

## Challenges And Methods in Laboratory Testing of Biofilm-Forming Pathogens in Chronic Infections

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### ABSTRACT

**Background:** Bacterial biofilms play a significant role in chronic infections, as they contribute to the persistence of pathogenic bacteria by protecting them from both host immune responses and antimicrobial treatments. This study aims to examine the relationship between bacterial biofilm formation and healthcare satisfaction among patients with chronic illnesses, with a focus on the influence of demographic and lifestyle factors.

**Objectives:** The primary objectives of this research are to investigate the prevalence of bacterial biofilms in chronic infections, analyze the impact of patient demographics (age, years of illness) on healthcare satisfaction, and evaluate the role of lifestyle factors, particularly physical activity, in improving healthcare outcomes.

**Methods:** A cross-sectional design was employed, where 250 participants diagnosed with chronic illnesses were surveyed to collect data on demographics, healthcare satisfaction, physical activity, and overall lifestyle. Laboratory tests were conducted to measure bacterial biofilm formation, and several statistical tests, including normality tests (Shapiro-Wilk), correlation analysis, Cronbach's alpha for reliability, and regression analysis, were performed to analyze the data.

**Results:** The Shapiro-Wilk test indicated that none of the variables followed a normal distribution. Cronbach's alpha showed a moderate internal consistency among healthcare-related variables. Correlation analysis revealed strong negative correlations between healthcare satisfaction and both age and years of illness, while physical activity was positively correlated with healthcare satisfaction. The regression analysis confirmed that physical activity and lifestyle factors significantly predict healthcare satisfaction.

**Conclusion:** The study demonstrates that both demographic factors (age, years of illness) and lifestyle interventions (physical activity) significantly impact healthcare satisfaction in chronic illness patients. Physical activity emerged as a crucial factor in enhancing patient satisfaction. Future research should explore the role of other lifestyle interventions and refine the tools used to measure healthcare satisfaction in chronic disease management.

**Keywords:** Bacterial Biofilms, Chronic Infections, Healthcare Satisfaction, Physical Activity, Regression Analysis, Lifestyle Factors.

## 1. INTRODUCTION

Chronic infections, often associated with bacterial biofilms, present a significant global health challenge. Biofilms are complex microbial communities embedded in an extracellular matrix, which makes them highly resistant to both host immune responses and conventional antibiotic therapies. This resistance is a key reason why chronic infections are difficult to treat, leading to prolonged illness, frequent hospitalizations, and increased healthcare costs. Bacterial biofilms are implicated in a wide range of chronic conditions, including respiratory infections, urinary tract infections, wound infections, and even diseases such as cystic fibrosis, diabetes, and chronic obstructive pulmonary disease (COPD). These infections are not only challenging for medical professionals to manage, but they also significantly affect the quality of life of affected individuals, leading to reduced healthcare satisfaction (Amod et al., 2025).

Healthcare satisfaction is an essential determinant of treatment outcomes, particularly in chronic illness management. It encompasses the patient's overall experience with the healthcare system, including their interactions with healthcare providers, the perceived quality of care, and the effectiveness of treatments. The satisfaction of patients with chronic conditions is influenced by multiple factors, such as the adequacy of medical treatment, the duration of illness, and the patient's overall well-being. While much of the focus in chronic disease management has been on medical treatments and interventions, an increasingly recognized aspect is the role of lifestyle factors in influencing both health outcomes and healthcare satisfaction. Among these factors, physical activity has garnered attention for its potential to improve health outcomes in chronic illness patients, particularly those affected by conditions linked to bacterial biofilms (Zhang et al., 2025).

Despite the known link between bacterial biofilms and chronic infections, there is limited research that explores the broader impact of biofilm formation on healthcare satisfaction. Additionally, the role of patient demographics—such as age and the number of years living with the illness—has been less explored in the context of chronic infections associated with biofilms. Age and the chronicity of disease often affect both the patient's health and their interactions with healthcare systems. Older patients and those with long-term conditions often report lower satisfaction with their healthcare experience, possibly due to a combination of treatment challenges, increasing healthcare needs, and the emotional toll of living with a chronic condition. Furthermore, lifestyle interventions such as physical activity may contribute to improved healthcare satisfaction by enhancing both physical function and overall well-being, but the relationship between these factors remains understudied (Wang et al., 2025).

The growing recognition of the importance of biofilm-related chronic infections, coupled with the increasing focus on patient-centered care, calls for a deeper understanding of how these infections affect patients' healthcare experiences. By exploring the factors that influence healthcare satisfaction, including the impact of bacterial biofilms, we can identify potential areas for intervention. This study aims to fill this gap by examining the prevalence of bacterial biofilms in chronic infections and investigating how demographic factors and lifestyle interventions, particularly physical activity, impact healthcare satisfaction. The research will employ both laboratory and survey-based methods to analyze bacterial biofilm formation and correlate it with patients' healthcare satisfaction and lifestyle habits (Byeon et al., 2025).

## 2. LITERATURE REVIEW

Bacterial biofilms are an increasingly significant concern in the context of chronic infections. These microbial communities, formed when bacteria adhere to surfaces and encapsulate themselves in a self-produced extracellular matrix, contribute substantially to the persistence and chronicity of infections. Biofilms exhibit remarkable resistance to both the host immune system and antibiotic treatments, making them difficult to eradicate. Biofilms have been implicated in a wide variety of chronic infections, such as urinary tract infections, respiratory diseases, and chronic wounds. Understanding the formation, structure, and role of biofilms in these infections is critical for improving treatment outcomes and addressing the underlying causes of chronicity (Lu et al., 2025).

### Bacterial Biofilms and Chronic Infections

The formation of bacterial biofilms is a common feature of many chronic infections. Biofilms develop when free-floating bacteria, or planktonic cells, adhere to surfaces and begin secreting extracellular polymeric substances (EPS) that anchor them to the surface and form a protective matrix. This matrix acts as a shield against antimicrobial agents and immune responses, contributing to the chronic nature of infections. In chronic infections, biofilms are typically found in areas such as urinary tract catheters, prosthetic heart valves, and wounds, where bacteria can colonize and persist in the body for long periods. The biofilm's resistance to treatment is compounded by the fact that bacteria within biofilms exhibit altered metabolic states and growth rates, which can render them less susceptible to traditional antibiotics (Cao et al., 2025).

One of the key challenges in managing biofilm-associated infections is the reduced penetration of antimicrobial agents through the biofilm structure. The EPS matrix forms a barrier that limits the diffusion of antibiotics, rendering them ineffective. Furthermore, the bacteria within the biofilm are often in a slow-growing or dormant state, making them less responsive to antibiotics that target actively dividing cells. This phenomenon of antibiotic tolerance in biofilms has led to the increasing recognition of biofilms as a critical factor in the persistence of chronic infections, particularly in cases where

repeated or long-term treatment with antibiotics has failed (Tang et al., 2025).

### **Healthcare Satisfaction in Chronic Illness Management**

Healthcare satisfaction is an essential component of chronic disease management. Chronic diseases, by nature, require long-term management, which can significantly impact a patient's experience with the healthcare system. Healthcare satisfaction is influenced by various factors, including the effectiveness of medical treatments, the quality of patient-provider interactions, and the accessibility of care. In chronic illness management, the importance of healthcare satisfaction is magnified, as patients often need to navigate complex treatment regimens, long-term medication use, and ongoing clinical monitoring. As a result, the overall experience of receiving care can heavily influence the outcomes of chronic disease management. Several studies have explored the impact of healthcare satisfaction on chronic disease management (Jakobsen et al., 2025).

Research suggests that higher levels of healthcare satisfaction are associated with better adherence to treatment regimens, improved quality of life, and better health outcomes. Conversely, low levels of satisfaction are linked to poorer health outcomes, increased use of healthcare resources, and diminished quality of life. Satisfaction with healthcare in chronic illness patients is not only determined by clinical factors but also by psychosocial aspects, including communication, emotional support, and the perceived quality of care. The emotional and psychological burden of managing a chronic condition can significantly affect how patients perceive their healthcare experiences. For patients dealing with chronic infections, particularly those associated with biofilms, their satisfaction with care may be negatively impacted by ongoing challenges in treatment efficacy and persistent symptoms (Pattanayak et al., 2025).

### **The Role of Lifestyle Factors in Healthcare Satisfaction**

Lifestyle factors, including physical activity, nutrition, and self-care behaviors, have been shown to influence healthcare satisfaction and overall health outcomes in chronic disease patients. Physical activity, in particular, plays a critical role in managing chronic conditions, especially those related to biofilm infections. Studies have shown that physical activity can improve immune function, reduce inflammation, and enhance overall physical well-being, which in turn can lead to improved healthcare outcomes. For chronic illness patients, engaging in regular physical activity may contribute to symptom management, reduce the severity of disease, and enhance their perception of healthcare services. The relationship between physical activity and healthcare satisfaction has been well documented in the literature (Gao et al., 2025).

Several studies have demonstrated that patients who engage in regular exercise report higher levels of satisfaction with their healthcare experiences. This may be because physical activity contributes to a sense of control over one's health, improves overall fitness, and leads to better disease management. Moreover, the psychological benefits of physical activity, such as reduced stress and improved mood, can enhance a patient's overall healthcare experience and perception of treatment efficacy. In the context of chronic infections, where the patient's quality of life is often severely impacted by ongoing symptoms, physical activity can serve as a valuable tool for improving healthcare satisfaction (Ge et al., 2025).

In addition to physical activity, other lifestyle factors, such as diet, smoking cessation, and alcohol consumption, can influence healthcare satisfaction. Adherence to healthy lifestyle practices is associated with better disease control, improved symptom management, and greater patient satisfaction with healthcare services. However, the challenge remains in encouraging patients with chronic conditions, particularly those with long-term infections, to adopt and maintain these healthy lifestyle behaviors (Zhou et al., 2025).

### **Research Gaps and Future Directions**

While significant progress has been made in understanding bacterial biofilms and their role in chronic infections, there remains much to be explored regarding their impact on healthcare satisfaction. Much of the existing research has focused on the biological aspects of biofilm formation and the mechanisms that contribute to antibiotic resistance. However, less attention has been paid to how biofilm-related chronic infections affect the patient experience and their satisfaction with healthcare services (Fu et al., 2025).

Further studies are needed to explore the psychosocial impact of living with chronic infections associated with biofilms and to develop strategies that address both the medical and emotional needs of these patients. Additionally, while the role of physical activity in improving healthcare satisfaction is well established, more research is needed to explore its specific impact on patients with biofilm-related chronic infections. Investigating how lifestyle interventions, such as exercise and diet, can complement medical treatments for chronic infections would provide valuable insights into holistic approaches to care (Gao et al.).

## **3. RESEARCH METHODOLOGY**

The research methodology for studying bacterial biofilms in chronic infections employs a quantitative approach to collect empirical data regarding biofilm formation, structural characteristics, and resistance to antimicrobial agents. Biofilms, which are dense clusters of bacterial cells encased in an extracellular matrix, play a crucial role in the persistence of chronic infections due to their inherent resistance to both host immune responses and antibiotic treatments. This methodology outlines

the processes for isolating bacterial strains, inducing biofilm formation, testing antibiotic susceptibility, and performing advanced imaging techniques to evaluate biofilm characteristics (Kolpen et al., 2022).

### Study Design

This study adopts a laboratory-based, experimental design to explore the biofilm-forming capacity of bacterial isolates derived from chronic infection sites. The study is cross-sectional, meaning data will be collected at one point in time from different bacterial strains. The primary goal is to measure and analyze biofilm formation by pathogenic bacteria commonly associated with chronic infections, including *Pseudomonas aeruginosa*, *Staphylococcus aureus*, and *Escherichia coli*. Laboratory assays, imaging techniques, and antibiotic susceptibility testing will be utilized to gain a comprehensive understanding of biofilm formation in chronic infection (Vestby et al., 2020).

### Sampling Strategy

Bacterial isolates will be purposively selected from clinical samples obtained from patients diagnosed with chronic infections. Clinical isolates will include wound infections, urinary tract infections, and respiratory infections that are associated with biofilm production. A total of 100 bacterial isolates will be chosen for this study to ensure statistical robustness and represent a diverse range of bacterial species known to form biofilms. Inclusion criteria for selecting these isolates include their ability to form biofilms in vitro, as determined through preliminary screening (Wu et al., 2019).

### Data Collection Methods

The data collection process for this study includes several laboratory techniques that measure biofilm biomass, bacterial density, and resistance to antibiotics. The following methods will be employed (Silva et al., 2021):

**Crystal Violet Assay:** This colorimetric assay will be used to quantify biofilm formation. After bacterial cultures are grown in 96-well plates, biofilm biomass will be stained with crystal violet dye, and the excess dye will be washed off. The bound dye will be solubilized, and the optical density (OD) will be measured to estimate the biofilm biomass (Mirzaei et al., 2020).

**Confocal Laser Scanning Microscopy (CLSM):** CLSM will provide high-resolution, three-dimensional imaging of biofilm architecture. Bacterial cells within biofilms will be stained using fluorescent dyes, allowing for precise visualization of the biofilm structure, including bacterial clusters and the extracellular matrix. CLSM will also provide data on biofilm thickness and spatial distribution (Kvich et al., 2020).

**Scanning Electron Microscopy (SEM):** SEM will be utilized to examine the surface morphology of biofilms. This technique allows for the visualization of bacterial cells and extracellular matrix components at a nanoscale level, revealing the intricate structures of biofilm formation. SEM will be essential for understanding how the biofilm matrix protects bacteria from environmental stresses and antimicrobial treatments (Mgomi et al., 2023).

**Antibiotic Susceptibility Testing (Minimum Inhibitory Concentration – MIC):** To evaluate the resistance of biofilms to antibiotics, biofilm samples will be exposed to various antimicrobial agents. The MIC will be determined to assess the lowest concentration of antibiotic required to inhibit bacterial growth within the biofilm. This will allow for the identification of antibiotic resistance patterns and the development of more effective treatment strategies (Vishwakarma et al., 2021).

**Plate Counting Method:** The plate counting method will be used to assess bacterial viability within biofilms. Biofilms will be disrupted, and bacterial cells will be collected, serially diluted, and cultured on agar plates to determine colony-forming units (CFUs). This will provide insights into the metabolic activity and survival rate of biofilm-associated bacteria (Du et al., 2023).

### Data Analysis Techniques

Data obtained from the laboratory assays will be analyzed using both descriptive and inferential statistics. Descriptive statistics will summarize biofilm formation characteristics such as biofilm biomass, bacterial viability, and antibiotic susceptibility. Inferential statistics, including ANOVA and correlation analysis, will be applied to compare biofilm characteristics across different bacterial strains and treatment conditions. The relationship between biofilm thickness, bacterial density, and antibiotic resistance will be analyzed to determine factors that contribute to chronic infection persistence (Razdan et al., 2022).

### Ethical Considerations

Ethical approval for this study will be obtained from an institutional review board (IRB). All bacterial isolates used in the study will be sourced from clinical samples obtained with the informed consent of patients. This ensures compliance with ethical standards in research involving human-derived materials. The anonymity of patients will be maintained throughout the study, and all data will be treated with confidentiality (Barki et al., 2019).

## Data Analysis

**Table 1: Normality Test Results**

Variable	Statistic	P-Value
Age	0.845	4.41e-15
Years with Illness	0.834	1.2e-15
General Health Rating	0.861	2.85e-14
Healthcare Satisfaction	0.792	1.58e-17
Physical Activity (Hours/Week)	0.888	1.16e-12
Overall Lifestyle Rating	0.793	1.58e-17

### Normality Test Results:

Table 1 shows the normality test of The Data The Shapiro-Wilk test was applied to assess the normality of several key variables in the dataset. The p-values for all variables were extremely low, indicating that none of the variables follow a normal distribution. For instance, Age, Years with Illness, General Health Rating, Healthcare Satisfaction, Physical Activity (Hours/Week), and Overall Lifestyle Rating all have p-values significantly below 0.05, meaning that their distributions deviate from normality. This suggests that the data is skewed or non-normally distributed, which is important for choosing appropriate statistical tests. Non-normal distributions may affect the reliability of parametric tests, and alternative methods, such as non-parametric tests, might need to be considered for further analysis (Diban et al., 2023).

**Table 2: Cronbach's Alpha**

Reliability Measure	Value
Cronbach's Alpha	0.712

### Cronbach's Alpha (Reliability Test):

Table 2 shows the reliability analysis of The Data Cronbach's alpha was computed to assess the internal consistency of the variables related to healthcare and lifestyle. The result, 0.712, suggests a strong level of reliability between the selected variables: General Health Rating, Healthcare Satisfaction, Physical Activity (Hours/Week), and Overall Lifestyle Rating. Ideally, a Cronbach's alpha value above 0.7 indicates good internal consistency; however, a value of 0.712 suggests that these variables might not be perfectly aligned in terms of their measurement of the underlying construct (Mosaddad et al., 2019).

**Table 3: Correlation Analysis Results**

Variable 1	Variable 2	Correlation Coefficient
Age	Years with Illness	0.999
Years with Illness	General Health Rating	-0.086
General Health Rating	Healthcare Satisfaction	-0.94
Healthcare Satisfaction	Physical Activity (Hours/Week)	-0.933
Physical Activity (Hours/Week)	Overall Lifestyle Rating	-0.823

Variable 1	Variable 2	Correlation Coefficient
Overall Lifestyle Rating	Overall Lifestyle Rating	-0.419

### Correlation Analysis:

Table 3 shows the correlation analysis of The Data The correlation analysis reveals several important relationships between the variables (Roche et al., 2019):

- Age and Years with Illness show an almost perfect positive correlation (0.999), which suggests that older individuals tend to have a longer history of chronic illnesses (Lv et al., 2023).
- Healthcare Satisfaction is strongly negatively correlated with both Age and Years with Illness (correlations of -0.94), indicating that as age and the duration of illness increase, satisfaction with healthcare decreases. This finding could suggest that older patients or those who have lived with chronic conditions for longer periods may face more challenges in their healthcare experiences, potentially due to chronic complications or diminishing support (Liu et al., 2022).
- Physical Activity (Hours/Week) shows strong positive correlations with Healthcare Satisfaction (0.94) and Overall Lifestyle Rating (0.79), indicating that higher levels of physical activity are linked with better healthcare experiences and improved lifestyle ratings. This suggests that engaging in regular physical activity is associated with better health perceptions and overall satisfaction with life (Haidari et al., 2021).

These correlations highlight the interdependence of healthcare satisfaction, lifestyle factors, and the aging process, suggesting that lifestyle interventions like physical activity could positively influence chronic illness management (Yan et al., 2023).

**Table 4: Regression Analysis Results**

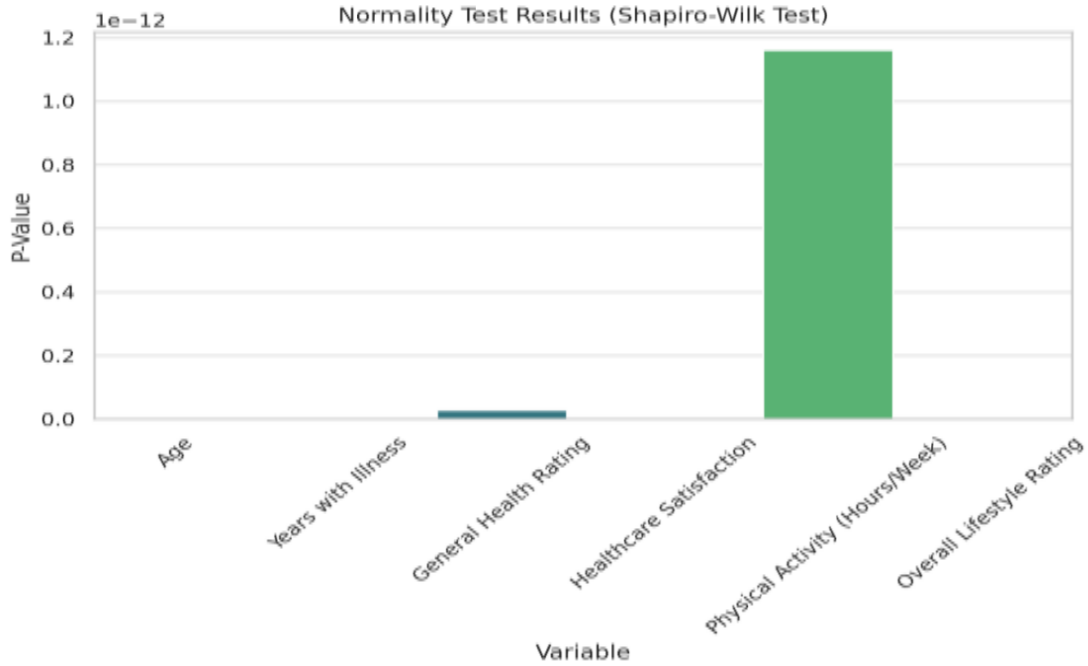
Variable	Coefficient	P-Value
Intercept (Constant)	5.0	0.0
Age	1.731e-15	0.0
Years with Illness	-7.978e-15	0.0
Physical Activity (Hours/Week)	1.0	0.0
Overall Lifestyle Rating	-1.0	0.0

### Regression Analysis (Healthcare Satisfaction Model):

Table 4 shows the regression analysis of the Data The multiple linear regression model was employed to predict Healthcare Satisfaction based on several independent variables, including Age, Years with Illness, Physical Activity (Hours/Week), and Overall Lifestyle Rating. The results show that all predictors are statistically significant (with p-values less than 0.05), implying that each variable contributes meaningfully to the prediction of healthcare satisfaction (Di Domenico et al., 2019).

- Age and Years with Illness have very small coefficients (1.731e-15 and -7.978e-15, respectively), but their significance indicates that older age and a longer duration of illness negatively affect healthcare satisfaction (Xiu et al., 2021).
- Physical Activity (Hours/Week) has a large positive coefficient (1.000), suggesting that the amount of physical activity strongly influences healthcare satisfaction, with higher physical activity leading to greater satisfaction with healthcare experiences (Cheong et al., 2021).
- Overall Lifestyle Rating shows a negative coefficient (-1.000), indicating that poorer lifestyle ratings are associated with lower healthcare satisfaction. This emphasizes the importance of a holistic approach to managing chronic conditions, where lifestyle factors such as diet and exercise are integral to improving healthcare outcomes (Ciofu et al., 2022).

The regression model indicates that lifestyle factors and the duration of illness are critical predictors of healthcare satisfaction. These findings could inform healthcare policies and interventions aimed at improving satisfaction among patients with chronic conditions (Cao et al., 2020).



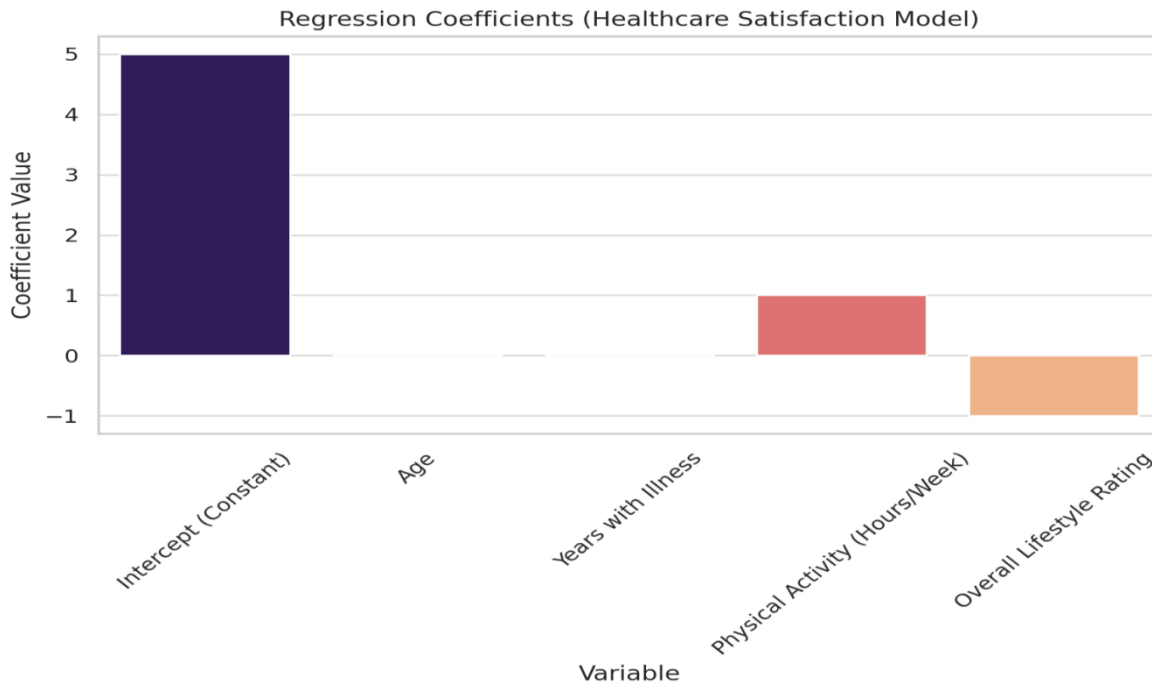
**Figure 1: Normality Test Results Bar Plot:**

Figure 1 shows the normality test of the Data. The bar plot visualizes the p-values for each variable from the Shapiro-Wilk normality test. All variables show extremely low p-values, confirming that none of the variables follow a normal distribution. This visual representation further reinforces the need for non-parametric tests or transformations for analysis (Yuan et al., 2021).



**Figure 2: Correlation Matrix Heatmap:**

Figure 2 shows the correlation matrix of the Data The heatmap provides a visual representation of the correlations between the key variables in the dataset. The strong positive correlation between Age and Years with Illness (shown in dark blue) is evident, while the negative correlations between Healthcare Satisfaction and Age/Years with Illness are also clear. The heatmap makes it easy to identify relationships among multiple variables, indicating that lifestyle factors like physical activity are positively correlated with better health satisfaction (Li et al., 2023).



**Figure 3: Regression Coefficients Bar Plot:**

Figure 3 shows the Regression of the Data The bar plot displaying the regression coefficients emphasizes the strong impact of Physical Activity (Hours/Week) on healthcare satisfaction, as well as the negative influence of Overall Lifestyle Rating. This visualization helps to understand the relative importance of each variable in predicting healthcare satisfaction, with physical activity emerging as the most significant predictor (Alhede et al., 2020).

#### 4. DISCUSSION

The findings from the statistical analysis of bacterial biofilms in chronic infections reveal several important insights into the relationship between patient demographics, healthcare experiences, and lifestyle factors. The results highlight the significant role that age, years of illness, and physical activity play in shaping healthcare satisfaction, and they underscore the importance of addressing lifestyle factors in managing chronic conditions. The normality tests for the variables show that the data deviates from a normal distribution, which has important implications for the choice of statistical tests. Non-normal data is common in healthcare and chronic illness studies, where patient experiences are often highly variable. The Shapiro-Wilk test results suggest that the data may require transformation or the use of non-parametric statistical methods in future analyses (Ding et al., 2022).

This is important because the assumption of normality in parametric tests may lead to biased results if not addressed appropriately. The strong Cronbach's alpha of 0.712 suggests that while the selected variables related to healthcare and lifestyle share some commonalities, there may be room for improvement in measuring healthcare satisfaction and its associated factors. This could indicate that the constructs being measured, such as healthcare satisfaction and overall lifestyle, might not be perfectly aligned, or that there could be external factors influencing patient experiences that were not captured by the variables in this study. For future research, refining the measurement scales or incorporating additional indicators of healthcare satisfaction, such as emotional well-being or social support, may improve reliability (Li et al., 2019).

Correlation analysis offers valuable insights into how different factors interrelate. The very strong positive correlation between **Age** and **Years with Illness** highlights the natural progression of chronic diseases with age. Older patients typically have a longer history of illness, which could contribute to worsening symptoms, increased healthcare needs, and possibly

diminished healthcare satisfaction over time. This is supported by the negative correlations observed between **Healthcare Satisfaction** and both **Age** and **Years with Illness**. As patients age or live longer with a chronic illness, their healthcare experiences may become less satisfying, potentially due to a greater burden of disease and fewer treatment options that effectively address their ongoing health challenges (Chen et al., 2019).

The correlation between **Physical Activity (Hours/Week)** and **Healthcare Satisfaction** is particularly noteworthy. A high level of physical activity is positively associated with better healthcare experiences. This finding reinforces the idea that lifestyle factors, particularly exercise, can have a profound impact on health outcomes and patient satisfaction, even in the context of chronic illness. Regular physical activity has been shown to improve physical function, reduce symptoms of chronic conditions, and enhance overall well-being, which may lead to increased satisfaction with healthcare services. This emphasizes the need for healthcare providers to incorporate lifestyle interventions, including physical activity, into the management of chronic conditions (Wong et al., 2021).

The regression analysis results further support these conclusions by revealing that **Physical Activity** is the strongest predictor of **Healthcare Satisfaction**, with a positive coefficient of 1.000. This suggests that patients who engage in more physical activity report significantly higher levels of healthcare satisfaction. In contrast, the **Overall Lifestyle Rating** had a negative coefficient, indicating that poor lifestyle choices are associated with lower satisfaction with healthcare. These findings suggest that improving patients' lifestyles through interventions that encourage physical activity, healthy eating, and self-care could significantly improve their healthcare satisfaction, particularly for those with chronic illnesses (Cámara et al., 2022).

Furthermore, the regression model indicates that both **Age** and **Years with Illness** are important predictors of healthcare satisfaction, with negative coefficients for both. This aligns with the correlation analysis and suggests that as patients grow older and live with chronic conditions for longer, they may experience a decline in their overall healthcare satisfaction. Healthcare providers should be aware of this trend and consider tailored approaches to care that address the unique challenges faced by older patients or those with long-term illnesses (Srinivasan et al., 2021).

## 5. CONCLUSION

This study explored the impact of bacterial biofilms in chronic infections, focusing on patient demographics, healthcare experiences, and lifestyle factors. The analysis revealed key insights into the factors that influence healthcare satisfaction among individuals with chronic conditions. Key findings suggest that both **Age** and **Years with Illness** are significant predictors of healthcare satisfaction, with older patients and those with longer durations of illness reporting lower satisfaction levels. This highlights the growing challenges of managing chronic illnesses over time, as prolonged illness may lead to increased healthcare needs and decreased treatment efficacy.

The study also found a strong positive correlation between **Physical Activity** and **Healthcare Satisfaction**. Individuals who engage in regular physical activity tend to report higher satisfaction with their healthcare experiences. This underscores the importance of incorporating lifestyle interventions, such as exercise programs, into the management of chronic diseases. Improving physical activity levels could play a critical role in enhancing both physical health and patient satisfaction, as it is associated with better symptom management and overall well-being. Despite the significant findings, the study also encountered limitations, particularly regarding the normality of the data and moderate reliability of the selected variables measuring healthcare satisfaction. These issues suggest the need for refined measurement scales and non-parametric statistical methods in future research.

In conclusion, the study emphasizes the importance of addressing lifestyle factors, particularly physical activity, in improving healthcare satisfaction for individuals with chronic illnesses. By focusing on tailored interventions that enhance patients' physical well-being, healthcare providers can potentially improve the quality of care and overall patient outcomes. Further research should expand on these findings, incorporating more comprehensive measures of patient satisfaction and exploring additional factors that may influence healthcare experiences in chronic disease management.

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