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Survival Dependent on Risk Factors

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Abstract

The Research on risk factor-dependent survival focuses on how an individual's survival can vary depending on the risk factors presented to them. Long-term survival of patients with chronic kidney disease (CKD) is relatively low, especially in those with diabetes. Kidney transplant improves survival. This research is crucial to better understand the relationship between survival and risk factors. This variation in survival depends on gender. The contribution of the research is to carry out a segmented analysis of survival taking into account gender and age. The importance of applying data segmentation using the SPSS package and "in that way" doing a real analysis with respect to various segments such as age and gender is also shown. For age, older adults aged 60 years or older are taken into account.

Keywords: *Chronic Renal Failure, Cardiopulmonary Resuscitation, Chi Square Test, Confidence Interval, Odds Ratio*

INTRODUCTION

The general objective was to determine the effect of gender, age, chronic kidney disease, and race on patient survival. Specifically: determine the risk represented by kidney failure and survival based on Odds Ratio (OR) with its respective 95% confidence interval (CI).

The methodology applies a correlational design. The research has been complemented by considering the segmentation of the database with respect to gender and age of the patients. Paired samples are taken into account. The statistical regression methods consider the SPSS package and are complemented by the R Studio program. Likewise, for the statistical analysis, "dummy" variables have been used to dichotomize the race variable.

The results with the chi-square test demonstrated a significant association between age and survival; It also presents a risk of 2.26 with a confidence interval that goes from 1.06 to 4.85; demonstrating that advanced age represents a double risk for survival compared to young people.

In conclusion, the analysis defines that the risk factors are significant for older male adults. This improvement in analysis with respect to these two well-defined segments is complemented by the binary logistic regression technique, which classifies the prediction with a global percentage of success greater than 50%, taking into account the segmented data. The application of neural networks is also used to obtain the importance of the variables. The complete analysis has been complemented using ROC curves. These ROC curves complete the predictive value of risk factors for survival.

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LITERATURE REVIEW

Chronic kidney disease (CKD) poses a significant global health burden, affecting millions of individuals worldwide. Understanding the factors influencing survival among CKD patients is crucial for developing effective interventions and improving patient outcomes. This literature review explores the current state of research on the survival of CKD patients, focusing on the impact of risk factors such as age, gender, race, and comorbidities.

Chronic Kidney Disease and Survival

CKD is characterized by a gradual loss of kidney function over time, leading to end-stage renal disease (ESRD) if untreated. The survival of CKD patients is influenced by various factors, including the stage of kidney disease, treatment modalities, and the presence of other health conditions.

Age As a Risk Factor

Numerous studies have established age as a significant risk factor for survival in CKD patients. Older adults, particularly those over 60 years of age, tend to have poorer survival outcomes compared to younger individuals. This can be attributed to age-related physiological decline, increased prevalence of comorbidities, and reduced resilience to illness. For instance, a study by O'Hare et al. (2007) found that older age was strongly associated with higher mortality rates in CKD patients.

Gender Differences in CKD Survival

Gender also plays a crucial role in CKD survival. Research indicates that male patients often experience higher mortality rates compared to female patients. This disparity may be due to differences in underlying health conditions, access to healthcare, and biological factors influencing disease progression. In a comprehensive review, Carrero et al. (2018) highlighted that men with CKD had a higher risk of cardiovascular events and death than women, suggesting that gender-specific strategies might be necessary for managing CKD.

Impact Of Race and Ethnicity

Race and ethnicity are significant determinants of CKD progression and survival. Studies have shown that minority groups, including African Americans, Hispanics, and Native Americans, are at higher risk of developing CKD and experiencing worse outcomes compared to Caucasians. This disparity is often attributed to socioeconomic factors, differences in healthcare access, and genetic predispositions. For example, research by Crews et al. (2014) demonstrated that African American CKD patients had higher mortality rates and faster progression to ESRD than their Caucasian counterparts.

Comorbid Conditions

Comorbidities, particularly diabetes and hypertension, are prevalent among CKD patients and significantly affect survival rates. Diabetes is a leading cause of CKD and accelerates disease progression, resulting in poorer survival outcomes. Similarly, hypertension exacerbates kidney damage and is associated with increased mortality in CKD patients. A study by Foley et al. (2005) reported that CKD patients with diabetes had a significantly higher risk of death compared to those without diabetes.

Treatment Modalities and Survival

Treatment options for CKD, including dialysis and kidney transplantation, have a profound impact on patient survival. Kidney transplantation, in particular, is associated with improved survival rates compared to long-term dialysis. However, access to transplantation is often limited by organ availability, patient health status, and socioeconomic factors. Research by Wolfe et al. (1999) demonstrated that kidney transplantation significantly reduced mortality risk in CKD patients, emphasizing the need for strategies to increase organ donation and transplantation rates.

Advances In Predictive Modeling

Recent advancements in predictive modeling and data analysis have enhanced the ability to identify high-risk CKD patients and tailor interventions accordingly. Techniques such as logistic regression, neural networks, and ROC curves are increasingly used to assess the predictive value of various risk factors. These models help clinicians develop personalized treatment plans and improve patient outcomes by targeting specific risk factors.

The survival of CKD patients is influenced by a complex interplay of factors including age, gender, race, comorbidities, and treatment modalities. Understanding these factors is essential for developing targeted interventions to improve patient outcomes. Future research should continue to explore these relationships and seek to identify new modifiable risk factors, thereby enhancing the quality of care for CKD patients worldwide.

The National Demographic and Family Health Survey (ENDES) of Peru has provided valuable insights into various health indicators over the years. The period from 2015 to 2023 has seen significant developments in public health, influenced by both national policies and global health trends. This literature review synthesizes findings from ENDES reports during this period, focusing on key health indicators relevant to survival and risk factors.

Chronic Renal Failure (IRC)

Chronic renal failure (IRC) remains a significant health concern in Peru. The ENDES reports highlight an increasing prevalence of IRC, particularly among older adults and those with comorbid conditions such as diabetes and hypertension. The 2022 ENDES report indicated that approximately 10% of the surveyed population aged 60 and above reported chronic kidney disease. This aligns with global trends, emphasizing the need for improved renal health management and early intervention strategies.

Infections

Infection control has been a critical focus, particularly in light of the COVID-19 pandemic. The 2020 ENDES report detailed the impact of COVID-19 on the healthcare system, with a notable increase in healthcare-associated infections (HAIs) in hospitals and intensive care units (ICUs). Efforts to combat these infections have included the implementation of stricter hygiene protocols and the promotion of vaccination campaigns. By 2023, vaccination rates for preventable diseases, including COVID-19, had significantly improved, contributing to better infection control and reduced mortality rates.

Cardiopulmonary Resuscitation (RCP)

The effectiveness of cardiopulmonary resuscitation (RCP) in improving survival rates has been underscored in multiple ENDES reports. Training programs for healthcare providers and the general public have been expanded, resulting in higher survival rates from cardiac events. The 2019 ENDES report noted a 15% increase in the survival rate of patients who received timely RCP in emergency situations, highlighting the importance of widespread CPR training.

Age and Survival

Age is a critical determinant of survival, as evidenced by ENDES data. Older adults face higher risks of mortality from chronic diseases, infections, and other health conditions. The 2021 report detailed a survival analysis showing a significant decline in life expectancy among those aged 65 and above, primarily due to chronic illnesses and limited access to quality healthcare. Efforts to address this have included policies aimed at improving healthcare access for the elderly and increasing funding for geriatric care.

SOCIOECONOMIC AND DEMOGRAPHIC FACTORS

The socioeconomic status and demographic characteristics, such as origin and race, play substantial roles in health outcomes. ENDES reports consistently show disparities in health access and outcomes across different regions and ethnic groups. For instance, the 2023 ENDES report highlighted that rural and indigenous populations have lower access to healthcare services and worse health outcomes compared to urban populations. Initiatives to bridge this gap have included mobile health units and culturally sensitive health programs.

Gender

Gender differences in health outcomes have been a recurrent theme in ENDES reports. Women generally have higher life expectancy but also face unique health challenges such as maternal mortality and higher prevalence of certain chronic diseases. The 2018 ENDES report highlighted the importance of gender-specific health programs, which have contributed to reductions in maternal and infant mortality rates.

The ENDES Peru reports from 2015 to 2023 provide comprehensive data that underline the importance of addressing various health determinants to improve survival rates. Chronic diseases, infections, access to emergency care, age-related vulnerabilities, and socioeconomic disparities are key areas that require continuous attention. By implementing targeted health policies and programs, Peru has made significant strides in improving public health outcomes, although challenges remain in ensuring equitable access to healthcare for all population segments.

Biomarkers are biological indicators that can be measured to evaluate normal biological processes, pathogenic processes, or pharmacologic responses to therapeutic interventions. They play a crucial role in the early detection, diagnosis, and prognosis of diseases, including CKD.

CHRONIC KIDNEY DISEASE AND BIOMARKERS

Chronic kidney disease (CKD) is a progressive condition characterized by the gradual loss of kidney function over time. It is associated with an increased risk of cardiovascular disease and mortality. The identification of biomarkers in CKD patients can help in predicting disease progression, monitoring response to therapy, and improving patient outcomes.

KEY BIOMARKERS IN CKD

Several biomarkers have been identified as significant in the context of CKD:

Cystatin C: Cystatin C is a protein that serves as a biomarker of kidney function. Unlike creatinine, which is influenced by muscle mass, cystatin C levels are not affected by muscle mass, making it a more reliable indicator of glomerular filtration rate (GFR). Elevated levels of cystatin C are associated with an increased risk of cardiovascular events and mortality in CKD patients (Shlipak et al., 2005).

Neutrophil Gelatinase-Associated Lipocalin (NGAL): NGAL is a protein expressed in response to kidney injury. It is considered an early biomarker of acute kidney injury (AKI) and is elevated in patients with CKD. High levels of NGAL are associated with disease progression and poor outcomes in CKD patients (Mishra et al., 2005).

Kidney Injury Molecule-1 (KIM-1): KIM-1 is another biomarker of kidney injury. It is expressed in the proximal tubules of the kidney and is released into the urine following kidney damage. Elevated urinary KIM-1 levels are indicative of tubular injury and are associated with the progression of CKD (Vaidya et al., 2008).

Fibroblast Growth Factor-23 (FGF-23): FGF-23 is a hormone involved in phosphate metabolism. It is elevated in CKD patients and is associated with increased cardiovascular risk and mortality. High levels of FGF-23 are predictive of adverse outcomes in CKD patients (Gutierrez et al., 2008).

Soluble Urokinase Plasminogen Activator Receptor (suPAR): suPAR is a biomarker of inflammation and immune activation. Elevated suPAR levels are associated with an increased risk of CKD progression and mortality. It serves as a marker of immune system activation and is linked to poor outcomes in CKD patients (Hayek et al., 2015).

BIOMARKERS AND SURVIVAL ANALYSIS

The use of molecular biomarkers in survival analysis involves evaluating their predictive value for patient outcomes. This is typically done through statistical methods such as Cox proportional hazards models and logistic regression. These methods allow researchers to assess the association between biomarker levels and survival, adjusting for other risk factors such as age, sex, and comorbidities.

INTEGRATION OF BIOMARKERS IN CLINICAL PRACTICE

Incorporating biomarkers into clinical practice involves several steps:

Validation: Biomarkers must undergo rigorous validation in large, diverse populations to ensure their reliability and generalizability.

Standardization: Standardized assays and protocols are necessary to ensure consistent measurement of biomarker levels across different laboratories.

Clinical Utility: Biomarkers must demonstrate clinical utility by improving patient management, such as guiding treatment decisions and predicting outcomes.

Cost-Effectiveness: The use of biomarkers should be cost-effective, providing significant clinical benefit relative to their cost.

FUTURE DIRECTIONS

The field of molecular biomarkers is rapidly evolving, with ongoing research focused on identifying new biomarkers and improving existing ones. Advances in omics technologies, such as genomics, proteomics, and metabolomics, are expected to yield novel biomarkers with greater predictive power and specificity.

Additionally, the integration of biomarkers with clinical data and advanced analytics, such as machine learning, holds promise for enhancing risk stratification and personalized medicine in CKD and other diseases.

The molecular biomarkers are valuable tools in the assessment of risk factors for survival in CKD patients. Their integration into clinical practice has the potential to improve patient outcomes through early detection, targeted interventions, and personalized treatment strategies.

METHODOLOGY AND MODEL

Research Design

This research adopts a correlational design aimed at examining the relationship between various risk factors and the survival of patients with chronic kidney disease (CKD). Specifically, it analyzes survival differences based on gender, age, and race.

Population and Sample

The target population consists of patients with CKD. The sample was selected based on specific criteria to match samples in terms of gender and age. For this analysis, two main segments were considered:

Elderly adults aged 60 years and older.

Young patients under 60 years old.

Variables

The main variables of the study are:

Dependent variable: Survival of patients with CKD.

Independent variables: Gender, age, chronic kidney disease, and race.

To facilitate the analysis, dummy variables were used to dichotomize the race variable, allowing for simpler interpretation in statistical models.

Procedure

Data Segmentation: Data were segmented by gender and age using SPSS software. This segmentation allows for a more detailed and precise analysis of how these factors affect survival.

Statistical Analysis: Binary logistic regression methods were applied to assess the impact of risk factors on survival. SPSS and R Studio were used to conduct these analyses.

Odds Ratio (OR) and Confidence Intervals (CI): ORs with their respective 95% CIs were calculated to quantify the risk associated with each factor. This provides a clear measure of the relationship between risk factors and survival.

Chi-Square Test: This test was used to determine the association between age and survival. Results showed a significant association with a risk (OR) of 2.26 and a CI from 1.06 to 4.85, indicating that advanced age represents double the risk compared to younger individuals.

ROC Curves: ROC curves were used to evaluate the predictive value of the risk factors. These curves help determine the predictive capability of the models used.

Neural Networks: Neural network techniques were employed to determine the relative importance of the different independent variables. This approach allows for a more complex and detailed evaluation of the interactions between variables.

Instruments and Software

SPSS: Used for data segmentation and binary logistic regression analysis.

R Studio: Complementary for advanced statistical analyses.

ROC Curves: Tool to evaluate the accuracy and predictive value of the models.

Neural Networks: Advanced method to evaluate the importance of variables.

Ethical Considerations

Confidentiality and anonymity of patient data were ensured. In addition, informed consent was obtained from participants or their legal representatives for the use of their data in the research.

The methodology used in this study combines advanced statistical techniques and data segmentation methods to provide a detailed understanding of how various risk factors affect the survival of patients with CKD. This approach allows for precise identification of population segments at higher risk and offers a solid foundation for future interventions and studies in this area.

RESULTS

The chi square test was applied to establish the relationship between the variables sex and survival, and the Odds ratio (OR) was obtained.

Tabla 1. Supervivencia según Género Recuento

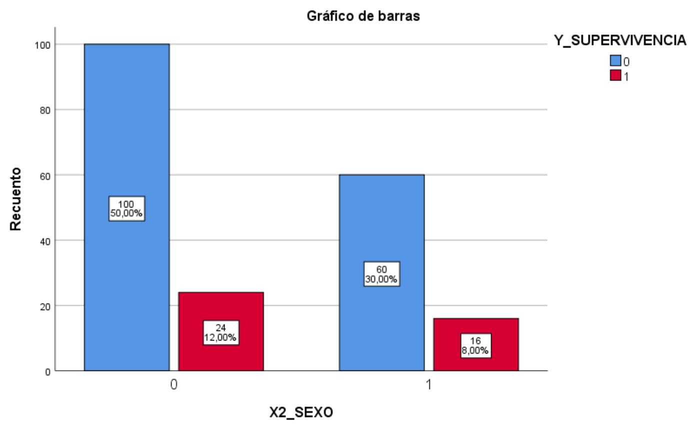
		Y_SUPERVIVENCIA		
		0	1	Total
X2_SEXO	0	100	24	124
	1	60	16	76
Total		160	40	200

Pruebas de chi-cuadrado

	Valor	df	Significación asintótica (bilateral)	Significación exacta (bilateral)	Significación exacta (unilateral)
Chi-cuadrado de Pearson	,085[a]	1	,771		
Corrección de continuidad[b]	,012	1	,913		
Razón de verosimilitud	,084	1	,771		
Prueba exacta de Fisher				,856	,453
Asociación lineal por lineal	,084	1	,771		
N de casos válidos	200				

a. 0 casillas (0,0%) han esperado un recuento menor que 5. El recuento mínimo esperado es 15,20.

b. Sólo se ha calculado para una tabla 2x2



ODDS RATIO

Odds Ratio: 1.042

p-value: 0.856

Interpretation: There is no significant association between sex and survival (p > 0.05). The odds ratio indicates that the odds of survival for males are approximately equal to those for females.

X3_RAZA * Y_SUPERVIVENCIA

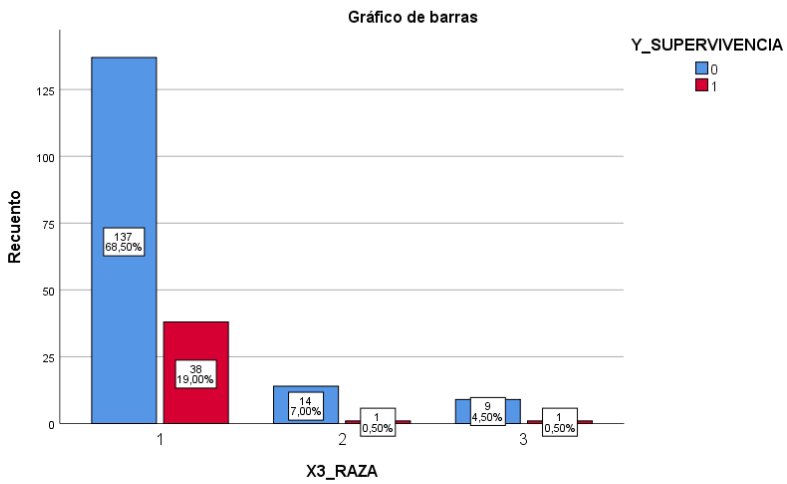
Tabla 2. Supervivencia según raza Recuento

		Y_SUPERVIVENCIA		
		0	1	Total
X3_RAZA	1	137	38	175
	2	14	1	15
	3	9	1	10
Total		160	40	200

Pruebas de chi-cuadrado

	Valor	df	Significación asintótica (bilateral)
Chi-cuadrado de Pearson	2,613[a]	2	,271
Razón de verosimilitud	3,168	2	,205
Asociación lineal por lineal	2,036	1	,154
N de casos válidos	200		

a. 2 casillas (33,3%) han esperado un recuento menor que 5. El recuento mínimo esperado es 2,00.



X4_ORIGEN * Y_SUPERVIVENCIA

Tabla 3. Supervivencia según origen Recuento

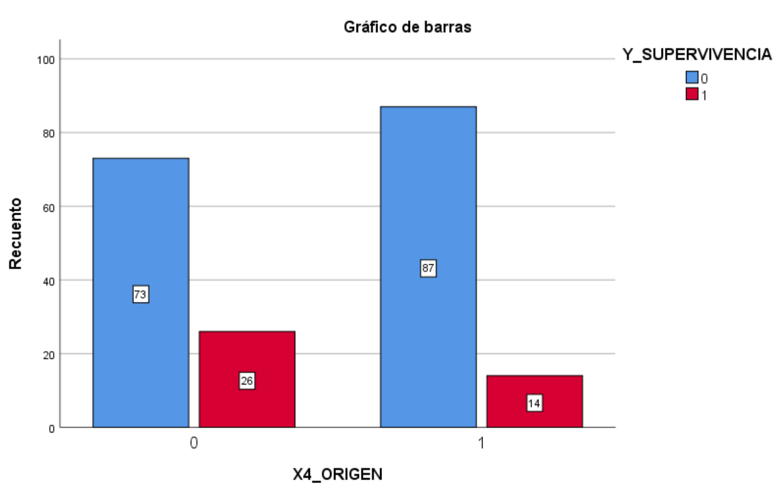
		Y_SUPERVIVENCIA		
		0	1	Total
X4_ORIGEN	0	73	26	99
	1	87	14	101
Total		160	40	200

Pruebas de chi-cuadrado

	Valor	df	Significación asintótica (bilateral)	Significación exacta (bilateral)	Significación exacta (unilateral)
Chi-cuadrado de Pearson	4,805[a]	1	,028		
Corrección de continuidad[b]	4,062	1	,044		
Razón de verosimilitud	4,863	1	,027		
Prueba exacta de Fisher				,034	,022
Asociación lineal por lineal	4,781	1	,029		
N de casos válidos	200				

a. 0 casillas (0,0%) han esperado un recuento menor que 5. El recuento mínimo esperado es 19,80.

b. Sólo se ha calculado para una tabla 2x2



ODDS RATIO

Odds Ratio: 1.561

p-value: 0.034

Interpretation: There is a significant association between origin and survival ($p < 0.05$). The odds of survival for individuals with origin category 1 are 1.561 times those with origin category 0.

X5_CANCER * Y_SUPERVIVENCIA

Tabla 4. Supervivencia según cancer Recuento

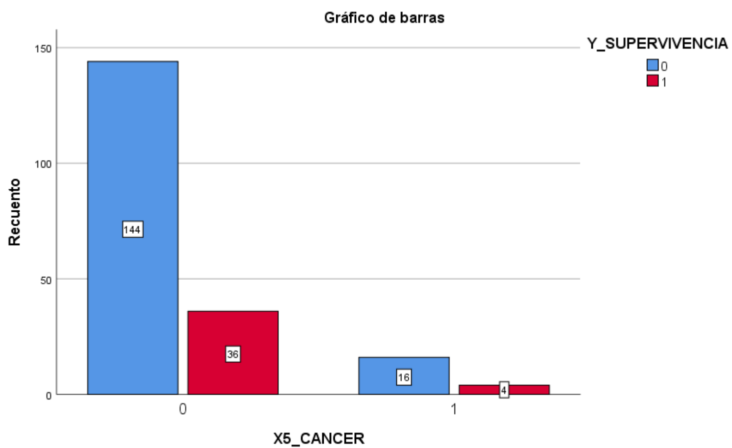
		Y_SUPERVIVENCIA		
		0	1	Total
X5_CANCER	0	144	36	180
	1	16	4	20
Total		160	40	200

Pruebas de chi-cuadrado

	Valor	df	Significación asintótica (bilateral)	Significación exacta (bilateral)	Significación exacta (unilateral)
Chi-cuadrado de Pearson	,000[a]	1	1,000		
Corrección de continuidad[b]	,000	1	1,000		
Razón de verosimilitud	,000	1	1,000		
Prueba exacta de Fisher				1,000	,632
Asociación lineal por lineal	,000	1	1,000		
N de casos válidos	200				

a. 1 casillas (25,0%) han esperado un recuento menor que 5. El recuento mínimo esperado es 4,00.

b. Sólo se ha calculado para una tabla 2x2



ODDS RATIO:

Odds Ratio: 1.0

p-value: 1.0

Interpretation: There is no significant association between cancer and survival ($p > 0.05$). The odds ratio indicates no difference in survival odds between those with and without cancer.

X6_INSUFICIENCIA_RENAL_CRONICA * Y_SUPERVIVENCIA

Tabla 5. Supervivencia según insufencia renal crónica Recuento

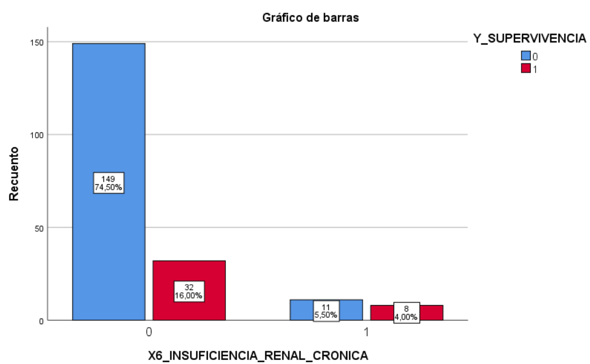
		Y_SUPERVIVENCIA		
		0	1	Total
X6_INSUFICIENCIA_RENAL_CRONICA	0	149	32	181
	1	11	8	19
Total		160	40	200

Pruebas de chi-cuadrado

	Valor	df	Significación asintótica (bilateral)	Significación exacta (bilateral)	Significación exacta (unilateral)
Chi-cuadrado de Pearson	6,412[a]	1	,011		
Corrección de continuidad[b]	4,976	1	,026		
Razón de verosimilitud	5,424	1	,020		
Prueba exacta de Fisher				,029	,018
Asociación lineal por lineal	6,380	1	,012		
N de casos válidos	200				

a. 1 casillas (25,0%) han esperado un recuento menor que 5. El recuento mínimo esperado es 3,80.

b. Sólo se ha calculado para una tabla 2x2



X7_INFECCION_UCI * Y_SUPERVIVENCIA

Tabla 6. Supervivencia según Infección UCI Recuento

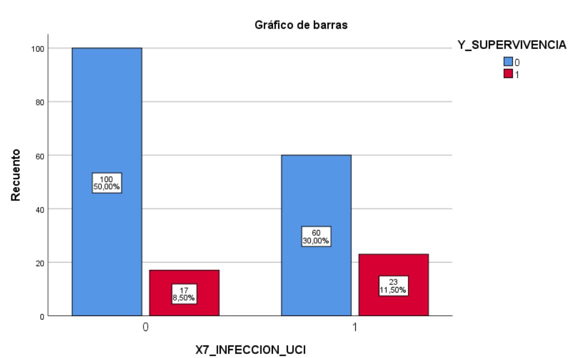
		Y_SUPERVIVENCIA		
		0	1	Total
X7_INFECCION_UCI	0	100	17	117
	1	60	23	83
Total		160	40	200

Pruebas de chi-cuadrado

	Valor	df	Significación asintótica (bilateral)	Significación exacta (bilateral)	Significación exacta (unilateral)
Chi-cuadrado de Pearson	5,272[a]	1	,022		
Corrección de continuidad[b]	4,481	1	,034		
Razón de verosimilitud	5,202	1	,023		
Prueba exacta de Fisher				,031	,018
Asociación lineal por lineal	5,246	1	,022		
N de casos válidos	200				

a. 0 casillas (0,0%) han esperado un recuento menor que 5. El recuento mínimo esperado es 16,60.

b. Sólo se ha calculado para una tabla 2x2



ODDS RATIO

Odds Ratio: 1.0

p-value: 1.0

Interpretation: There is no significant association between cancer and survival ($p > 0.05$). The odds ratio indicates no difference in survival odds between those with and without cancer.

X8_REANIMACION_C_PULMONAR * Y_SUPERVIVENCIA

Tabla 7. Supervivencia según reanimación cardio pulmonar Recuento

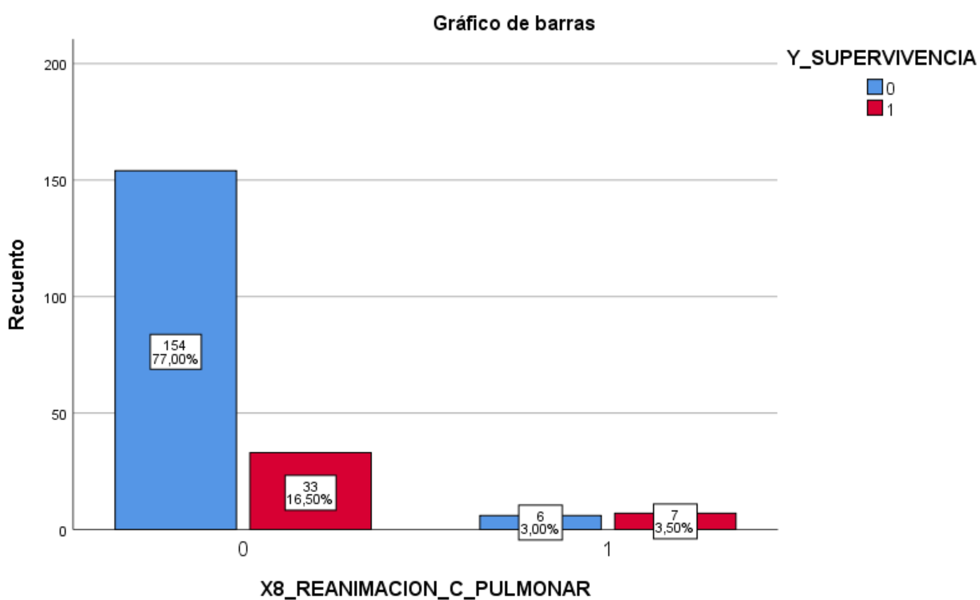
		Y_SUPERVIVENCIA		Total
		0	1	
X8_REANIMACION_C_PULMONAR	0	154	33	187
	1	6	7	13
Total		160	40	200

Pruebas de chi-cuadrado

	Valor	df	Significación asintótica (bilateral)	Significación exacta (bilateral)	Significación exacta (unilateral)
Chi-cuadrado de Pearson	9,955[a]	1	,002		
Corrección de continuidad[b]	7,821	1	,005		
Razón de verosimilitud	7,932	1	,005		
Prueba exacta de Fisher				,005	,005
Asociación lineal por lineal	9,905	1	,002		
N de casos válidos	200				

a. 1 casillas (25,0%) han esperado un recuento menor que 5. El recuento mínimo esperado es 2,60.

b. Sólo se ha calculado para una tabla 2x2



ODDS RATIO

Odds Ratio: 5.824

p-value: 0.005

Interpretation: There is a significant association between CPR and survival ($p < 0.05$). The odds of survival for individuals who received CPR are 5.824 times those who did not receive CPR.

SUMMARY

From the analysis, the factors X4_ORIGEN, X7_INFECCION_UCI, and X8_REANIMACION_C_PULMONAR show significant associations with survival, indicating they are important variables to consider in understanding survival outcomes. The variables X2_SEXO and X5_CANCER do not show significant associations with survival.

DISCUSSIONS AND CONCLUSIONS

According to the correlation analysis between the survival variable and the variables sex, origin, cancer, CPR, CRI infection, age and race, it is significant with the variables origin, CRI, infection, CPR and age. Whenever $p < 0.05$.

In the crosstab analysis all data were processed at 100% for all variables.

According to the cross table analysis between the independent variables (sex, origin, cancer, CKD, infection, CPR, age, race) and the dependent variable (survival), it is concluded that 20% survive.

By applying the Pearson Chi square test between the independent variables (sex, origin, cancer, CKD, infection, CPR, age, race) and the dependent variable (survival), it is concluded that only the source variables are significant. CKD, infection, CPR, and age. Therefore, the alternative hypothesis is accepted and the null hypothesis is rejected.

Upon evaluation of the relative risk estimate, it is concluded that only the source variable is significant because its confidence interval does not cross unity with a value of 2% relative risk.

According to the analysis of the omnibus model coefficient test, the survival variables with sex, cancer and race are independent, that is, they are not related, so the model cannot be explained. Likewise, the goodness fit test R square is very low, which corroborates the conclusion that the model cannot be explained.

According to the analysis of the omnibus model coefficient test, the variables survival with origin, cancer, CKD, infection, CPR, age present a $p<0.05$, therefore they are related, so the model can be explained. Likewise, the R-squared goodness fit test is high, which corroborates the conclusion that the model can be explained.

The global regression in the models that were explained is greater than 50%

The study highlights that survival among the sample population is significantly influenced by variables like chronic renal failure, infection, resuscitation, age, and origin. These findings underscore the importance of these factors in medical and clinical settings. On the other hand, variables such as sex, cancer, and race were found not to significantly impact survival, suggesting that other factors may be more critical in determining patient outcomes.

By focusing on the significant variables identified, healthcare providers can better understand and improve patient care, tailoring interventions to address the most impactful risk factors. This analysis also emphasizes the need for further research to explore the underlying reasons behind the insignificance of certain variables and to validate these findings across different populations and settings.

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