 between age and NUMI-S. Again, without context for NUMI-S, it is difficult to interpret the practical implications of this correlation.

The associated p-value of 0.44 suggests that this correlation is not statistically significant.

Whereas analysis also shows that only NUMI-S had a statistically significant effect on KCCQ scores as showed in table 3 model 1. In Model 2, after adjusting for various covariates, Functional Subjective Literacy remained a statistically significant predictor of KCCQ scores, while Communicative Subjective Literacy did not show a significant effect.

Furthermore, results suggest that heart failure patients experienced an initial improvement in their health-related quality of life (as measured by KCCQ scores) after 14 days of intervention or treatment. Although there was a slight decrease in scores by the 30-day follow-

up, the scores remained significantly higher than at baseline, indicating an overall positive impact of the intervention or treatment over this time frame. (Table 4).

The significant predictors in table 5 ‘s model are NUMIS (negatively related) and PHQ9 score (negatively related), indicating that lower numeric memory and higher depression scores are associated with lower KCCQ scores. Other variables, such as age, sex, education level, history of CAD, and history of a pacemaker, did not reach statistical significance in predicting KCCQ scores in this model. This regression results provide insights into the relationships between various predictor variables and KCCQ scores.

Graph NYHA shows the varying NYHA (New York Heart Association) classifications which offer valuable insights into how the severity of heart failure can impact patients' levels of functional literacy, communicative abilities, and NUMIS. These findings underscore the complex relationship between heart health and literacy.

Patients classified as NYHA 2, while still managing their heart condition, exhibit moderate levels of functional literacy with an average of 14.8 and NUMI-S with an average of approximately 3.56 Functional lit seems most important compare with the communicative lit scores and NUMI. And most of the plausible difference occur between the NYHA 3 and 4 classes.

Their ability to communicate, as indicated by the "comm lit total score" of 3.4, also reflects a level of competency. However, as heart failure progresses to NYHA 3, there is a noticeable improvement in scores. Patients in this group display notably higher "functional lit total scores" (average of 17.77) and significantly enhanced numeracy skills (average numeracy score of approximately 5.08). This suggests that as heart failure becomes more severe, patients

may exhibit increased literacy, possibly as a result of heightened awareness and the need for more informed self-management.

Conversely, the shift to NYHA 4, representing the most severe stage of heart failure, presents a somewhat contrasting picture. While "functional lit total scores" still remain higher than those of NYHA 2 patients at 10.5, the "comm lit total score" increases to 4. The observed decrease in functional literacy could be due to the debilitating effects of advanced heart failure on patients' overall well-being. However, the stable "numeracy_score" at 3 suggests that numeracy skills remain largely unchanged.

Further, education with these variables produces quiet surprising results as shown in the education graph. The dataset offers a comprehensive examination of how distinct levels of education intertwine with KCCQ scores, encompassing functional literacy, communicative proficiency, and numeracy. Among the educational categories, individuals with an elementary education level demonstrate robust functional literacy skills, with an average "functional lit total score" of 18, though with room for improvement in communicative and numeracy skills. High school graduates exhibit lower average scores across all three domains, that is "functional lit total score" is approximately 12.91, while their "comm lit total score" is around 3.91, and their "numeracy_score" is 3.44, suggesting a potential decline in sxores compared to the elementary education group. In contrast, those with some college education display moderate skills in functional literacy and communication but excel in numeracy. Trade college education stands out with strong literacy in all three domains. Data gaps exist for the associates, doctorate, and medical education levels.

On average, individuals who received inotropes (labeled as Group 1 in inotropes graph), show slightly higher scores in functional literacy, communicative abilities, and numeracy

compared to the patient who were not on inotropes(labeled as Group 0). For patients not on inotropes the averages are approximately 15.54 for functional literacy, 3.5 for communicative abilities, and 4.25 for numeracy. In contrast, the patients on inotropes averages approximately 16 for functional literacy, 3.67 for communicative abilities, and 4.67 for numeracy. These findings suggest a potential association between inotrope use and literacy.

CAD graph shows that the data is divided into two groups: "0" for individuals without a history of Coronary Artery Disease (CAD) and "1" for those with a history of CAD. On average, individuals without CAD history (labeled as "0") exhibit slightly higher scores in functional literacy, communicative abilities, and numeracy. For "0," the averages are approximately 15.94 for functional literacy, 3.5 for communicative abilities, and 4.36 for numeracy. Conversely, the "1" group, with a history of CAD, shows slightly lower averages: approximately 15.09 for functional literacy, 3.55 for communicative abilities, and 4.22 for numeracy. This suggests a potential association between CAD history and literacy.

Further for the hx of ICD graph the data is split into two groups: "0" for individuals without an Implantable Cardioverter-Defibrillator (ICD) and "1" for those with an ICD. On average, individuals without an ICD (labeled as "0") exhibit higher scores in functional literacy, communicative abilities, and numeracy. For "0," the averages are 237 for functional literacy, 60 for communicative abilities, and 57 for numeracy. Conversely, the "1" group, with an ICD, shows lower averages: 184 for functional literacy, 35 for communicative abilities, and 42 for numeracy. This suggests a potential association between the presence of an ICD and health literach, with individuals without an ICD displaying stronger literacy.

Pacemaker graph shows the data is divided into two groups: "0" for individuals without a pacemaker and "1" for those with a pacemaker. On average, individuals without a pacemaker

(labeled as "0") have lower scores in functional literacy but higher scores in communicative abilities and numeracy. Their averages are approximately 15.27 for functional literacy, 3.59 for communicative abilities, and 4.61 for numeracy. In contrast, the "1" group, with a pacemaker, exhibits higher functional literacy scores (average of 17) but lower scores in communicative abilities and numeracy (both averaging 3.2). This suggests a potential association between the presence of a pacemaker and health literacy, with individuals having a pacemaker showing stronger functional literacy skills but slightly weaker communicative and numeracy abilities.

The dataset classifies individuals into different racial or ethnic groups: "3" for Black or African American, "5" for White or Caucasian, and "6" for Other. Among those identifying as Black or African American (labeled as "3"), the average "functional lit total score" hovers around 15.05, with an "average of comm lit total score" at 3.58 and an "average of numeracy_score" reaching 4. In contrast, individuals identifying as White or Caucasian (labeled as "5") exhibit notably higher averages across all three domains: an "average of functional lit total score" of approximately 16.86, an "average of comm lit total score" at 3.43, and an "average of numeracy_score" peaking at 5.

The "Other" group (labeled as "6") presents an intriguing combination of results. While this group records the highest average in functional literacy, scoring 17, they display lower averages in communicative abilities (averaging 3) and numeracy (averaging 4). These findings indicate variations in health literacy level among different racial or ethnic categories, with individuals identifying as White or Caucasian tending to exhibit higher health literacy, especially in numeracy.

In summary, the analysis of predictor variables and KCCQ scores highlights a significant negative correlation between heart failure symptoms management and communicative subjective

literacy. While a weak positive correlation exists between heart failure management and functional subjective literacy, it lacks statistical significance. Factors like inotropes, CAD history, and ICD presence seem to have minor associations with literacy. Education level demonstrates a connection, with higher education generally correlating with higher literacy, especially in numeracy. Racial or ethnic groups exhibit literacy level variations, with White or Caucasian individuals often showing stronger abilities.

Discussion:

This analysis of health literacy exposures variables and KCCQ scores reveals several noteworthy findings. There is a significant negative correlation between KCCQ scores and communicative subjective literacy, indicating that individuals admitted with heart failure tend to have lower levels of communicative subjective literacy. However, the weak positive correlation between KCCQ scores and functional subjective literacy is not statistically significant at the conventional level. Age shows weak correlations with both functional and communicative subjective literacy, but these correlations are not statistically significant. The positive correlation between heart failure and NUMI-S lacks context and statistical significance. In the education analysis, higher education levels generally correspond to stronger literacy level, particularly in numeracy. Racial or ethnic groups exhibit variations in literacy levels, with White or Caucasian individuals often displaying stronger abilities.

Additionally, factors like inotropes, CAD history, and ICD presence show minor associations with literacy, suggesting potential relationships that warrant further exploration. Notably, the results emphasize the importance of considering demographic factors when studying literacy in the context of heart failure. Understanding these relationships can inform tailored interventions to improve the overall quality of life for heart failure patients.

The study conducted by Morrow et al. (2006), which examined the connections between health literacy and various factors, including general cognitive and sensory abilities, education, health status, and demographic characteristics, offers valuable insights for health literacy interventions and models aimed at alleviating the negative effects of limited health literacy on health outcomes. For instance, simplifying medication instructions to reduce the level of patient comprehension required is crucial. By understanding the factors that influence health literacy and tailoring interventions accordingly, healthcare providers can enhance communication and better support patients in effectively managing their health and treatment.

It is important to teach and educate patients based on their literacy levels for them to identify and understand their disease process better. With that, it is crucial to consider additional factors and context-specific information when interpreting and understanding the implications of these results. Overall, this comprehensive analysis sheds light on the intricate connections between heart failure, literacy level, and demographic variables, offering valuable insights for future research and healthcare strategies. Further research and exploration may be necessary to gain a comprehensive understanding of the factors influencing the KCCQ score and to inform potential interventions targeting cardiovascular health.

Strengths and limitation:

The study possesses several notable strengths and limitations. It draws from the extensive dataset of the PRemHealth study, incorporating diverse physiological and behavioral data, making it comprehensive in its analysis. Additionally, its clinical relevance is high, as it centers on heart failure patients, aiming to predict health deterioration, which holds significant implications for healthcare practitioners. The utilization of multiple questionnaires, encompassing various aspects of patients' health and quality of life, provides a holistic

assessment. However, limitations exist, notably incomplete data collection due to technology issues, resulting in missing survey data from many participants. This shortfall in data may introduce bias and hinder generalizability. The relatively small sample size also limits statistical power and general applicability. While data imputation with median values was used to address missing values, it may introduce bias. The study's predominantly Black or African American participant pool may restrict generalizability, and the reliance on subjective measures introduces potential bias. Despite these limitations, the study contributes valuable insights into the interplay of health literacy, quality of life, and heart failure outcomes, underscoring the need for further research with larger, more diverse cohorts to validate and expand upon these findings.

Conclusions:

In conclusion, the analysis of the relationships between exposure variables and KCCQ scores has provided valuable insights into the complex relationship between heart failure, literacy level, and demographic factors. Key findings include a significant negative correlation between KCCQ scores and communicative subjective literacy, suggesting that individuals admitted with heart failure tend to have lower levels of communicative subjective literacy. Moreover, while there is a weak positive correlation between KCCQ scores and functional subjective literacy, it is not statistically significant.

Patient on inotropes, a history of coronary artery disease (CAD), and the presence of an Implantable Cardioverter-Defibrillator (ICD) appear to be associated with variations in literacy level. For example, individuals on inotropes tend to have slightly higher literacy scores across all areas, whereas individuals with a history of CAD or those with an ICD show slightly lower literacy scores.

The dataset emphasizes the positive impact of higher education on score, indicating higher scores among those with advanced education levels. However, the subtle variations within each educational category highlight the complexity of this relationship, emphasizing the need for comprehensive data collection to design effective educational strategies for diverse educational backgrounds.

The analysis of racial or ethnic groups reveals variations in literacy, with individuals identifying as White or Caucasian tending to display higher health literacy, especially in numeracy. These results underscore the importance of considering demographic factors when studying health literacy in the context of heart failure.

Overall, these findings contribute to our understanding of how history of heart failure, literacy level, and demographic factors are interconnected. This study suggests higher education can have positive impact of reporting. However, the significance and magnitude of these associations differ across models. It is essential to consider the limitations of the data and interpret the results with caution. These findings emphasize the importance of considering multiple factors including demographics and education level when assessing and understanding the KCCQ score, providing valuable insights for future research and potential interventions targeting cardiovascular health to better support individuals in improving their health literacy and overall quality of life.

Tables and Graphs

Table 1:

Cohort Description	
	# of Participants
Toal Number of participants	87
Admitted with HF	69
Age	64
	SD. 12.92
Sex	
Female	42.52%
Male	57.47%
Race	
American Indian or Alaska Native	4.60%
Asian	0%
Black or African Amercian	60.92%
Native Hawaiian or other pacific Islar	1.15%
White or Caucasian	32.18%
Other	1.15%
Highest degress education	
Elementary/Middle	2
High school	15
Some college	11
Trade/Vocational	4
Associates Degree	2
Bachelor's degree	8
Master's degree	2
Doctoral degree	1
Juris Doctor Degree	0
Medical Doctor degree	1
Symptoms (presenting_symptoms)	
SOB	58
Orthopnea	20
Cough	4
Lower extremity Edema	30
Abdominal fullness	16
weight gain	7
Faitugre/weakness	19
High blood pressure	5
Chets pain	9
Palpitations	4
Types of HF	
Systolic	67.50%
Diastolic	32.50%
NYHA	
I	0%
II	32.50%
III	56.60%
IV	9.60%
unknown	1.20%
Missing	9.80%
Home inotropes	
Yes	8.95
No	91.10%
Missing	2.20%
LVEF	36
History of CAD	
Yes	36.70%
No	63.30%
Missing	2.20%
history of Congenital heart disease	
Yes	7.80%
No	92.20%
Missing	2.20%
Presence of Pacemaker	
Yes	22.20%
No	77.80%
Missing	2.20%
Presence of ICD	
Yes	31.10%
N0	68.90%
Missing	2.20%

Table 2:

		Correlation of health literacy with KCCQ		
		Correlation with Functional Subjective literacy	Correlation with Communicative Subjective literacy	Correlation with NUMI-S
Total Number	80			
Admitted with HF	69	0.06	-0.15	0.11
Admitted with HF- p-value		0.18	0.01	0.07
Age	64	-0.08	0.07	-0.04
Age P-value		0.18	0.29	0.44

Table 3:

Model 1 - Unadjusted regression results for KCCQ Score with Functional and Communicative Subjective Literacy and NUMI-S			
	B estimate	**95% Confidence intervals**	**p**
Functional Subjective literacy	42.8711	(32.15, 53.60)	0.39
Communicative Subjective literacy	47.54	(37.92, 57.16)	0.97
NUMI-S	62.46	(55.06,69.85)	<0.01
Model 2 - Adjusted (age, sex, race, education, phq9, hx CAD, hx pacemaker, hx icd and hx congential heart disease) with Functional and Communicative Subjective Literacy and NUMI-S			
	B estimate	**95% Confidence intervals**	**p**
Functional Subjective literacy	30.84	(25.34,32.62)	<0.01
Communicative Subjective literacy	0.58	(0.46,2.47)	0.33
NUMI-S	0.58	(4.41,7.42)	0.33

Table 4:

KCCQ Scores Over Time for Heart Failure Patients

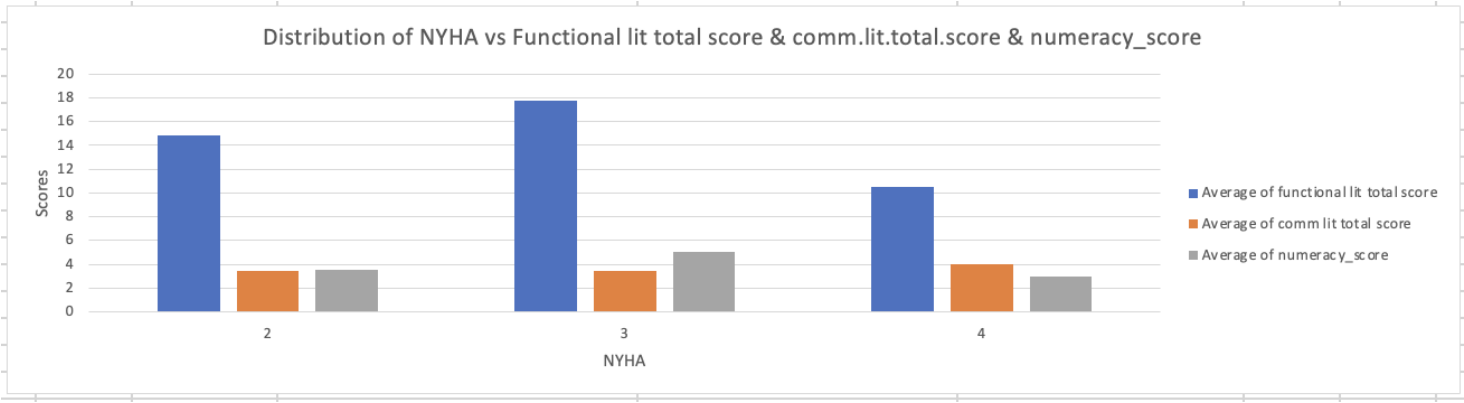
	Baseline	**14 days followup**	**30 days followup**
KCCQ score	45.62	72.89	67.9

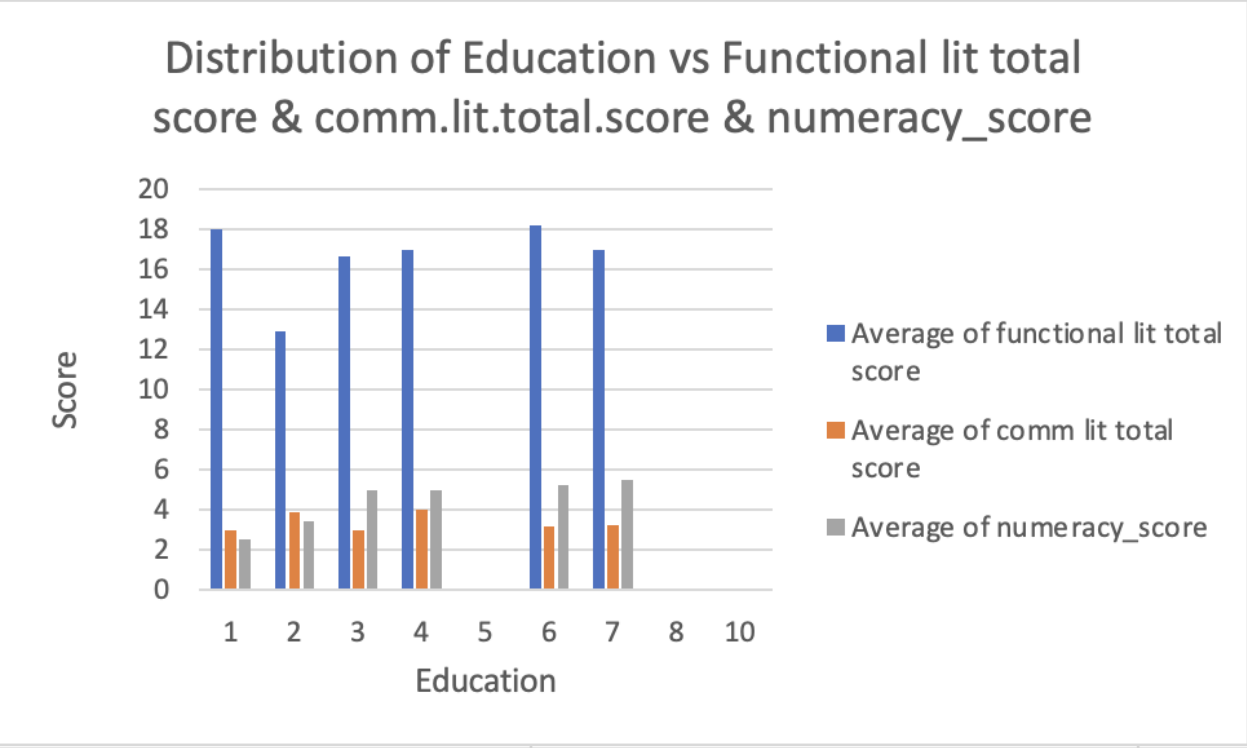
Table 5:

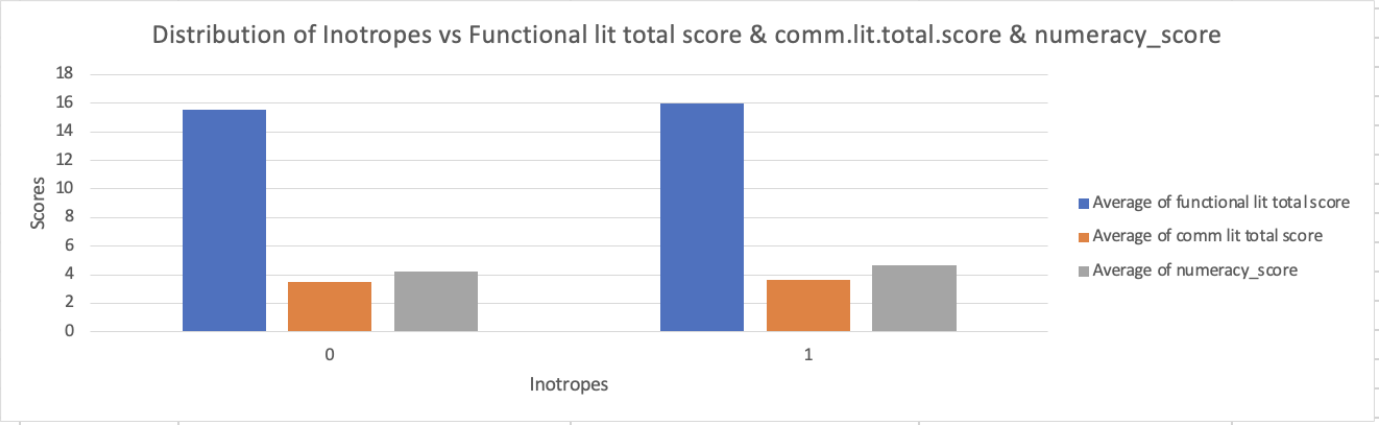
Regression Coefficients for Predicting KCCQ Score

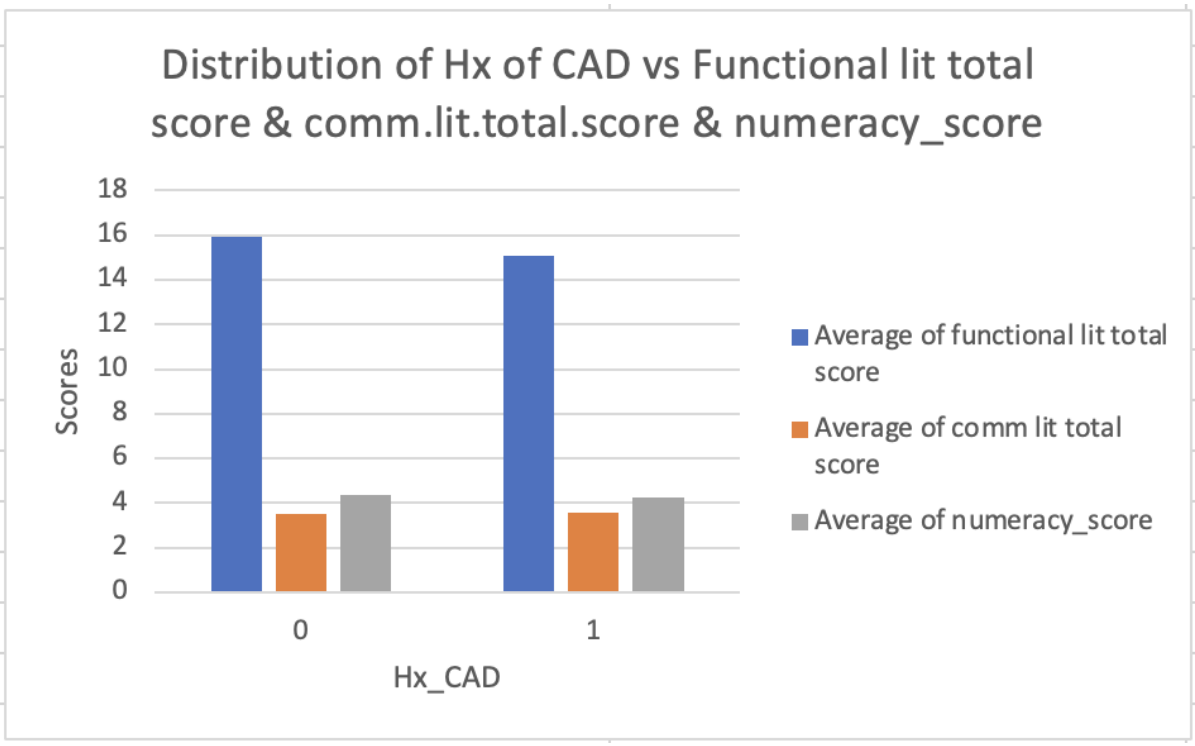
	Value	Std. Error	T-value	P-value
Comm.lit.total.score	0.30	0.47	0.65	0.26
NUMIS	-0.82	0.44	-1.87	0.03
Age	-0.07	0.05	-1.45	0.07
Sex	-1.84	1.29	-1.43	0.08
Education Level	0.32	0.26	1.21	0.11
PHQ9 score	-0.43	0.15	-2.76	0.00
HX of CAD	1.56	1.13	1.38	0.08
Hx of pacemaker	-3.06	1.45	-2.11	0.02

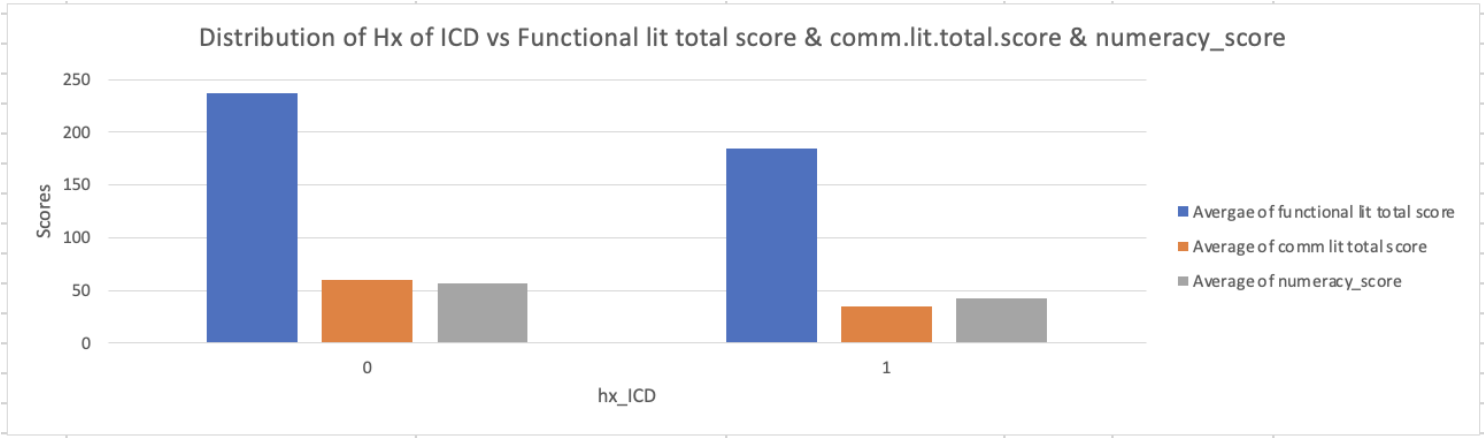
Graphs:

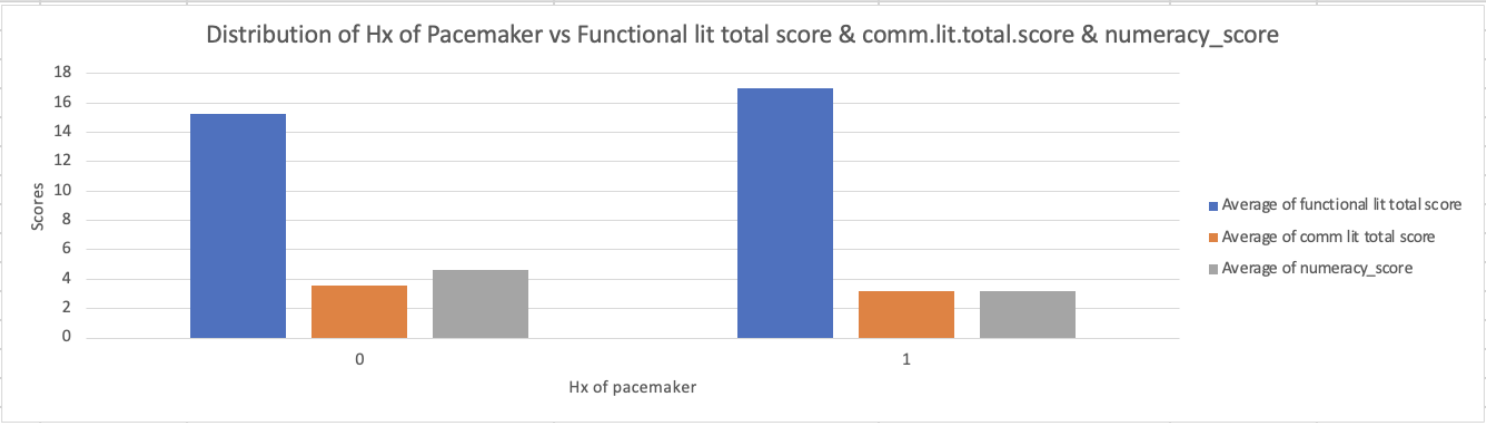


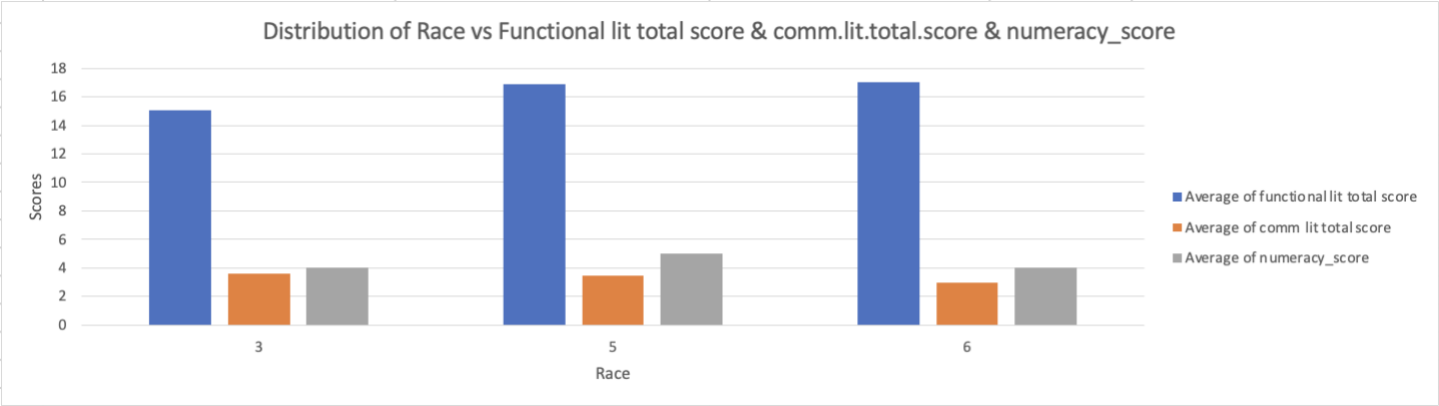

Distribution of Education vs Functional lit total score & comm.lit.total.score & numeracy_score
Score
20
18
16
14
12
10
8
6
4
2
0
1
2
3
4
5
6
7
8
10
Education
Average of functional lit total score
Average of comm lit total score
Average of numeracy_score


Distribution of Inotropes vs Functional lit total score & comm.lit.total.score & numeracy_score
Scores
18
16
14
12
10
8
6
4
2
0
0
1
Inotropes
Average of functional lit total score
Average of comm lit total score
Average of numeracy_score


Distribution of Hx of CAD vs Functional lit total score & comm.lit.total.score & numeracy_score
Scores
18
16
14
12
10
8
6
4
2
0
0
1
Hx_CAD
Average of functional lit total score
Average of comm lit total score
Average of numeracy_score


Distribution of Hx of ICD vs Functional lit total score & comm.lit.total.score & numeracy_score
Scores
250
200
150
100
50
0
0
1
hx_ICD
Avergae of functional lit total score
Average of comm lit total score
Average of numeracy_score


Distribution of Hx of Pacemaker vs Functional lit total score & comm.lit.total.score & numeracy_score
Scores
18
16
14
12
10
8
6
4
2
0
0
1
Hx of pacemaker
Average of functional lit total score
Average of comm lit total score
Average of numeracy_score


Distribution of Race vs Functional lit total score & comm.lit.total.score & numeracy_score
Scores
18
16
14
12
10
8
6
4
2
0
3
5
6
Race
Average of functional lit total score
Average of comm lit total score
Average of numeracy_score

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