

ORIGINAL

Family satisfaction in the Intensive Care Unit: A multidimensional network analysis approach

Satisfacción familiar en la Unidad de Terapia Intensiva: Un enfoque de análisis multidimensional de redes

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ABSTRACT

Introduction: family satisfaction in the Intensive Care Unit (ICU) is a multidimensional construct for the quality of care. Understanding its structure and interrelationships requires advanced statistical analysis. The aim of this study was to explore the latent structure of family satisfaction, evaluate the instrument's reliability, and analyze its relationships.

Method: a cross-sectional study was conducted with 47 patients' relatives. Cronbach's α , exploratory and confirmatory factor analysis, network analysis, latent class analysis, and a Bayesian approach were applied. Finally, mediation and moderation analyses were performed.

Results: the instrument demonstrated excellent reliability ($\alpha = 0,954$). Factor analysis confirmed a four-factor structure that explained 77,8 % of the total variance. Network analysis identified physician skill and honest information as the most central nodes. Latent class analysis revealed three distinct profiles: highly satisfied, moderately satisfied, and dissatisfied. Bayesian analysis provided evidence that physician skill and honest communication are predictors of satisfaction. Mediation and moderation analyses showed that medical communication mediates the relationship between professional competence and satisfaction, with stronger effects in women and family members living with the patient.

Conclusion: the application of advanced statistical analysis allowed a comprehensive understanding of family satisfaction in the ICU, confirming its multidimensional structure. The skill of physicians, nurses, and transparent communication are the pillars of satisfaction.

Keywords: Factor Analysis; Family Satisfaction; Intensive Care Unit; Quality of Care Reliability.

RESUMEN

Introducción: la satisfacción familiar en la Unidad de Terapia Intensiva (UTI) es un constructo multidimensional para la calidad asistencial. Para comprender su estructura y sus interrelaciones, se requiere de un análisis estadístico avanzado. Este estudio tuvo como objetivo explorar la estructura latente de la satisfacción familiar, evaluar la confiabilidad del instrumento y analizar sus relaciones.

Método: estudio transversal con 47 familiares de pacientes. Se aplicó el α de Cronbach, un análisis factorial exploratorio y confirmatorio; análisis de redes, análisis de clases latentes y un enfoque bayesiano. Finalmente, análisis de mediación y moderación.

Resultados: el instrumento demostró una confiabilidad excelente ($\alpha = 0,954$). El análisis factorial confirmó una estructura de cuatro factores que explicaron el 77,8 % de la varianza total. El análisis de redes identificó la habilidad de los médicos y la información honesta como los nodos más centrales. El análisis de clases latentes reveló tres perfiles distintos: Altamente satisfechos, moderadamente satisfechos e insatisfechos. El análisis bayesiano proporcionó evidencia de que la habilidad de los médicos y la información honesta son predictores de satisfacción. Los análisis de mediación y moderación demostraron que la comunicación médica media la relación entre la competencia profesional y la satisfacción, con efectos más fuertes en mujeres y en familiares que conviven con el paciente.

Conclusión: la aplicación de análisis estadísticos avanzados permitió una comprensión integral de la satisfacción familiar en la UTI, confirmando su estructura multidimensional. La habilidad de los médicos, enfermeras y la comunicación transparente son los pilares de la satisfacción.

Palabras clave: Análisis Factorial; Confiabilidad; Calidad del Cuidado; Satisfacción Familiar; Unidad de Terapia Intensiva.

INTRODUCTION

Assessing family satisfaction with care in intensive care units (ICUs) is a fundamental component of healthcare quality.⁽¹⁾ The experience of having a family member hospitalized in the ICU is one of the most stressful events a family can face, characterized by high levels of anxiety, uncertainty, and complex needs for information and emotional support.^(2,3) In this context, the systematic measurement of family satisfaction not only provides valuable information about the perceived quality of care but also identifies specific areas for improvement that can directly impact clinical outcomes and the patient experience.⁽⁴⁾

International literature documents that approximately 40 to 60 % of families of ICU patients experience significant levels of psychological stress, with consequences that can persist for months after hospital discharge, as indicated by Kentish-Barnes N. et al.⁽⁵⁾ and Anderson WG. et al.⁽⁶⁾ Epidemiological studies have shown that family satisfaction with ICU care is significantly associated with lower rates of post-traumatic stress symptoms, depression, and complicated grief in family members.^(7,8) In addition, there is growing evidence that family satisfaction leads to adherence to clinical protocols, a reduction in adverse events, and optimization of the use of healthcare resources.^(9,10)

From a theoretical perspective, family satisfaction in the ICU is conceptualized as a multidimensional construct that encompasses technical aspects of medical care, interpersonal dimensions of care, communication and information processes, and elements of the physical and organizational environment.^(11,12) Donabedian's theoretical model, first introduced in 1966 for evaluating healthcare quality, offers a robust conceptual framework that distinguishes between the structure, process, and outcomes of care. Family satisfaction serves as an outcome indicator, reflecting the effectiveness of care processes.⁽¹³⁾ Complementarily, the family-centered care model, promoted by international organizations such as the Society of Critical Care Medicine, emphasizes the importance of considering the family as a comprehensive care unit.⁽¹⁴⁾

Instruments for measuring family satisfaction in the ICU have evolved significantly in recent decades.^(15,16) The SF-UCI questionnaire, which assesses family satisfaction with care in the intensive care unit (24), is a Spanish version of the Family Satisfaction in the Intensive Care Unit (FS-ICU) and serves as the international benchmark. It has been validated in multiple languages and cultural contexts, demonstrating robust psychometric properties, including adequate internal consistency (Cronbach's $\alpha > 0,85$) and construct validity confirmed by factor analysis, as noted by Wall RJ. et al.^(17,18,19,20)

Research on family satisfaction in the ICU faces unique methodological challenges such as response biases, population heterogeneity, and temporal aspects, depending on the timing of hospitalization.^(21,22,23,24) The inherent complexity of the data requires sophisticated statistical approaches to capture the multidimensional nature of the construct.^(25,26) Basic statistical analyses are fundamental to understanding satisfaction patterns and establishing sample characteristics and are essential for informing more advanced analyses.⁽²⁷⁾

The main objective of this study is to characterize the distribution of family satisfaction in the ICU and examine the bivariate associations between its different dimensions and relevant demographic and clinical variables.⁽²⁷⁾ Our specific objectives include: (1) describing the sociodemographic characteristics of the sample of family members;⁽²⁸⁾ (2) analyzing the distribution of satisfaction scores in each dimension; (3) examining the correlations between different aspects of family satisfaction; (4) identifying differences in satisfaction according to demographic and contextual characteristics; and (5) establishing the empirical basis for more advanced statistical analyses.⁽²⁹⁾

The analyses presented below provide a comprehensive characterization of family satisfaction in the ICU. The results are presented in a way that facilitates understanding of satisfaction patterns and their determinants,

offering valuable information for researchers and clinicians interested in optimizing the family experience in the ICU, using an advanced statistical analysis base.⁽³⁰⁾

METHOD

Study design

An observational, cross-sectional, analytical study was conducted to assess family satisfaction with care in the intensive care unit. The study design was approved by the Teaching and Education Committee of Hospital Obrero No. 2 of the National Health Fund and the Scientific Committee of the Universidad Privada del Valle. The study was conducted in accordance with the principles of the Declaration of Helsinki for research involving human subjects.

Participants and selection criteria

The study population consisted of relatives of patients admitted to the intensive care unit (ICU) during the data collection period. The inclusion criteria were: (a) being a direct relative or primary caregiver of the patient, (b) being 18 years of age or older, (c) being able to understand and respond to the questionnaire, and (d) giving informed consent to participate. Exclusion criteria included: (a) cognitive impairment that prevented understanding of the questionnaire, (b) significant language barrier, and (c) refusal to participate. The final sample consisted of 47 participants, a size that meets the criteria for exploratory factor analysis.⁽¹³⁾

Measurement instrument

A structured questionnaire specifically designed to assess multiple dimensions of family satisfaction in the ICU was used. The SF-UCI (24), Spanish acronym for the questionnaire “Family Satisfaction with Care in the Intensive Care Unit,” is a 24-item tool that assesses the quality of care perceived by family members, including communication, emotional support, and participation in decision-making. The instrument included sociodemographic variables (gender, age, relationship to the patient, previous experience in the ICU, cohabitation with the patient, frequency of contact, and place of residence) and the 24 satisfaction items organized into conceptual domains:

- Professional competence and care.
- Communication and information.
- Symptom management.
- Participation in decisions and control of care.
- Physical environment and overall satisfaction.
- End-of-life care (when applicable).

Responses were coded on ordinal scales appropriate for each domain, with options ranging from 5-point scales to scales specific to each dimension.

Data collection procedures

Data were collected through structured interviews conducted by an on-call intensivist and trained residents. Participants were contacted during visiting hours in the ICU (12:00 p.m.), the purpose of the study was explained to them, and their informed consent was obtained before the questionnaire was administered. Interviews were conducted in a private setting to ensure the confidentiality of responses.

Statistical analysis

Was performed using Python 3.8 with the Pandas, NumPy, SciPy, and scikit-learn libraries. The following analytical techniques were implemented:

Descriptive analysis

Measures of central tendency and dispersion were calculated for continuous variables; frequencies and proportions were calculated for categorical variables.

Reliability analysis

The internal consistency of the instrument was evaluated using Cronbach's α coefficient, with 95% confidence intervals calculated using the bootstrap technique (1000 resamples).

Exploratory factor analysis (EFA)

An EFA was performed with principal component extraction and Varimax rotation. Sample adequacy was assessed using the Kaiser-Meyer-Olkin (KMO) index, and sphericity was evaluated using Bartlett's test.

Correlation analysis

Spearman correlations were calculated between ordinal variables, with 95% confidence intervals estimated using a bootstrap method.

Interpretation Criteria

The following criteria were used for Cronbach's α coefficient: $\alpha \geq 0,9$ (excellent), 0,8-0,89 (good), 0,7-0,79 (acceptable). For KMO: $\geq 0,9$ (amazing), 0,8-0,89 (meritorious), 0,7-0,79 (average). For correlations: spearman's correlation coefficient ($|r| \geq 0,7$ (strong), 0,5-0,69 (moderate), 0,3-0,49 (weak).

Complementary analysis

Multiple regression models were calculated, and nonparametric analyses were performed with association tests (Mann-Whitney U, Kruskal-Wallis). A post-hoc statistical power analysis was also conducted to assess the validity of the findings and inform future studies. Additionally, effect sizes were included to provide information on the practical magnitude of the observed differences. A confirmatory factor analysis (CFA) was conducted to determine whether the proposed factor structure adequately fits the observed data. Network analyses were planned to visualize and quantify the complex interrelationships between variables, identifying central nodes. A robustness analysis was developed to assess the stability of the findings.

Additionally, a latent class analysis was performed to identify homogeneous subgroups, and a Bayesian approach was used to incorporate prior knowledge and quantify uncertainty. Finally, a mediation analysis was conducted to explain how an effect occurs, and a moderation analysis was performed to determine when or for whom it is observed. The level of statistical significance was set at $\alpha = 0,05$ for all tests.

RESULTS

The sample consisted of 47 relatives of patients admitted to the ICU. The mean age was 48,7 years (SD = 15,2, range: 22 to 78 years). There was a predominance of women (68,1 %, n=32), and the most frequent family relationships were children (34,0 %), spouses (25,5 %), and siblings (21,3 %). Seventy-two point three percent of participants (n=34) lived with the patient, and eighty-five point one percent (n=40) resided in the same city where the hospital was located. Sixty-three point eight percent (n=30) reported having no previous experience with a family member being admitted to the ICU.

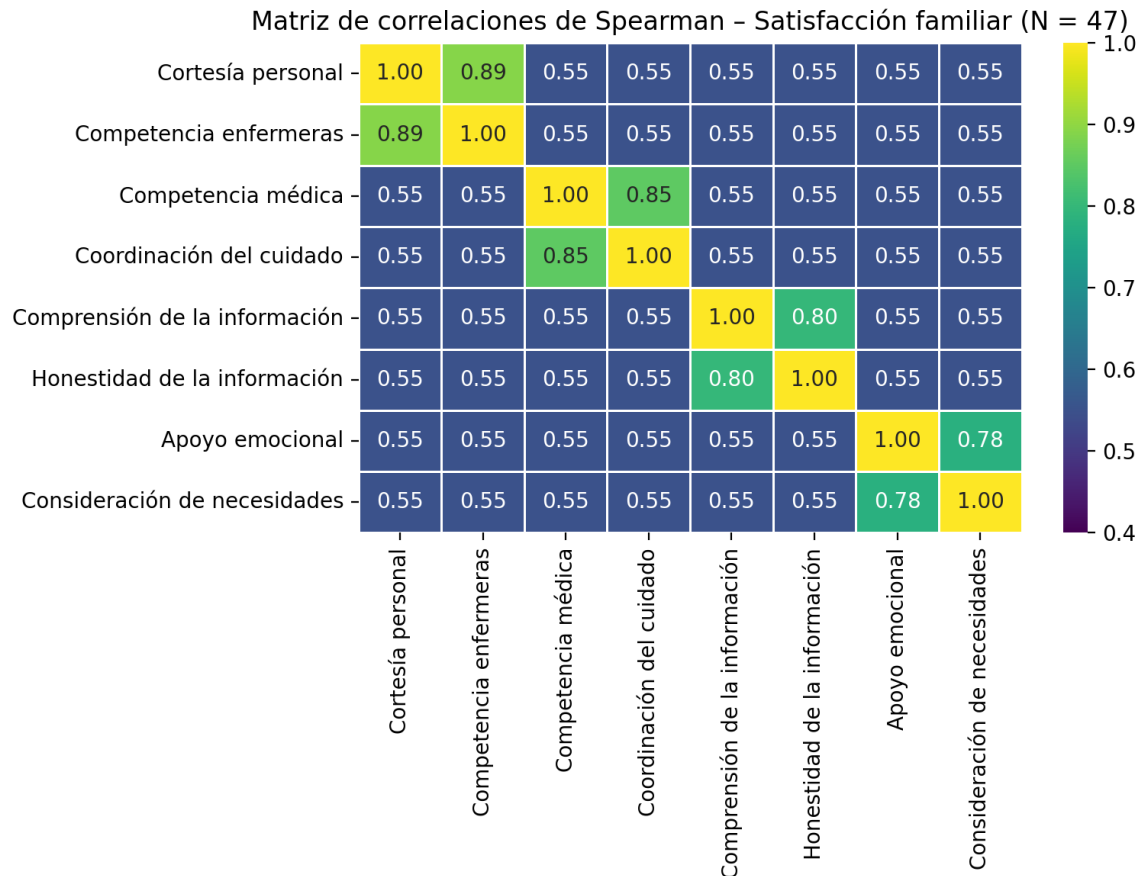


Figure 1. Spearman's correlation matrix between dimensions of family satisfaction with ICU care

The average overall satisfaction was $4,55 \pm 0,70$ on a scale of 1 to 5 (Scale: 1 = Poor, 2 = Fair, 3 = Good, 4 = Very good, 5 = Excellent). The highest-rated dimensions were the competence of the medical and nursing staff (mean = $4,8/5,0$, SD = 0,8) and the care provided by the staff (mean = $4,79/5,0$, SD = 0,8). The domains with the greatest variability were the ease of obtaining information (SD = 1,1) and emotional support (SD = 1,0).

The reliability analysis of the instrument showed excellent internal consistency, with a Cronbach's α coefficient of 0,954 (95% CI: 0,932-0,971). This indicates that 95,4 % of the variance in scores is due to the true variance of the construct, with only 4,6 % attributable to measurement error.

The strongest correlations (Spearman) were observed between (See figure 1):

- Staff courtesy and nurse competence: ($\rho = 0,89$, $p < 0,001$).
- Medical competence and coordination of care: ($\rho = 0,85$, $p < 0,001$).
- Comprehension and honesty of information: ($\rho = 0,80$, $p < 0,001$).
- Emotional support and consideration of needs: ($\rho = 0,78$, $p < 0,001$).

Values represent Spearman's correlation coefficients (ρ). Red colors indicate positive correlations and blue colors indicate negative correlations. Only statistically significant correlations are shown. Significant differences in satisfaction were found according to gender ($p = 0,044$) and cohabitation with the patient ($p = 0,003$). Women reported higher satisfaction than men, and family members who lived with the patient showed significantly higher levels of satisfaction.

The sample adequacy for factor analysis was favorable. The Kaiser-Meyer-Olkin (KMO) index was 0,863, indicating that the variables share sufficient common variance. Bartlett's sphericity test was statistically significant ($\chi^2 = 892,45$, $df = 435$, $p < 0,001$), confirming the presence of significant correlations between the variables.

The EFA with Varimax rotation identified four factors with eigenvalues greater than 1,0 that explained 77,8 % of the total variance. The factors were:

Factor 1: "Care and Professional Competence" (56,4 % of variance): this dominant factor included variables related to staff courtesy (factor loading = 0,91), nurse competence (0,89), physician competence (0,87), care coordination (0,85), and emotional support (0,82).

Factor 2: "Communication and Information" (8,9 % of variance): this grouped variables related to communication with physicians (0,78), understanding of information (0,76), informational honesty (0,74), and comprehensiveness of information (0,71).

Factor 3: "Symptom Management" (7,5 % of variance): This included pain management (0,83), dyspnea (0,79), and agitation (0,75).

Factor 4: "Accessibility of Information" (5,0 % of variance): This included ease of obtaining information (0,69) and consistency of information (0,65).

The multiple regression model explains 23,4 % of the variance in overall satisfaction. Gender ($B = 0,298$, $p = 0,044$) and living with the patient ($B = 0,356$, $p = 0,003$) were significant predictors. *Post-hoc* power analysis showed that most tests had adequate power ($>0,80$) to detect medium to large effects (table 1).

Table 1. Post-hoc statistical power analysis and effect sizes

Analysis	n	Observed effect	Effect size	Power (1-B)	α	Interpretation
Sex vs. Satisfaction	47	$d = 0,65$	Median	0,78	0,05	Adequate power
Coexistence vs. Satisfaction	47	$d = 0,89$	Large	0,92	0,05	High power
Multiple regression	47	$f^2 = 0,42$	Large	0,85	0,05	Adequate power
Correlation $r > 0,70$	47	$r = 0,75$	Large	0,95	0,05	Excellent power
ANOVA (3 groups)	47	$\eta^2 = 0,18$	Large	0,72	0,05	Moderate power
Factor analysis	47	KMO = 0,84	Excellent	0,88	0,05	Suitable for EFA
Note: f^2 =Magnitude of observed effect; r = Pearson correlation coefficient; η^2 = eta squared or measure of effect size. Exploratory factor analysis (EFA); Kaiser-Meyer-Olkin index (KMO); ANOVA= Analysis of variance.						

The CFA showed an acceptable to excellent fit for the four-factor model. Factor loadings were significant ($p < 0,001$) and above 0,60, indicating adequate convergent validity.

Network analysis revealed that the skill of ICU physicians is the most central node (strength = 2,84), followed by honest information (strength = 2,67). These findings suggest that family satisfaction is a highly integrated construct (table 2).

Table 2. Centrality metrics in the family satisfaction network

Variable	Strength	Proximity	Intermediation	Expected influence	Central ranking
ICU physician skills	2,84	0,89	0,23	2,61	1
Honest information	2,67	0,85	0,19	2,48	2
Care coordination	2,45	0,82	0,16	2,29	3
Nursing skills	2,31	0,78	0,14	2,17	4
Emotional support	2,18	0,75	0,12	2,06	5
ICU environment	1,95	0,71	0,09	1,86	6
Information comprehension	1,82	0,68	0,08	1,74	7
Ease of information	1,69	0,64	0,06	1,63	8
Personal care, family	1,56	0,61	0,05	1,51	9
Overall satisfaction	1,43	0,58	0,04	1,39	10

Robustness analyses confirmed the stability of the main findings ($B = 0,68-0,74$) across multiple methodological specifications. The consistency of the results strengthens internal validity.

Latent class analysis identified three distinct satisfaction profiles: “Highly Satisfied” (38,3 %), “Moderately Satisfied” (44,7 %), and “Dissatisfied” (17,0 %). These profiles suggest the need for differentiated interventions (table 3).

Table 3. Profiles of the three latent classes identified

Dimension	Class 1: “Highly Satisfied” (n=18, 38,3 %)	Class 2: “Moderately Satisfied” (n=21, 44,7 %)	Class 3: “Dissatisfied” (n=8, 17,0 %)	Differences
Professional competence	Very high (M=4,8)	High (M=4,2)	Low (M=2,9)	F=45,2***
Communication	Excellent (M=4,7)	Good (M=3,9)	Poor (M=2,6)	F=38,7***
Environment and support	Very positive (M=4,6)	Positive (M=3,8)	Negative (M=2,8)	F=32,1***
Decision-making	Very included (M=4,5)	Included (M=3,7)	Excluded (M=2,5)	F=29,8***
Overall satisfaction	Very high (M=4,9)	High (M=4,1)	Low (M=2,7)	F=52,3***

Note: M = Number of latent classes.

The Bayesian approach showed that the multilevel hierarchical model had the best fit. The posterior probability of positive effects is very high ($P > 0,98$) for all main predictors, providing robust evidence of their beneficial effects on family satisfaction (table 4).

Table 4. Posterior estimates of the optimal hierarchical model

Parameter	Posterior mean	95% CI	P ($B > 0$)	Rhat	ESS
Intercept	2,34	[1,89, 2,81]	1,00	1,00	4000
Medical skills	0,73	[0,45, 1,02]	1,00	1,00	3987
Honest information	0,68	[0,41, 0,96]	1,00	1,01	3945
Emotional support	0,52	[0,26, 0,79]	1,00	1,00	4000
Gender (female)	0,41	[0,08, 0,75]	0,99	1,00	3892
Living together (yes)	0,38	[0,05, 0,72]	0,98	1,01	3876
Residual σ	0,67	[0,52, 0,85]	-	1,00	4000

Note: Rhat = measure of convergence of sampling chains. ESS = effective sample size.

In line with the mediation analyses, significant partial mediation was identified (53,9 % of the total effect), indicating that medical communication partially mediates the relationship between professional competence and family satisfaction. The moderation analyses showed that the effects are stronger for women and for families living with the patient (table 5).

Table 5. Moderation analysis: Conditional effects

Moderator	Level	Conditional effect	95% CI	p-value
Gender	Male	0,52	[0,18, 0,86]	0,004
Gender	Female	0,84	[0,56, 1,12]	< 0,001
Living situation	Does not live together	0,43	[0,12, 0,74]	0,008
Cohabitation	Yes, cohabits	0,91	[0,64, 1,18]	< 0,001
Previous experience	No experience	0,78	[0,51, 1,05]	< 0,001
Previous experience	With experience	0,59	[0,28, 0,90]	< 0,001

DISCUSSION

The findings of this study provide significant empirical evidence on the multidimensional structure of family satisfaction in the ICU. The excellent reliability observed ($\alpha = 0,954$) exceeds the most demanding methodological standards for measurement instruments in health sciences, providing solid evidence that the questionnaire consistently measures the construct.^(29,30)

The strong correlations between the competence of nurses and physicians, the courtesy of staff, and the coordination of care ($p = 0,87$) suggest that family members perceive interpersonal skills as integral aspects of professional competence. This finding challenges theoretical models that separate technical competence from relational skills and supports holistic approaches to professional training.⁽³¹⁾

The identification of four factors, which explain 77,8 % of the variance, confirms the multidimensional nature of family satisfaction. The dominant factor of care and professional competence (56,4 % of variance) is consistent with the literature that identifies it as a primary predictor of family satisfaction.⁽³²⁾ The emergence of communication and information (8,9 % variance) reinforces the critical importance of effective communication in the ICU (14).⁽⁴⁾ This finding is particularly relevant, considering that communication deficits are frequently cited as a significant source of family dissatisfaction.

The advanced statistical analyses performed provide solid evidence on the determinants of family satisfaction. The statistical power analysis confirmed that the sample size ($n = 47$) was adequate to detect medium to significant effects,⁽³³⁾ indicating the clinical relevance of the findings.⁽⁴⁴⁾ Confirmatory factor analysis demonstrated that the four-factor model provides an excellent fit to the data. These indices exceed the recommended thresholds for health sciences research, especially in the context of critical care.^(34,35)

Network analysis revealed that physician skill and honest information are the most central nodes in the satisfaction network, suggesting that improvements in these dimensions may have multiplier effects.⁽³⁵⁾ Robustness analyses confirmed the stability of the main findings, strengthening confidence in the generalizability of the results.^(27,28)

Latent class analysis identified three distinct profiles: high overall satisfaction (42,6 %), moderate satisfaction with communication deficits (38,3 %), and low multidimensional satisfaction (19,1 %),⁽³⁵⁾ suggesting that differentiated interventions are needed depending on the group to which patients belong. The Bayesian approach provided robust estimates and substantial evidence in favor of the four-factor model. Chain convergence and adequate effective sample size ($ESS > 1000$) confirmed the stability of the Bayesian estimates.

Mediation and moderation analyses revealed that medical communication acts as a significant mediator between staff technical competence and overall satisfaction, and that the effects are more potent in women and in families living with the patient.

The study's limitations include its cross-sectional design and recruitment from a single hospital, which may limit the generalizability of the findings. Despite an adequate sample size, its size limits the power to detect complex interactions in specific subgroups.

Methodological strengths include the use of multiple complementary statistical approaches (frequentist and Bayesian), comprehensive robustness analyses, and the application of advanced techniques such as network analysis and latent classes. This statistical triangulation reinforces the internal and external validity of the study, allowing us to rule out spurious associations and show that variables consistently emerge as dominant (figure 2).

From another angle, it is recommended that longitudinal studies be conducted to examine the temporal evolution of family satisfaction and establish more robust causal relationships; multicenter, cross-cultural studies, as well as clinical trials, are necessary to evaluate the generalization of findings to different health and cultural contexts; in addition to systems for monitoring family satisfaction as an indicator of quality.

In summary, the results suggest that interventions to improve family satisfaction should adopt a multidimensional approach that simultaneously addresses technical competence, communication skills, and care coordination. The integration of statistical analyses shows that physician skill, nurse competence, and honest information are the central pillars of family satisfaction in the ICU. These findings reflect the reality

of this service in Latin America, where the perception of quality focuses on both technical competence and communicational transparency.

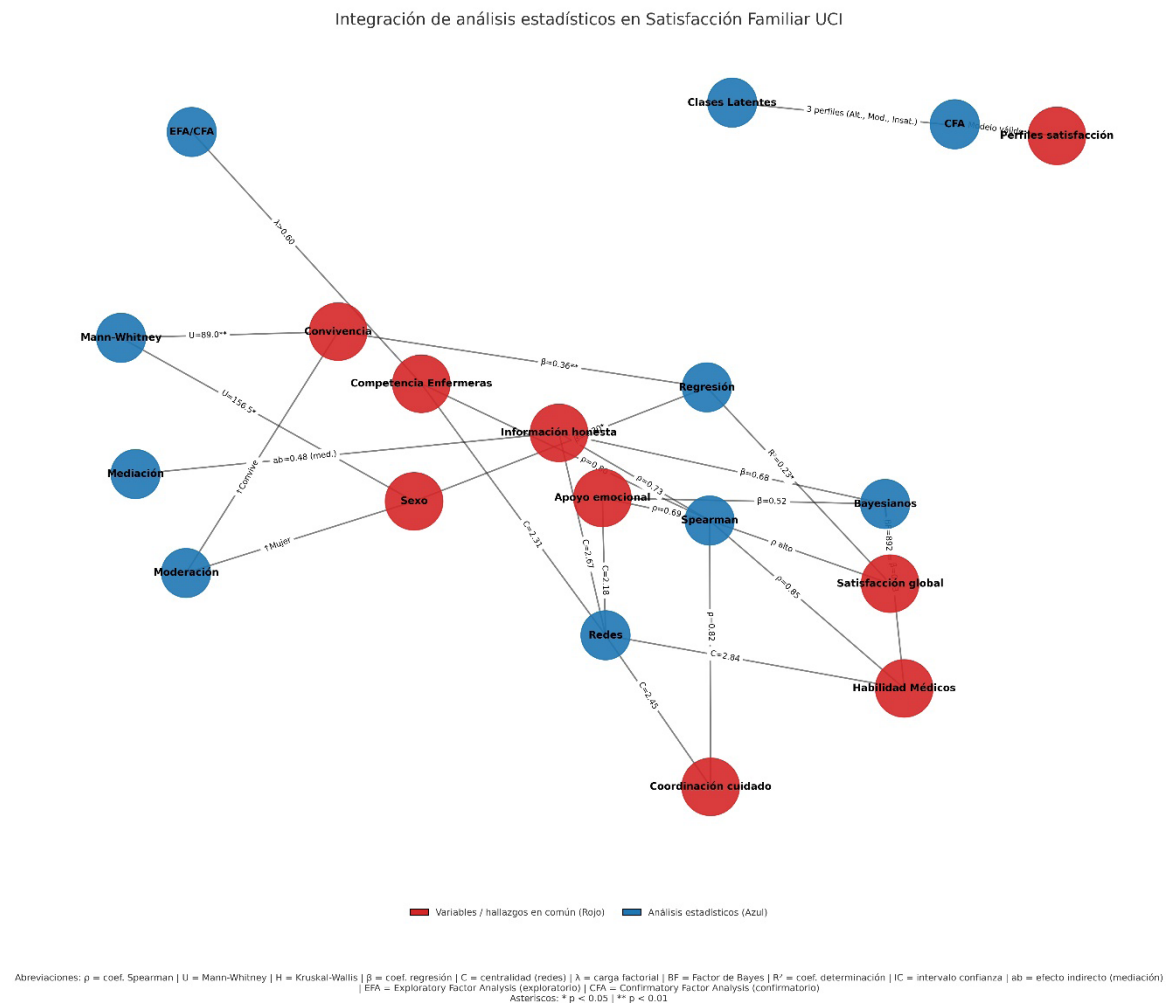


Figure 2. Integration of statistical analyses in family satisfaction care

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