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THE JOURNAL OF LATIN AMERICAN GERIATRIC MEDICINE ORIGINAL ARTICLE

Vitamin D deficiency in elderly people in Ecuador

Francisco J. Rodríguez-Lanfranco[1,2], Karina E. Pazmiño-Vizuete[1,2], Gloria P. Cueva-Martínez[1,2], and Edy Quizhpe[3]*

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Abstract

Background: *In Ecuador, the increase in the older adult population requires specific attention to problems, such as vitamin D deficiency, associated with frailty, fractures, and chronic diseases. Factors such as limited sun exposure and socioeconomic barriers aggravate this deficiency, despite a favorable climate.* **Objective:** *This study analyzed vitamin D levels in over-65s in a hospital in 2020, considering sociodemographic variables to guide interventions to improve their health and quality of life.* **Material and methods:** *Cross-sectional descriptive observational study that determined the prevalence of vitamin D deficiency and insufficiency and examined their relationship with sex and age.* **Results:** *The mean vitamin D status was 18.57 ng/mL. Deficiency was found in 62.8%, more frequent in women (66.9%) than in men (49.7%). There was a negative correlation between age and vitamin D levels, with significant differences by gender.* **Conclusion:** *The high prevalence of vitamin D deficiency in older adults highlights the urgency of establishing preliminary specific protocols for its evaluation and management as well as promoting educational campaigns to increase safe sun exposure.*

Keywords: *Geriatrics. Vitamin D. Elderly. Ecuador.*

Déficit de vitamina D en adultos mayores en Ecuador

Resumen

Antecedentes: *En Ecuador, el aumento de la población adulta mayor requiere atención específica a problemas como la deficiencia de vitamina D la cual está asociada a una mayor fragilidad, fracturas y enfermedades crónicas. Factores como la limitada exposición solar y las barreras socioeconómicas agravan esta deficiencia, a pesar del clima favorable.* **Objetivo:** *Este estudio analizó los niveles de vitamina D en personas mayores de 65 años en un hospital en 2020, considerando variables sociodemográficas para orientar intervenciones que mejoren su salud y calidad de vida.* **Material y métodos:** *Estudio observacional descriptivo transversal que determinó la prevalencia de deficiencia e insuficiencia de vitamina D y examinó su relación con el sexo y la edad.* **Resultados:** *El nivel medio de vitamina D fue de 18,57 ng/mL. La deficiencia fue del 62,8%, más frecuente en mujeres (66,9%) que en hombres (49,7%). Hubo una correlación negativa entre la edad y los niveles de vitamina D, con diferencias significativas por sexo.* **Conclusiones:** *La elevada prevalencia de deficiencia de vitamina D en adultos mayores pone de manifiesto la urgencia de establecer protocolos específicos para su evaluación y manejo.*

Palabras clave: *Geriatría. Vitamina D. Adulto mayor. Ecuador.*

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INTRODUCTION

Vitamin D (25 OH) plays a crucial role in calcium and phosphorus metabolism and is essential for bone mineral development. It also plays an important role in the regulation of the immune system, as it acts as a mediator in the proliferation and differentiation of various cell lines, and regulates multiple physiological processes in various organs and systems[1]. In the elderly, vitamin D deficiency is associated with increased frailty and loss of autonomy, which increases morbidity and mortality in this age group. Therefore, it is essential to assess vitamin D levels in this population to develop intervention strategies to improve their quality of life and reduce the risks associated with their deficiency[2].

In Ecuador, the older adult population (according to Ecuador's comprehensive health model, older adults are defined as those aged 65 years or older) has been increasing significantly, so it is important to address the specific health problems of this age group. According to the National Institute of Statistics and Census (INEC), the population of older people has increased considerably in recent decades, which calls urgently to schedule medical care tailored to their needs[3]. Vitamin D deficiency in this population can have serious consequences, such as an increased risk of fractures, cardiovascular diseases, and a weakened immune system that makes them more susceptible to infections and other diseases[4,5].

Limited sun exposure, dietary changes, and the reduced capacity of the skin to synthesize vitamin D are factors that contribute to greater deficiency in the elderly. In Ecuador, despite a favorable climate for vitamin D production, few studies have shown that vitamin D is deficient and insufficient in the older adult population[6,7]. This may be due to multiple factors, such as socioeconomic barriers, lack of access to supplements, and lack of awareness of the importance of vitamin D[8].

The aim of this study was to analyze vitamin D levels in older adult patients who received care at the *Hospital de Atención Integral del Adulto Mayor* in 2020 and examine their correlation with sociodemographic variables.

MATERIALS AND METHODS

This observational, descriptive, cross-sectional study aimed to assess vitamin D levels in older adult patients receiving healthcare at the *Hospital de Atención Integral del Adulto Mayor de Quito*. The sample included all patients enrolled in the hospital's inpatient and outpatient comprehensive healthcare program, regardless of their health status. The serological samples were collected between January and December 2020, and the hospital is a tertiary level center belonging to the public network of services of the Ministry of Public Health of Ecuador (MoPH).

Vitamin D levels were determined by enzyme-linked fluorescence assay (alpha) in the hospital's own laboratory. According to the Endocrine Society classification, the results allowed us to categorize the patients as: with sufficient or normal levels, those with values between 30 and 100 ng/mL; with insufficient levels, those with values between 21 and 29 ng/mL; and with deficient levels, those with values equal to or lower than 20 ng/mL. Finally, values above 100 ng/mL were considered toxic[2,4].

For the statistical analysis, descriptive statistics were used to determine the prevalence of vitamin D according to sociodemographic variables. In addition, multivariate analysis was performed using Analysis of variance (ANOVA) and ordinary least squares regression to evaluate the correlation between the variables of gender, age, and vitamin D values. The protocol of this study was approved by the hospital ethics committee in accordance with the health regulations of the MoPH.

RESULTS

A total of 1017 vitamin D determinations were analyzed. Table 1 shows the main findings on vitamin D levels according to sex and age. Seventy percent of the samples corresponded to the female group. The mean age of the participants was 79 ± 7.99 years, with a range from 65 to 100 years. The mean vitamin D value obtained was 18.57 ± 8.95 ng/mL. According to the established vitamin D ranges, 61.8% of the patients were deficient, followed by 31.9% with insufficient levels. Only 6.2% of the patients were within the normal range. In addition, two determinations were found in toxicity ranges, with levels above 100 ng/mL.

In the analysis by sex, a statistically significant difference ($p < 0.001$) in mean vitamin D levels was found between women (17.16 ng/mL) and men (20.32 ng/mL). Female sex was associated with an odds ratio (OR) of 2.048 (95% CI: 1.558-2.693) for having a higher vitamin D deficiency. In addition, it was evident that female patients have a higher risk of

Table 1. Sociodemographic characteristics of older adult patients and vitamin D levels

Variables	Total	Women	Men
Sex, n (%)	1017 (100)	713 (70)	304 (30)
Age, mean, SD	79.37 (± 7.99)	79.49 (± 8.14)	79.12 (± 7.62)
Vitamin D values, mean, n (%)	18.57 (± 8.95)	17.16 (± 6.52)	20.32 (± 7.54)
Levels, n (%)			
Deficit	628 (63)	477 (67)	151 (50)
Insufficiency	324 (32)	203 (28)	121 (40)
Normal	63 (5.8)	31 (4)	32 (10)
Toxicity	2 (0.2)	2 (0.7)	0 (0)

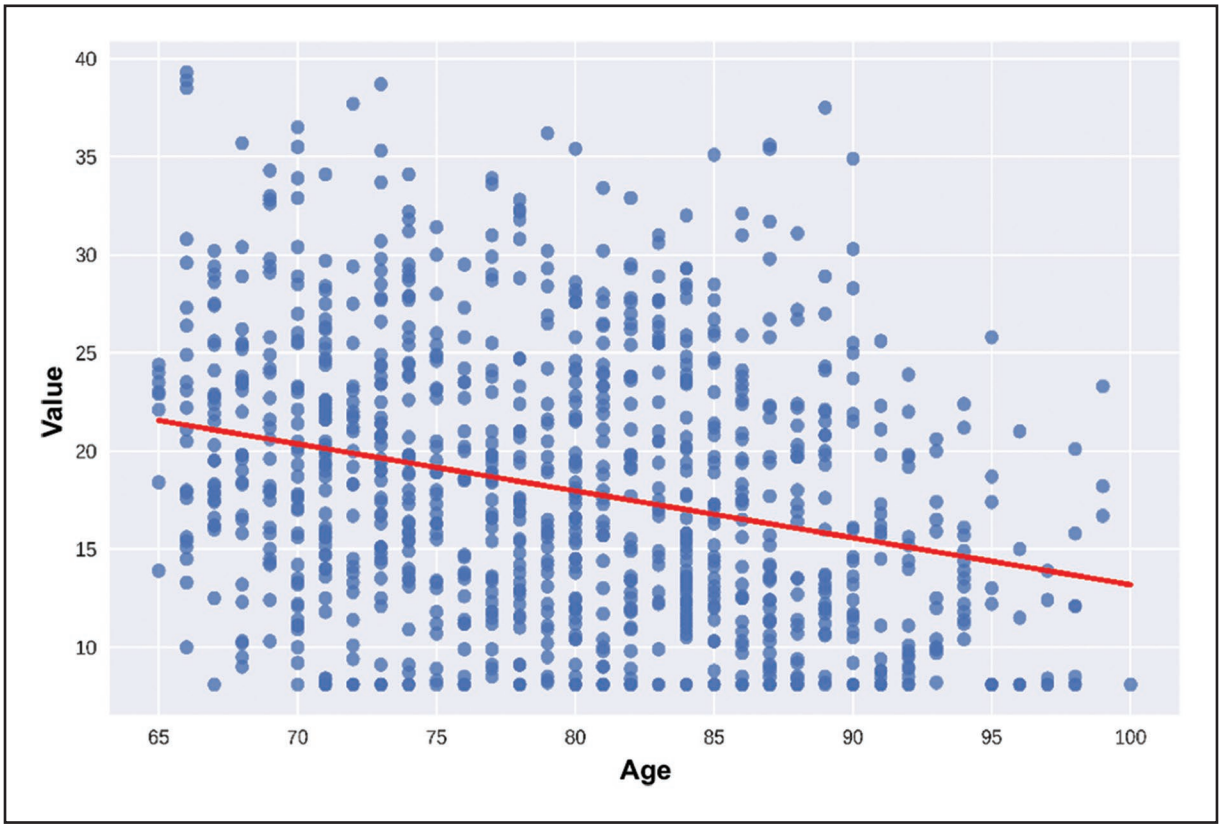

Figure 1. *Levels and trend of vitamin D values in older adult patients by age groups.*

severe vitamin D deficiency (< 10 ng/mL), with an OR of 1.876 (95% CI: 1.211-2.905), p < 0.004.

In relation to age, a progressive decrease in vitamin D levels was observed with increasing years (Fig. 1), a result corroborated by a Pearson correlation analysis (–0.22). ANOVA showed statistically significant differences between the different age groups (p < 0.001). The decrease in vitamin D levels with age was maintained in both men and women (Fig. 2). However, these levels were consistently lower in women than in men. Furthermore, in the multivariate analysis, we found an R-squared value of 0.115, indicating that approximately 11.5% of the variance in vitamin D values can be explained by this model, in which an intercept coefficient (constant): 35.8607, a correlation with age: –0.2352 and, in relation to male gender: 3.0723 are evident. All these coefficients were statistically significant, with p < 0.05.

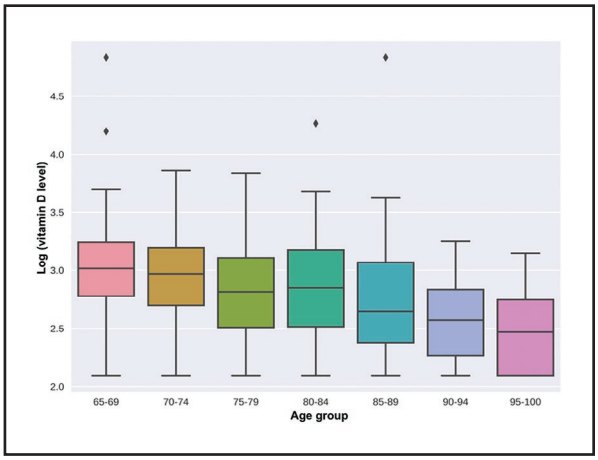

Figure 2. *Levels of vitamin D in older adult patients by age groups.*

DISCUSSION

The present study found a high prevalence (61,8%) of vitamin D deficiency in older adult patients, which increased with age and is more common in women than in men.

Although there are few studies in Ecuador, our results are relatively similar to others carried out in alike contexts[9,10]. However, there is a notable difference with the results of other studies in countries of the Latin America region, such as Peru, which found a prevalence of 13% deficiency in the older adult population, and Brazil and Chile with values between 40% and 50%[11,12]. However, our values are very close to those of the Mexican population, which has reported ranges between 47% and 67%[13,14]. These deficiencies could be due to the physiological decrease in the cutaneous vitamin D synthesis capacity, low sun exposure due to low mobility, and deficient dietary intake of vitamin D[15]. In addition, it is important to consider that our study was conducted in 2020, during a period when mobility restrictions imposed due to the COVID-19 pandemic may have significantly limited patients' exposure to sunlight.

As in other studies, we observed that women have a higher risk of vitamin D deficiency. The higher prevalence of vitamin D deficiency in women has also been demonstrated in other populations in the region, such as Peru, Brazil, and Colombia[9,16]. Although the exact reason for this difference is still not completely clear, from a physiological point of view, it could be due to a greater amount of fatty tissue in women, which would act as a reservoir of vitamin D and cause lower plasma concentrations of this vitamin. Another possible explanation is the greater amount of vitamin D binding protein in women due to the action of estrogens[17,18]. However, the latter explanation is less likely in our population of post-menopausal women, where the estrogenic effect is reduced.

Age is a recognized risk factor for vitamin D deficiency[19,20]. In our study, we have observed that, within the group of older people, vitamin D figures decrease with age, finding a difference of 6 ng/mL between the 65-69 years and 95-100 years' groups. This decrease is related to the reduction in the capacity for cutaneous synthesis of vitamin D in the elderly, together with the lower sun exposure to which they are subjected[21]. This inverse relationship between age and vitamin D levels is independent of sex, although lower levels are observed in women.

Finally, this study has some strengths and limitations that have to be taken into account by the readers. From our point of view, it is the first study conducted in a large population of older adults in a geriatric care service in Ecuador. In addition, many of the patients in the future could be monitored to evaluate and correlate their results with other pathologies. One of the main limitations of this research is that most of the patients included have underlying diseases that could have affected the vitamin D results compared to a healthy older adult population.

CONCLUSION

These results show that despite being in a country with a high degree of sun exposure, vitamin D deficiency is highly prevalent in the older adult population. Furthermore, our results highlight the importance of early determination of vitamin D levels in the older adult population during the provision of health services. It is important to highlight that these interventions could contribute to reducing the risk of falls, and the development of sarcopenia, as well as reducing the risk of developing some neoplasms[22,23]. It is also important to establish a preliminary specific protocol to determine vitamin D levels during the provision of health services and recommendations to supplement or compensate for deficiencies in older adult patients such as educational campaigns of safe sun exposure. Finally, it is important to recommend the development of other studies in which other variables that may be associated with vitamin D deficiency are identified to adequately profile the type of patients with a greater risk of presenting vitamin D deficiency.

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FUNDING

The authors declare that they have not received funding.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

ETHICAL CONSIDERATIONS

Protection of human subjects and animals. The protocol of this study was reviewed and approved by the Research Ethics Committee of the *Hospital General Docente de Calderón* under number CEISH-HGDC-2023-007). The study was conducted in accordance with the guidelines of the Declaration of Helsinki, Good Clinical Practice, and the rights of Ecuadorian older adults.

Confidentiality, informed consent, and ethical approval. The authors have obtained approval from the Ethics Committee for the analysis of routinely collected and anonymized clinical data; therefore, individual informed consent was not required. Relevant ethical recommendations have been followed.

Declaration on the use of artificial intelligence. The authors declare that no generative artificial intelligence was used in the writing or creation of the content of this manuscript.

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Risk factors associated with the development of delirium in hospitalized older adults with cardiopathy

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Abstract

Background: *Delirium is a frequent and serious neuropsychiatric complication in hospitalized older adults and is associated with poor outcomes. Its incidence varies widely, but it is estimated to affect between 11% and 42% of hospitalized patients worldwide. Identifying the risk factors in this population is crucial for optimizing preventive strategies.* **Objective:** *To evaluate the risk factors associated with the development of delirium in older adults hospitalized for cardiac pathologies.* **Material and methods:** *A retrospective cohort study was conducted that included adults aged ≥ 70 years who were hospitalized for heart disease between January 2022 and December 2023. From the total population included in the study, two groups were defined: patients admitted under a delirium prevention protocol and patients with delirium present at hospital admission, who were designated as the delirium follow-up program group. All patients included underwent a comprehensive geriatric assessment. The associated risk factors were analyzed using multivariate logistic regression.* **Results:** *A total of 847 patients were included; 52.5% were men, with a mean age of 78 ± 6.4 years. The overall frequency of delirium was 48%. In the prevention group, 17% developed delirium during hospitalization. The risk factors for delirium in the multivariate analysis were male sex (Relative risk [RR] = 1.45), prior history of delirium (RR = 2.78), admission to the intensive care unit (RR = 5.58), and history of recent non-cardiac surgery (RR = 4.80).* **Conclusion:** *The identified risk factors could be used as inclusion criteria for preventive protocols.*

Keywords: *Delirium. Heart disease. Predisposing factors. Precipitating factors.*

Factores de riesgo asociados al desarrollo del delirium en el adulto mayor hospitalizado por cardiopatía

Resumen

Antecedentes: *El delirium es una complicación neuropsiquiátrica frecuente y grave en adultos mayores hospitalizados, asociada con peores desenlaces clínicos. Su incidencia varía ampliamente, pero se estima que afecta del 11% al 42% de los pacientes hospitalizados en el mundo. La identificación de los factores de riesgo en esta población es fundamental para optimizar las estrategias preventivas.* **Objetivo:** *Evaluar los factores de riesgo asociados al desarrollo de delirium en adultos mayores hospitalizados por patologías cardíacas.* **Material y métodos:** *Se realizó un estudio de cohorte retrospectivo que incluyó adultos mayores de 70 años o más hospitalizados por enfermedad cardíaca entre enero de 2022 y diciembre de 2023. Del total de pacientes incluidos en el estudio, se establecieron dos grupos: pacientes ingresados bajo un protocolo de prevención de delirium y pacientes con delirium presente desde el ingreso hospitalario, designados como el grupo del programa de seguimiento de delirium. Todos los pacientes incluidos contaban con una valoración geriátrica integral. Los factores de riesgo asociados se analizaron mediante regresión logística multivariada.* **Resultados:** *De los 847 pacientes; 52.5% fueron hombres, con una edad media de 78 ± 6.4 años. La frecuencia global de delirium fue del 48%. En el grupo de prevención, 17% lo desarrolló durante la hospitalización. Los factores de riesgo para delirium en el análisis multivariado fueron: sexo masculino (RR = 1.45), antecedente de delirium (RR = 2.78), admisión a la UCI (RR = 5.58) y antecedente de cirugía no cardíaca reciente (RR = 4.80).* **Conclusión:** *Los factores de riesgo identificados podrían emplearse como criterios de inclusión en protocolos preventivos.*

Palabras clave: *Delirium. Enfermedad cardíaca. Factores predisponentes. Factores precipitantes.*

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INTRODUCTION

Delirium, or an acute confusional state, is a neuropsychiatric syndrome characterized by disturbances in attention, consciousness, and cognition, with an acute onset and fluctuating course[1]. It is common in hospitalized older adults and is associated with serious consequences, such as functional decline, cognitive deterioration, and increased mortality[2,3].

Cardiac diseases represent a high-risk clinical scenario for delirium due to increased precipitating factors. Older adults with ischemic heart disease, arrhythmias, valvulopathies, or heart failure often experience hemodynamic instability, metabolic disturbances, hypoxia, and exposure to multiple medications, which favor its development[4,5].

The pathophysiological mechanisms include systemic inflammation, oxidative stress, neurotransmitter imbalance, and decreased cerebral perfusion[6,7]. Despite this, delirium remains underdiagnosed in cardiology wards, where it is often mistaken for cognitive impairment or depression. Considering that it is preventable in up to 40% of cases, identifying high-risk patients is a geriatric priority[8,9].

This study aimed to determine the independent risk factors associated with delirium, as well as its prevalence and clinical subtypes, in older adults hospitalized for heart disease in a tertiary-care Instituto Mexicano del Seguro Social (IMSS) unit.

MATERIAL AND METHODS

This retrospective cohort study was conducted at the UMAE Hospital de Cardiología No. 34 "Dr. Alfonso J. Treviño Treviño," IMSS, Monterrey, Mexico, between January 2022 and December 2023. The study was approved by the Local Ethics and Research Committee and classified as minimal risk according to the "Ley General de Salud."

Population and inclusion criteria

A total of 5,378 patients were evaluated, of whom 883 entered delirium prevention and follow-up programs; however, 36 did not meet the inclusion criteria. A total of 847 patients aged ≥ 70 years and hospitalized for cardiac pathology (chronic ischemic heart disease, valvular heart disease, bradyarrhythmia, or heart failure) were included. A comprehensive geriatric assessment was performed within 24 h of admission. Patients with a length of stay of < 48 h, incomplete clinical records, or prolonged prior transfer from the intensive care unit (ICU) were excluded.

Variables

Delirium diagnosis was assessed using the confusion assessment method (CAM)[5]. The predisposing factors included: age, sex, prior history of delirium, comorbidities, frailty, polypharmacy, and baseline cognitive and functional status.

The precipitating factors included: infection, hypoxia, hypoalbuminemia, pain, metabolic alterations, invasive devices, recent surgery, and ICU stay.

Statistical analysis

Continuous variables are expressed as mean ± standard deviation and categorical variables are expressed as frequencies and percentages. Chi-square and Student's t-tests were used. Relative risks (RRs) with 95% confidence intervals were calculated. Variables with $p < 0.05$ in the bivariate analysis were included in the multivariate logistic regression model. Statistical significance was set at $p < 0.05$. All analyses were performed using the Statistical Package for the Social Sciences v26.0.

RESULTS

General characteristics

A total of 847 patients were analyzed, with a mean age of 79.5 ± 6.6 years; 54% were male. The most frequent diagnoses were chronic ischemic heart disease (30.8%), bradyarrhythmia (29.6%), and heart failure (20.1%). A total of 526 patients were included in the delirium prevention program, and 321 patients were included in the follow-up delirium program. The overall incidence of delirium was 48% (n = 411). Among them, 38% presented with delirium upon admission, and 17% developed it during hospitalization. The characteristics are shown in Table 1.

Subtypes of delirium

The hyperactive subtype was the most frequent (49.5%), followed by the mixed (31.8%) and hypoactive (18.7 %) subtypes. The classification of delirium subtypes (hyperactive, hypoactive, and mixed) followed the standard clinical criteria (Table 2).

Table 1. General characteristics of patients enrolled in the prevention and follow-up programs

Variables	Characteristics	(n = 847), n (%)
Sex	Female	388 (46)
	Male	459 (54)
Age	Mean ± SD	79 ± 6.6
Diagnosis	Acute coronary syndrome	261 (30.8)
	Chronic coronary syndrome	52 (6.1)
	Bradyarrhythmias	251 (29.6)
	Tachyarrhythmias	23 (2.7)
	Valvulopathies	93 (11.0)
	Congestive heart failure	25 (3.0)
	Infections	30 (3.5)
	Arterial disease	64 (7.6)
	Post-intervention	47 (5.5)
	Pericardial effusion	1 (0.1)
Protocol entry	Prevention	526 (62.1)
	Delirium	321 (37.9)
Developed delirium	No	436 (51.5)
	Yes	411 (48.5)

SD: standard deviation.

Table 2. Characteristics of patients enrolled in 321 patients in the delirium follow-up program group

Variables	Characteristics	(n = 321), n (%)
Sex	Female	138 (43)
	Male	183 (57)
Age	Mean ± SD	79 ± 7
Diagnosis	Acute coronary syndrome	110 (34.3)
	Chronic coronary syndrome	16 (5.0)
	Bradyarrhythmias	103 (32.1)
	Tachyarrhythmias	7 (2.2)
	Valvulopathies	35 (10.9)
	Congestive heart failure	12 (3.7)
	Infections	7 (2.2)
	Arterial disease	16 (5.0)
	Post-intervention	15 (4.7)
	Pericardial effusion	0 (0.0)
Type of delirium	Hypoactive	60 (18.7)
	Mixed	102 (31.8)
	Hyperactive	159 (49.5)

SD: standard deviation.

Predisposing factors

The predisposing factors significantly associated with the outcomes are summarized in table 3. A prior history of delirium showed the strongest association (RR 2.78, p < 0.001). Associations were also observed with benzodiazepine use (RR 2.04, p = 0.009), psychotropic medication (RR 1.54, p = 0.014), and male sex (RR 1.46, p = 0.007).

Precipitating factors

The main precipitating factors are listed in Table 4. These included hypoxia (RR 2.22, p = 0.005), shock (RR 2.29, p = 0.007), hypoalbuminemia (RR 2.36, p = 0.004), use of invasive devices (RR 3.27, p < 0.001), acute pain (RR 2.36, p = 0.003), ICU admission (RR 5.58, p < 0.001), and recent non-cardiac surgery (RR 4.80, p = 0.01).

Multivariate model

After adjusting for confounding variables, the independent predictors of delirium were ICU admission (p < 0.001), recent non-cardiac surgery (p = 0.01), previous delirium (p < 0.001), and male sex (p = 0.004) (Tables 5 and 6).

Length of stay and outcomes

Patients with delirium had longer hospital stays and more complications than those without. Mortality was higher among patients with delirium, particularly those with the hypoactive subtype.

DISCUSSION

This study identified a high incidence of delirium (48%) among older adults hospitalized for heart disease, confirming its clinical relevance in cardiogeriatric units[10]. The high proportion of patients with delirium upon admission (38%) suggests that many patients already had baseline vulnerability before tertiary hospitalization, possibly due to frailty or chronic hypoperfusion.

The actual incidence of 17% among patients admitted without delirium highlights a favorable point for our geriatric service, which focuses on prevention. Considering that the prevalence reported in the literature ranges from 11% to 42%, this finding highlights the importance of strengthening the inclusion criteria for preventive programs.

Table 3. Predisposing factors for delirium development in 847 patients enrolled in the prevention and follow-up programs

Predisposing factor	Without delirium (n = 436), n (%)	With delirium (n = 411), n (%)	Relative risk 95% CI	p
Male sex	**225 (51.6)**	**250 (60.8)**	**1.456 (1.108-1.913)**	**0.007**
Institucionalizes	10 (2.3)	6 (1.5)	0.631 (0.227-1.752)	0.453
Poor family support network (Gijon)	89 (20.4)	91 (22.1)	1.109 (0.798-1.541)	0.557
Mild cognitive impairment	132 (30.3)	106 (25.8)	0.800 (0.592-1.081)	0.169
Major cognitive impairment	98 (22.5)	80 (19.5)	0.834 (0.598-1.162)	0.311
Severe or terminal disease	105 (24.1)	119 (29)	1.285 (0.946-1.745)	0.119
Stroke history	58 (13.3)	53 (12.9)	0.965 (0.647-1.439)	0.919
Neurologic disease	43 (10.9)	45 (10.9)	1.124 (0.723-1.748)	0.653
Metabolic disease	176 (40.4)	186 (45.3)	1.221 (0.930-1.604)	0.165
Fracture or trauma	48 (11)	30 (7.3)	0.636 (0.395-1-026)	0.074
HIV infection	0 (0)	2 (0,5)	2.066 (1.927-2.215)	0.235
Fall history	142 (32.6)	126 (30.7)	0.915 (0.685-1.223)	0.555
Chronic immobility	79 (18.1)	95 (23.1)	1.359 (0.972-1.898)	0.075
Visual or auditory sensory deprivation	371 (85.1)	349 (84.9)	0.986 (0.676-1.438)	1
Malnutrition	144 (33)	128 (31.1)	0.917 (0.687-1.224)	0.606
Polypharmacy	342 (78.4)	301 (73.2)	0.752 (0.548-1.031)	0.078
Antipsychotics	24 (5.5)	34 (8.3)	1.548 (0.901-2.659)	0.134
Other psychotropics	**86 (19.7)**	**112 (27.3)**	**1.524 (1.106-2.201)**	**0.012**
Anxiolytics	11 (2.5)	13 (3.2)	1.262 (0.559-2.850)	0.68
Benzodiazepines	**23 (5.3)**	**42 (10.2)**	**2.044 (1.206-3.463)**	**0.009**
Anticonvulsants	3 (0.7)	4 (1.0)	1.419 (0.316-6.377)	0.718
Anticholinergics	6 (1.4)	7 (1.7)	1.242 (0.414-3.726)	0.784
Opioids and derivatives	21 (4.8)	37 (6.6)	1.390 (0.773-2.499)	0.3
Active smoking	3 (0.7)	9 (2.2)	3.231 (0.869-12.020)	0.082
Active alcoholism	11 (2.5)	12 (2.9)	1.162 (0.507-2.663)	0.833
Drug abuse	0 (0)	2 (0.5)	2.066 (1.927-2.215)	0.235
Previous episode of delirium	**91 (20.9)**	**174 (42.3)**	**2.783 (2.056-3.767)**	**< 0.001**

Bold values indicate statistically significant associations.
CI: confidence interval.

The predominance of the hyperactive subtype reflects both the physiological response to cardiovascular stress and a diagnostic bias toward more evident clinical forms. A prior history of delirium confirmed its role as a predisposing factor, supporting the theory of cumulative neuroinflammatory vulnerability[7,11].

Benzodiazepine and psychotropic drug use increased the risk, consistent with evidence linking these drugs to cholinergic imbalance and delirium onset[10]. Male sex was independently associated with a greater cardiovascular burden and hormonal or pharmacological differences[8,12].

Among the precipitating factors, hypoxia and hypoalbuminemia emphasize the role of metabolic and cerebral perfusion mechanisms[5,13]. ICU admission showed the strongest association (RR 5.58), consistent with studies attributing this risk to environmental disorientation, sleep deprivation, immobility, and sedative use[11,12].

These results support the need to implement multifactorial prevention protocols, especially for patients with these risk factors. Early geriatric

Table 4. Precipitating factors associated with the development of delirium in 526 patients enrolled in delirium prevention program group

Precipitating factors	Without delirium (n = 436), n (%)	With delirium (n = 90), n (%)	Relative risk 95% CI	p
Polypharmacy	306 (70)	66 (74.2)	1.288 (0.733-2.060)	0.523
Alcohol or drug withdrawal	19 (4.3)	5 (5.6)	1.310 (0.476-3.605)	0.579
Non-dominant hemisphere stroke	**10 (2.3)**	**6 (6.7)**	**3.087 (1.092-8.725)**	**0.038**
Meningitis or encephalitis	**0 (0.0)**	**3 (3.4)**	**6.081 (5.013-7.7377)**	**0.005**
Infections	66 (15.1)	17 (19.1)	1.327 (0.736-2.394)	0.341
Iatrogenic complications	**14 (3.2)**	**11 (12.4)**	**4.261 (1.866-9.731)**	**0.001**
Hypoxia	**42 (9.6)**	**17 (19.1)**	**2.221 (1.198-4-115)**	**0.015**
Shock	**40 (9.2)**	**18 (20.2)**	**2.516 (1.366-4.635)**	**0.005**
Fever or hypothermia	21 (4.8)	9 (10.1)	2.229 (0.985-5.043)	0.074
Anemia	**190 (43.5)**	**52 (58.4)**	**1.827 (1.151-2.900)**	**0.01**
Dehydratrion	37 (8.5)	16 (18)	2.369 (1.253-4.482)	0.11
Malnutrition	57 (13)	15 (16.9)	1.351 (0.726-2.514)	0.397
Hypoalbuminemia	**59 (13.5)**	**24 (27)**	**2.366 (1.375-4.070)**	**0.004**
Metabolic alterations	141 (32.3)	32 (36)	1.179 (0.731-1.899)	0.536
Urea/creatinine elevation	115 (26.3)	27 (30.3)	1.219 (0.740-2.010)	0.434
Low cardiac output	183 (41.9)	36 (40.4)	0.943 (0.593-1.499)	0.815
Electrolyte imbalance	76 (17.4)	21 (23.6)	1.467 (0.848-2.538)	0.178
Admission to the intensive care unit	**58 (13.3)**	**41 (46.1)**	**5.582 (3.385-9.203)**	**< 0.001**
Physical restraints	66 (15.1)	18 (20.2)	1.425 (0.798-2.545)	0.266
Catheters	**84 (19.2)**	**39 (43.8)**	**3.278 (2.025-5.306)**	**< 0.001**
Multiple invasive procedures	222 (50.8)	52 (58.4)	1.361 (0.858-2.159)	0.202
Pain	**155 (35.5)**	**47 (52.8)**	**2.036 (1.285-3.225)**	**0.003**
Cardiac valve surgery	**31 (7.1)**	**13 (14.6)**	**2.240 (1.121-4.477)**	**0.033**
Revascularization surgery	**19 (4.3)**	**19 (21.3)**	**5.971 (3.012-11.839)**	**< 0.001**
Non-cardiac surgery	**10 (2.3)**	**9 (10.1)**	**4.804 (1.892-12.195)**	**0.002**
Prolonged sleep deprivation	46 (10.5)	12 (13.5)	1.325 (0.671-2.617)	0.457

Bold values indicate statistically significant associations.
CI: confidence interval.

Table 5. Logistic regression analysis

Factor	Beta	OR	95% CI	Significance
Admission to the intensive care unit	1.597	5.014	3.508-12.536	< 0.001
Non-cardiac surgery	1.477	4.167	1.490-12.712	0.013
Male sex	0.841	2.496	1.134-3.280	0.004
Previous episode of delirium	1.303	3.261	1.898-5.535	< 0.001
Constant	–61.753	-	-	0.999

CI: confidence interval; OR: odds ratio.

assessment, medication review, and non-pharmacological strategies are effective tools[14]. Programs, such as the Hospital Elder Life Program have demonstrated significant reductions in delirium incidence through simple measures, such as orientation, mobilization, and sleep optimization[15].

Table 6. Variables in the equation

Step 1[a]	B	Standard errors	Wald	Degrees of freedom	Significance	Exp (B)	95% CI for EXP (B)	
							Inferior	Superior
Shock clinical data (hypotension) compatible with shock or documented evidence of any type of shock in the medical notes	–0.358	0.415	0.746	1	0.388	0.699	0.310	1.575
Fracture or trauma patient with a history of unresolved bone fracture, bedridden due to it, or with a traumatic brain injury	–1.098	0.639	2.957	1	0.085	0.334	0.095	1.166
Other psychoactive drugs (anxiolytics, benzodiazepines, anticonvulsants, anticholinergics, and neuroleptics)	0.584	0.307	3.629	1	0.057	1.794	0.983	3.272
Active smoking patient with a history of active smoking	–18.822	22891.410	0.000	1	0.999	0.000	0.000	
Male	0.657	0.271	5.880	1	0.015	1.929	1.134	3.280
Hypoalbuminemia laboratory report showing albumin < 3.5 g/dL	0.776	0.323	5.779	1	0.016	2.173	1.154	4.090
Admission to Intensive Care Unit patient admitted to the intensive care unit during hospitalization	1.892	0.325	33.911	1	0.000	6.632	3.508	12.536
Non-cardiac surgery	1.471	0.547	7.235	1	0.007	4.353	1.490	12.712
Previous episode of delirium	1.176	0.273	18.536	1	0.000	3.241	1.898	5.535
Constant	–3.088	0.303	103.937	1	0.000	0.046		

[a]Variable (s) entered on step 1: shock clinical data (hypotension) compatible with shock or documented evidence of any type of shock in the medical notes. Fracture or trauma patient with a history of unresolved bone fracture, bedridden due to it, or with a traumatic brain injury. Other psychoactive drugs (anxiolytics, benzodiazepines, anticonvulsants, anticholinergics, and neuroleptics). Active smoking patient with a history of active smoking. Hypoalbuminemia laboratory report showing albumin < 3.5 g/dL. Admission to intensive care unit patient admitted to the intensive care unit during hospitalization. Non-cardiac surgery previous episode of delirium.
CI: confidence interval.

The main limitations of this study are its retrospective design and the potential underestimation of hypoactivity. Nevertheless, the large sample size and standardized application of CAM strengthen the validity of the findings. These results support the integration of delirium prevention as part of standard care in cardiac units[16-19].

CONCLUSION

Delirium is a frequent and preventable complication. The independent risk factors identified were ICU admission, recent non-cardiac surgery, prior delirium, and male sex. Early detection and prevention based on these factors may reduce morbidity, hospital stay, and mortality[20].

The systematic implementation of comprehensive geriatric assessments, daily delirium screenings, and interdisciplinary interventions are essential for improving clinical outcomes and optimizing hospital resources. These findings emphasize the need to develop and apply preventive strategies guided by the identified risk factors and use them as inclusion criteria for structured prevention protocols.

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CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

ETHICAL CONSIDERATIONS

Protection of human subjects and animals. The authors declare that no experiments on humans or animals were performed for this research.

Confidentiality, informed consent, and ethical approval. The authors have obtained approval from the Ethics Committee for the analysis of routinely collected and anonymized clinical data; therefore, individual informed consent was not required. Relevant ethical recommendations have been followed.

Declaration on the use of artificial intelligence. The authors declare that no generative artificial intelligence was used in the writing or creation of the content of this manuscript.

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ORIGINAL ARTICLE

Six-month functional outcomes in elderly patients with severe aortic stenosis: percutaneous versus surgical

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Abstract

Background: *Severe aortic stenosis (SAS) is a common valvular disease in older adults, with a prevalence of 9.8% in those aged 80-89 years. Surgical aortic valve replacement (SAVR) is the standard treatment, whereas transcatheter aortic valve implantation (TAVI) has emerged as a less invasive alternative. Functional assessment is crucial for this population.* **Objective:** *The objective of the study was to compare functional outcomes in elderly patients with symptomatic SAS undergoing TAVI versus SAVR after 6 months.* **Material and methods:** *A retrospective cohort study including patients aged ≥70 years with SAS treated with TAVI or SAVR between September 2023 and 2024. Functional status was assessed using the Barthel index (BI) at baseline and 6 months. Data were analyzed using descriptive and inferential statistics (Student's t-test) using the Statistical Package for Social the Sciences v25 and Excel.* **Results:** *A total of 155 patients were analyzed (TAVI, n = 47; SAVR, n = 108). The TAVI group was older (80 ± 6 vs. 76 ± 4 years, p < 0.05) and had more comorbidities (3 vs. 2) and geriatric syndromes (6 vs. 4) than the surgical group. The baseline BI was similar (89, p = 0.232). After 6 months, functionality remained stable (BI = 90, p = 0.525), with no significant difference in BI change (TAVI −0.53 vs. SAVR + 0.47).* **Conclusion:** *Functional status remained stable and comparable between TAVI and SAVR, suggesting similar effectiveness despite higher vulnerability in TAVI patients.*

Keywords: *Treatment outcomes. Transcatheter aortic valve replacement. Aortic valve stenosis. Observational study.*

Funcionalidad post-intervención a 6 meses en personas mayores con estenosis aórtica severa: comparando técnica percutánea vs quirúrgica

Resumen

Antecedentes: *La estenosis aórtica severa (EAS) es una valvulopatía frecuente en personas mayores, con prevalencia de hasta el 9.8% en aquellos de entre 80-89 años. El reemplazo valvular aórtico quirúrgico (SARV) es el tratamiento estándar, mientras que el implante valvular aórtico (TAVI) ha surgido como una alternativa eficaz y menos invasiva. En geriatría la funcionalidad entendida como la capacidad de realizar actividades básicas de la vida diaria, es un indicador de salud definido por la OMS, además de predictor de desenlaces.* **Objetivo:** *Analizar las diferencias de funcionalidad en pacientes mayores con EAS sometidos a TAVI frente a SARV en un periodo de 6 meses.* **Material y métodos:** *Estudio de cohorte retrospectivo que incluyó pacientes ≥ 70 años con EAS tratados con TAVI o SARV entre septiembre 2023 y 2024. Se evaluó la funcionalidad mediante el índice de Barthel (IB) al ingreso y a los seis meses. Se aplicó estadística descriptiva e inferencial (prueba t de Student) con SPSS v26 y Excel para el análisis de datos.* **Resultados:** *Se analizaron 155 pacientes (TAVI n = 47; SARV n = 108). El grupo TAVI presentó mayor edad (80 ± 6 vs. 76 ± 4 años, p < 0.05), mayor número de comorbilidades (3 vs. 2) y mayor presencia de síndromes geriátricos (6 vs. 4). La funcionalidad basal fue similar (IB = 89, p = 0.232). A los seis meses se mantuvo estable en ambos grupos (IB = 90, p = 0.525), sin diferencias significativas en el cambio funcional (TAVI −0.53 vs. SARV + 0.47).* **Conclusión:** *El estado funcional se mantuvo estable y fue comparable entre TAVI y SARV, lo que sugiere una efectividad funcional similar, a pesar de la mayor vulnerabilidad observada en los pacientes sometidos a TAVI.*

Palabras clave: *Resultados del tratamiento. Reemplazo de la válvula aórtica transcatéter. Estenosis de la válvula aórtica. Estudio observacional.*

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INTRODUCTION

Severe aortic stenosis (SAS) is the most prevalent degenerative valvular disease in the geriatric population, with an uncertain prognosis once symptoms appear if valve replacement is not performed[1]. The two main therapeutic options are surgical aortic valve replacement (SAVR), considered the traditional gold standard, and transcatheter aortic valve implantation (TAVI), a less invasive alternative that has gained relevance, particularly in patients with high surgical risk or frailty[2,3].

In the evaluation of outcomes in geriatrics, traditional measures such as mortality and morbidity are insufficient. Functional status, defined as the ability to perform activities of daily living (ADLs), is a highly relevant patient-centered outcome, as it is directly correlated with quality of life, independence, and healthcare resource utilization[4]. The Barthel index (BI) is a validated and widely used tool for assessing independence in ADLs in geriatric populations[5].

Although both TAVI and SAVR have demonstrated effectiveness in terms of hemodynamic performance and survival, there remains a need to better understand their differential impacts on mid-term functional trajectories in older adults.

The objective of this study was to analyze functional differences in older patients with SAS undergoing TAVI versus SAVR over a 6-month period at a tertiary care center of the *Instituto Mexicano del Seguro Social*.

At present, at the *Unidad Médica de Alta Especialidad* (UMAE) No. 34, more than 200 patients with symptomatic SAS are treated annually. The TAVI program has experienced exponential growth, increasing from five to approximately 50 procedures per year. The patient volume and increasing complexity of cases undergoing TAVI make it imperative to generate robust local evidence beyond acute outcomes. Decision-making by the multidisciplinary heart Team requires data on long-term functional prognosis to guide truly individualized treatment selection and plan adequate post-intervention follow-up.

However, only short-term follow-up studies have focused on complications and morbidity-mortality have been conducted, with no available data on functional outcomes after therapeutic intervention. This justifies the need to explore functional status as a clinically relevant outcome in this population group.

Based on the available evidence, the implicit hypothesis of this study suggests that TAVI may offer functional outcomes comparable to or superior to those of SAVR in older adults, especially considering that the percutaneous technique is less invasive in a population that is typically frailer and older.

Accordingly, this study was guided by the following research question: what is the difference in functional status at 6 months between older adults with symptomatic SAS undergoing TAVI and those undergoing SAVR?

MATERIAL AND METHODS

An observational, retrospective, and longitudinal cohort study was performed. The target population included patients aged ≥ 70 years with a diagnosis of symptomatic SAS. An initial sample of 169 patients was identified; the final sample that met the inclusion criteria consisted of 155 patients divided into two groups according to the intervention received: The TAVI group (n = 47) and the SAVR group (n = 108). The inclusion period will range from September 2023 to September 2024.

Patients of both sexes aged ≥ 70 years who underwent aortic valve replacement at UMAE No. 34 were included. Patients who underwent more than two concomitant procedures (e.g., percutaneous coronary intervention) were excluded, and those who died during the follow-up period or did not complete the 6-month follow-up were excluded from the final analysis. Baseline assessment was performed during hospitalization, and a 6-month evaluation was conducted in the outpatient clinic.

The choice of procedure (TAVI or SAVR) was determined by a multidisciplinary heart team based on each patient's clinical and anatomical characteristics.

The study was approved by the Local Research and Ethics Committee (registration number R-2023-1902-007). Demographic, clinical, and geriatric data were collected from the participants. The variables included type of procedure, age, sex, comorbidities, geriatric syndromes (frailty, sarcopenia, polypharmacy, and cognitive impairment), and nutritional status.

The primary outcome was a change in functional status, assessed using the BI at admission and 6 months post-procedure. The BI is a 10-item scale that measures independence in basic ADLs, with scores ranging from 0 to 100 (0 = total dependence; 100 = total independence).

Table 1. Sociodemographic characteristics of the study population

Variable	Total n (%)	TAVI n (%)	SARV n (%)	*p (95% CI)
Age (years) mean ± SD	77.16 ± 5.16	80.49 ± 6.3	75.7 ± 4.6	< 0.000 (2.9-6.5)
Sex				
Female	77 (49.7)	22 (46.8)	55 (50.9)	0.637
Male	78 (50.3)	25 (53.2)	53 (49.1)	-
Educational level				
None	14 (9.0)	3 (21.4)	11 (78.6)	0.903**
Primary	40 (25.8)	13 (32.5)	27 (67.5)	-
Incomplete primary	44 (28.3)	13 (29.5)	31 (70.5)	-
Secundary	14 (9.03)	3 (21.4)	11 (78.6)	-
High school	20 (12.9)	7 (35.0)	13 (65.0)	-
Bachelor's degree	22 (14.9)	8 (36.4)	14 (63.6)	-
Postgraduate degree	1 (0)	0 (0)	1 (100)	-
Marital status				
Marrried	86 (55.4)	21 (24.4)	65 (75.6)	0.074
Widowed	56 (36.1)	22 (39.3)	34 (60.7)	-
Single	7 (4.5)	4 (57.1)	3 (42.9)	-
Divorced	4 (2.5)	0 (0)	4 (100)	-
Cohabiting	2 (1.2)	0 (0)	2 (100)	-

*Chi-square test.
**Mann-Whitney u test.
TAVI: transcatheter aortic valve implantation; SAVR: surgical aortic valve replacement; CI: confidence interval; SD: standard deviation.

Statistical analysis

Statistical analyses were performed using the Statistical Package for the Social Sciences version 26. Continuous variables are expressed as mean ± standard deviation, and categorical variables are expressed as frequencies and percentages. Student's t-test for independent samples was used to compare the BI means between the TAVI and SAVR groups, with a 95% confidence interval, and the chi-square test was used for categorical variables. Statistical significance was set at $p < 0.05$.

RESULTS

A total of 155 patients were included in the study: 47 in the TAVI group (Group 1) and 108 in the SAVR group (Group 2). The TAVI group had a significantly higher mean age than the SAVR group (80 ± 6 vs. 76 ± 4 years, $p < 0.05$) (Table 1). Unlike the surgical group, TAVI patients presented a more complex clinical profile, as they were initially not candidates for surgery; therefore, the therapeutic decision was later established by consensus of the multidisciplinary team.

Baseline analysis revealed significant differences between the TAVI and SAVR groups, with a higher vulnerability profile among patients who underwent TAVI. Clinical risk was higher in the TAVI group, with a mean of three comorbidities compared to two in the SAVR group. The prevalence of atrial fibrillation (10.6% vs. 2.8%) and chronic heart failure (10.6% vs. 2.8%) was also higher in the TAVI group (Table 2).

Similarly, the burden of geriatric syndromes was greater in the TAVI group (mean of six syndromes) than in the SAVR group (mean of four). In particular, a higher prevalence of frailty (46.8% vs. 35.2%), suspected sarcopenia (57.4% vs. 40.7%), and mood disorders was observed in the TAVI group (Table 3).

At baseline, despite differences in risk profiles, functional status measured by the BI was similar between the groups, with an overall mean of 89 points and no statistically significant difference ($p = 0.232$). The TAVI group had a higher proportion of patients with mild dependence (63.8% vs. 51.9%), whereas the SAVR group had a higher proportion of fully independent patients (46.3% vs. 34%) than the other groups (Table 4).

At 6-month follow-up, the overall functional status remained stable, with a mean BI score of 90 points. No statistically significant differences were observed between the groups ($p = 0.525$). The TAVI

Table 2. Comorbidity burden by group

Comorbidities	Total (n = 155) n (%)	TAVI (n = 47) n (%)	SARV (n = 107) n (%)	p*
Smoking	95 (61.3)	25 (53.2)	70 (64.8)	0.21
Alcohol consumption	92 (59.4)	31 (66.0)	61 (56.5)	0.291
Type 2 diabetes mellitus	77 (49.7)	24 (51.1)	53 (49.1)	0.862
Arterial hypertension	117 (75.5)	35 (74.5)	82 (75.9)	0.842
Dyslipidemia	15 (9.7)	3 (6.4)	12 (11.1)	0.555
Atrial fibrillation	8 (5.2)	5 (10.6)	3 (2.8)	0.56
Chronic heart failure	20 (12.9)	9 (19.1)	11 (10.2)	0.19
Depression	16 (10.3)	7 (14.9)	9 (8.3)	0.254
Anxiety	14 (9.0)	6 (12.8)	8 (7.4)	0.361
Chronic coronary syndrome	5 (3.2)	2 (4.3)	3 (2.8)	0.639
Cerebrovascular event	6 (3.9)	2 (4.3)	4 (3.7)	1
Hypothyroidism	12 (7.7)	6 (12.8)	6 (5.6)	0.187
Osteoarthritis	18 (11.6)	6 (12.8)	12 (11.1)	0.788
Fractures	2 (1.3)	1 (2.1)	1 (0.9)	0.516
Benign prostatic hyperplasia	19 (12.3)	6 (12.8)	13 (12.0)	1

*Chi-square test.
TAVI: transcatheter aortic valve implantation; SAVR: surgical aortic valve replacement; SD: standard deviation.

group showed a non-significant mean decrease in BI score (−0.53 points), whereas the SAVR group exhibited a non-significant mean improvement (+0.47 points). The proportion of fully independent patients increased in both groups, reaching 53.2% in the TAVI group and 55.5% in the SAVR group (Table 5).

DISCUSSION

This study aimed to compare the evolution of functional status in patients with SAS undergoing TAVI versus SAVR, incorporating relevant clinical and geriatric variables. A total of 155 patients were included, with a mean age of 76 ± 4 years. The TAVI group was significantly older and presented a higher burden of comorbidities and geriatric syndromes compared with the SAVR group, which is consistent with trends reported in the literature, where TAVI is preferentially reserved for older patients or those with higher surgical risk[6,7].

The older age of the TAVI group was associated with a higher prevalence of atrial fibrillation and chronic heart failure, reflecting greater baseline cardiovascular disease complexity. In addition, this group exhibited a higher burden of frailty, suspected sarcopenia, mood disorders, and risk of malnutrition, configuring a profile of greater clinical and geriatric vulnerability, which has previously been linked to poorer functional outcomes and increased mortality[8,9].

From a sociodemographic perspective, the TAVI group showed a lower educational level and a lower proportion of married patients, factors that may negatively influence disease understanding, therapeutic adherence, and social support, aspects previously associated with worse health outcomes[10,11].

Despite these baseline differences, functional status at admission, assessed using the BI, was high and comparable between the groups, suggesting an adequate level of independence before the intervention. At 6 months, the overall functional status remained stable in both groups, with no statistically significant differences, a clinically relevant finding considering the greater vulnerability of the TAVI group.

These results are consistent with previous studies reporting functional stability after TAVI in high-risk populations when the baseline functional status is preserved[12,13]. However, other studies have demonstrated more significant improvements when using broader instruments to assess functionality and

Table 3. Geriatric syndromes by group

Geriatrics syndromes	Total (n = 155) n (%)	TAVI (n = 47) n (%)	SARV (n = 107) n (%)	p*
Polypharmacy	58 (37.4)	14 (29.8)	44 (47)	0.212
Pluripathology	91 (58.7)	26 (55.3)	65 (60.2)	0.598
Frailty	60 (38.7)	22 (46.8)	38 (35.2)	0.21
Suspected sarcopenia	71 (45.8)	27 (57.4)	44 (40.7)	0.079
Neurocognitive disorder	18 (11.6)	6 (12.8)	12 (11.1)	0.788
In-hospital delirium	11 (7.1)	2 (4.3)	9 (8.3)	0.506
Depression	30 (19.4)	11 (23.4)	19 (17.6)	0.507
Anxyety	24 (15.5)	11 (23.4)	13 (12.0)	0.091
Falls syndrome	23 (14.8)	9 (19.1)	14 (13.0)	0.333
Acute functional decline	46 (29.7)	13 (27.7)	33 (30.6)	0.849
Chronic functional delineation	28 (18.1)	6 (12.8)	22 (20.4)	0.364
Immobility	10 (6.5)	3 (6.4)	7 (6.5)	1
Pressure injuries (pressure ulcers)	5 (3.2)	1 (2.1)	4 (3.7)	1
Urinary incontinence	33 (21.3)	15 (31.9)	18 (16.7)	0.053
Abuse or mistreatment	2 (1.3)	1 (2.1)	1 (0.9)	0.516
Caregiver burben	3 (1.9)	2 (4.3)	1 (0.9)	0.218
Risk of malnutrition	42 (27.1)	17 (36.2)	25 (23.1)	0.116
Constipation	30 (19.4)	12 (25.5)	18 (16.7)	0.268
Visual sensory deprivation	130 (83.9)	40 (85.1)	90 (83.3)	1
Benzodiazepine use	25 (16.1)	7 (14.9)	18 (16.7)	1
Gait disorder	36 (23.2)	14 (29.8)	22 (20.4)	0.219
Institutionalization	2 (1.3)	0 (0)	2 (1.9)	1
Pain	47 (30.3)	15 (31.9)	32 (29.6)	0.85
Sleep disorder	53 (34.2)	15 (31.9)	38 (35.2)	0.717
Dysphagia	5 (3.2)	0 (0)	5 (4.6)	0.323

*Chi square test.
TAVI: transcatheter aortic valve implantation; SAVR: surgical aortic valve replacement.

quality of life[14]. The absence of significant functional improvement in this study may be attributed to the ceiling effect of the BI, as well as to the high burden of comorbidities and geriatric syndromes.

The functional stability observed in the TAVI group, despite greater frailty, may be explained by the less invasive nature of the procedure, which allows the preservation of independence in patients at high surgical risk. However, the exclusive use of the BI may underestimate changes in more complex functional domains.

Finally, this study highlights the importance of comprehensive geriatric assessment and the implementation of multimodal intervention strategies (rehabilitation, nutritional support, psychosocial care), which have been shown to improve functional outcomes in similar populations[15,16].

Limitations

The main limitations of this study include its observational design, 6-month follow-up, reduced sample size in the TAVI group, functional assessment restricted to basic ADL, and the single-center nature of the study. Future prospective studies with longer follow-up and broader functional measures will allow for a more precise characterization of the functional impact of both interventions in the geriatric population.

Table 4. Functional classification according to the BI

Functional classification according to the BI	Total (n = 155) n (%)	TARV (n = 47) n (%)	SARV (n = 108) n (%)	*p
Independent 100	66 (42.6)	16 (34.0)	50 (46.3)	0.423
Mild dependence 95-60	86 (55.48)	30 (63.8)	56 (51.9)	-
Moderate dependence 40-55	2 (0.0)	1 (0.9)	1 (0.6)	-
Severe dependence 20-35	2 (1.3)	1 (0.9)	1 (2.1)	-
Total dependence < 20	0 (0)	0 (0)	0 (0)	-
Functional status at 6 months				
Independent 100	85 (54.83)	25 (53.19)	60 (55.5)	0.584
Mild dependence 95-60	64 (41.29)	20 (42.5))	44 (40.7)	-
Moderate dependence 40-55	4 (2.5)	1 (2.12)	3 (2.8)	-
Severe dependence 20-35	1 (0.6)	0 (0)	1 (0.9)	-
Total dependence < 20	1 (0.6)	1 (2.12)	0 (0)	-

*Mann-Whitney u test.
TAVI: transcatheter aortic valve implantation; SAVR: surgical aortic valve replacement; BI: Barthel index.

Table 5. Difference in functionality at 6 months

BI	Mean TARV ± DE	Mean SARV ± DE	*p (95% CI)
BI at admission (mean ± SD)	89.47 ± 14.00	92.04 ± 11.42	0.232 (–6.7-1.6)
BI at 6 months (mean ± SD)	88.94 ± 16.15	90.51 ± 13.18	0.525 (–6.4-3.3)

*Independent samples t-test.
BI: Barthel index; TAVI: transcatheter aortic valve implantation; SAVR: surgical aortic valve replacement; SD: standard deviation; CI: confidence interval.

CONCLUSION

In older adults with SAS, both TAVI and SAVR are effective in maintaining functional independence at 6-month follow-up. Despite a significantly higher baseline risk profile, patients undergoing TAVI achieved a functional status comparable to that of those treated with SAVR. These findings reinforce the need for individualized and multidisciplinary therapeutic decision-making, considering functional status as a key, patient-centered outcome.

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CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

ETHICAL CONSIDERATIONS

Protection of human subjects and animals. The authors declare that no experiments involving humans or animals were conducted for this research.

Confidentiality, informed consent, and ethical approval. The authors have obtained approval from the Ethics Committee for the analysis of routinely collected and anonymized clinical data; therefore, individual informed consent was not required. Relevant ethical recommendations have been followed.

Declaration on the use of artificial intelligence. The authors declare that no generative artificial intelligence was used in the writing or creation of the content of this manuscript.

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ORIGINAL ARTICLE

Family functionality and risk of malnutrition in adults aged 60 years and older

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Abstract

Background: *Malnutrition among older adults represents a frequent and multifactorial condition with significant repercussions on overall health and quality of life. Within this context, the family assumes a pivotal role by influencing dietary habits, caregiving practices, and access to healthcare services. Assessing family functionality provides a comprehensive understanding of its potential relationship with nutritional risk in this population.* **Objective:** *To determine the association between family functionality and the risk of malnutrition among adults aged 60 years and older.* **Material and methods:** *An analytical cross-sectional study was conducted in older adults aged 60 years and above. Participants were classified into two groups: those with adequate nutritional status (n = 97) and those at risk of malnutrition (n = 87). Nutritional status was assessed using the Mini Nutritional Assessment (MNA®), whereas family functionality was evaluated with the family adaptability, partnership, growth, affection, and resolve instrument. Statistical analysis included independent t-tests, Chi-square tests, odds ratios (ORs), and 95% confidence intervals (CIs) for the ORs.* **Results:** *Family functionality was identified in 85.5% of the well-nourished group and in 12.9% of the group at risk of malnutrition (p < 0.001). The OR was 31.65 (95% CI: 13.92-71.99), indicating a strong association between family functionality and nutritional status.* **Conclusion:** *The findings provide evidence that family functionality is closely associated with the risk of malnutrition in older adults, underscoring the importance of considering family dynamics in geriatric nutritional assessment and intervention.*

Keywords: *Elderly nutrition. Malnutrition. Aged. Family relations.*

Funcionalidad familiar y riesgo de malnutrición en adultos mayores de 60 años y más

Resumen

Antecedentes: *La malnutrición en adultos mayores representa un problema frecuente y multifactorial con impacto en la calidad de vida. La familia cumple un papel central al influir en la alimentación, el cuidado y el acceso a la salud. Evaluar la funcionalidad familiar permite comprender mejor su relación con el riesgo de nutricional en este grupo.* **Objetivo:** *Determinar la asociación entre funcionalidad familiar y riesgo de malnutrición en adultos mayores de 60 años y más.* **Material y métodos:** *Diseño trasversal analítico en adultos mayores de 60 años y más, los grupos de comparación fueron adultos mayores de 60 años y más, el primer grupo con buen estado nutricional (n = 97) y segundo grupo con riesgo de malnutrición (n = 87). La condición nutricional se evaluó con el cuestionario Mini Nutritional Assessment (MNA®). La funcionalidad familiar fue determinada con el Apgar familiar. El análisis estadístico incluyó prueba de t para grupos independientes, ch2, razón de momios e intervalo de confianza para razón de momios.* **Resultados:** *La funcionalidad familiar en el grupo con buen estado nutricional fue 85.5% y en el grupo con riesgo de malnutrición fue 12.9 % (p < 0.001). Razón de momios 31.65 (IC 95 %: 13.92-71.99).* **Conclusión:** *Se encuentra evidencia de que la funcionalidad familiar se asocia estrechamente con el riesgo de malnutrición en adultos mayores.*

Palabras clave: *Nutrición del adulto mayor. Malnutrición. Adulto mayor. Dinámica familiar.*

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INTRODUCTION

Population aging represents one of the greatest challenges faced by health systems worldwide. By the year 2025, it is estimated that approximately 14% of the population will be 60 years of age or older[1], whereas in 2016, this proportion was 11.3%[2]. By 2050, projections indicate that 22% of the global population will be 60 years or older; in Mexico, the population aged 65 and over is expected to reach 20% by that same year[1].

In developing countries, older adults are defined as individuals aged 60 years or older, whereas in developed nations the threshold is typically set at 65 years[3]. This population group faces a high degree of vulnerability: around 60% of older adults have incomes below the poverty line, and 85% lack access to a retirement pension[4].

Malnutrition among older adults is highly prevalent. Studies report rates of 41.9% among hospitalized individuals, 32.1% among institutionalized adults, and an overall prevalence of 16.1% in community-dwelling populations[4,5]. Nutritional risk is defined as the probability of developing an inadequate nutritional status as a result of the interaction among biological, psychological, social, and economic factors. Instruments such as the Mini Nutritional Assessment (MNA®) enable the early detection of this risk[2].

Social determinants strongly influence older adults' access to adequate nutrition and timely health care. Among these determinants, family functioning, patterns of support, caregiving, and communication within the family structure play a central role[6]. To assess family functionality, the family adaptability, partnership, growth, affection, and resolve (APGAR) instrument is used; it consists of five Likert-type questions and classifies families as functional, moderately dysfunctional, or severely dysfunctional. Its application in older adults is particularly relevant, as it facilitates the identification of family relationships that may influence nutritional vulnerability[7].

In this regard, identifying the relationship between family functionality and the risk of malnutrition acquires particular significance. The literature highlights that weakened family environments, migration, and social abandonment increase the vulnerability of older adults' nutritional status[1]. Therefore, the objective of this study was to determine the association between family functionality and the risk of malnutrition among adults aged 60 years and older.

MATERIAL AND METHODS

An analytical cross-sectional design was conducted among adults aged 60 years and older who received medical care at a social security institution in Oaxaca de Juárez, Oaxaca, Mexico, between January and December 2024. The study population was divided into two comparison groups: the first consisting of older adults with adequate nutritional status, and the second comprising those at risk of malnutrition. Nutritional status was assessed using the MNA® questionnaire[8]. Questionnaire, a widely validated and internationally accepted tool for older adults, is commonly used in Mexico due to its proven diagnostic performance and the limited availability of locally validated instruments for this population.

Participants who agreed to take part in the study were included, whereas those diagnosed with psychiatric disorders or medical conditions known to cause nutritional alterations, as well as individuals following a special diet prescribed by a physician, were excluded.

The sample size was calculated using the formula for comparing two proportions, with a 95% confidence level for a null hypothesis rejection region ($Z^{\alpha} = 1.64$) and a test power of 80% ($Z^{\beta} = 0.84$). It was assumed that the prevalence of family functionality would be 50% ($p_0 = 0.50$) in the well-nourished group and 20% ($p_1 = 0.20$) in the group at risk of malnutrition. The calculated sample size was 28 participants per group; however, the final sample included 97 individuals with adequate nutritional status and 85 individuals at risk of malnutrition.

A simple random sampling technique was employed, with cases identified through a computerized program, using as a sampling frame the institutional database of adults aged 60 years and older attending the social security unit.

Sociodemographic variables included age, sex, educational level, and cohabitation status. Anthropometric characteristics such as weight, height, and body mass index (BMI) were recorded, along with comorbidities and edentulism. Family type and family life cycle were determined according to the classification established by the World Health Organization, while independence in basic activities of daily living was evaluated using the Katz Index.

Family functionality was assessed using the original (primary) five-item version of the Family APGAR instrument, as proposed by Smilkstein[9]. This brief instrument assesses the older adult's perception of

family functioning across key dimensions and allows for a rapid, standardized evaluation in the older adult population.

Statistical analysis included descriptive measures (percentages, means, and standard deviations), t-tests for independent samples, Chi-square (χ^2) tests, odds ratios (ORs), and 95% confidence intervals for the ORs.

RESULTS

In the group with adequate nutritional status, the mean age was 78.08 years, while in the group at nutritional risk, it was 78.16 years ($p = 0.450$). In the former group, females predominated (60.8%), whereas in the latter, the prevalence of females was 56.5% ($p = 0.552$). The remaining sociodemographic characteristics are presented in table 1.

The mean BMI in the well-nourished group was 27.48 kg/m^2, compared with 24.48 kg/m^2 in the group at nutritional risk ($p < 0.001$). Body weight and height by group are detailed in table 2.

Independence in basic activities of daily living was observed in 49.5% of participants in the well-nourished group and in 54.1% of those at risk of malnutrition ($p = 0.533$). Table 3 shows the distribution of family type and family life-cycle stage.

The prevalence of comorbidities was statistically similar between the well-nourished group and the group at risk of malnutrition. The distribution of comorbid conditions by group is presented in table 4.

Family functionality was identified in 82.5% of participants with adequate nutritional status and in 12.9% of those at risk of malnutrition ($p < 0.001$). The OR was 31.65, indicating a strong association between family functionality and nutritional status. Table 5 summarizes the association between family functionality and nutritional condition.

DISCUSSION

The findings of the present study demonstrate that family functionality is associated with the risk of malnutrition among older adults, reaffirming the importance of the family environment as a social determinant of health[8]. Older adults with adequate nutritional status predominantly belonged to functional families, whereas those at risk of malnutrition were more frequently found within dysfunctional family environments[6]. This suggests that the presence of emotional support, effective communication, and family cohesion may act as protective factors against nutritional decline. Previous research has shown that the fragility of the family environment increases the vulnerability of older adults to malnutrition, even when economic conditions are relatively stable[9-11].

BMI reflected clear differences between groups, indicating that although this measure does not capture all aspects of nutritional quality, it does reflect weight-related alterations associated with nutritional deficit risk. Notably, in this study, a lower BMI was observed among older adults from dysfunctional families, even among those who remained functionally independent. This finding suggests that physical autonomy alone does not necessarily protect against malnutrition when family bonds are weak. Similar findings have been reported in international studies, where nutritional risk in older adults is more frequent among individuals with limited family support, regardless of their ability to perform basic activities of daily living[11].

Age, sex, independence in basic activities of daily living, and comorbidity prevalence were similar between groups. This pattern suggests that the risk of malnutrition cannot be explained solely by traditional factors such as these; rather, it emerges as a multifactorial phenomenon in which family functionality constitutes an independent determinant. Studies conducted in older adult populations have shown comparable trends: family support acts as a modulator of nutritional status, while demographic or socioeconomic variables demonstrate a lower predictive capacity when considered in isolation[12,13].

The lack of association between physical autonomy and nutritional status may indicate that, even when older adults retain the capacity to perform basic activities, the absence of family support can increase nutritional vulnerability, thereby affecting overall health, quality of life, and the ability to prevent age-related diseases. This observation aligns with international evidence showing that older adults living alone or within dysfunctional families exhibit higher risks of malnutrition, weight loss, and related complications, even in contexts where healthcare services are accessible[14,15].

The results underscore the importance of integrating the assessment of family functionality into the medical care of older adults. Instruments such as the Family APGAR facilitate the identification of risk situations that may go unnoticed during conventional clinical evaluation, allowing for timely interventions such as nutritional education and

Table 1. Sociodemographic characteristics by nutritional status in adults aged 60 years and older

Characteristics	Nutritional status		Chi-square	p
	Adequate nutritional status (n = 97)	Risk of malnutrition (n = 85)		
	Percentages			
Sex				
Female	60.8	56.5	0.35	0.552
Male	39.2	43.5		
Living with a partner				
Yes	77.3	82.1	0.64	0.422
No	22.7	17.9		
Educational level				
None	19.6	16.5	2.44	0.485
Literate (reads/writes)	40.2	34.1		
Primary or secondary	28.9	30.6		
High school or higher	11.3	18.8		

Table 2. Anthropometric characteristics by nutritional status in adults aged 60 years and older

Characteristics	Nutritional status		t	p
	Adequate nutritional status (n = 97)	Risk of malnutrition (n = 85)		
Height (meters)				
Mean	1.62	1.65	0.52	0.604
Standard deviation	0.41	0.37		
Weight (kilograms)				
Mean	63.45	57.09	3.57	< 0.001
Standard deviation	12.33	11.55		
BMI	27.48	24.48	3.93	< 0.001
Mean	4.94	5.33		
Standard deviation				

BMI: body mass index.

individualized follow-up[16]. Furthermore, the literature highlights that psychosocial factors - including emotional support and family communication - are closely related to both nutritional status and functional capacity in older adults. Considering these factors not only enriches clinical evaluation but also enables a more comprehensive approach to preventing malnutrition and its consequences for health[6].

Moreover, the association between family functionality and nutritional status appears to be independent of socioeconomic status. Evidence suggests that the presence of family support networks does not always correlate with greater economic resources, and that older adults from middle- or low-income groups may maintain adequate nutrition if they belong to functional families[14,17,18].

However, future studies could explore populations without institutional coverage, as well as social and economic variables related to family dynamics, to further enhance the understanding of these findings.

Table 3. Family characteristics and functional independence by nutritional status in adults aged 60 years and older

Characteristics	Nutritional status		Chi-square	p
	Adequate nutritional status (n = 97)	Risk of malnutrition (n = 85)		
	Percentages			
Family type				
Nuclear	45.4	9.4	91.04	< 0.001
Extended	26.8	16.4		
Single-parent	2.0	67.1		
Composite	25.8	7.1		
Family life cycle				
Constitutive	0.0	2.3	4.18	0.12
Dispersal	2.1	5.9		
Final	97.9	91.8		
Independence in basic activities of daily living				
Dependent	50.5	45.9	0.38	0.533
Independent	49.5	54.1		

Table 4. Comorbidities and edentulism by nutritional status in adults aged 60 years and older

Condition	Nutritional status		Chi-square	p
	Adequate nutritional status (n = 97)	Risk of malnutrition (n = 85)		
	Percentages			
Edentulism Yes	20.6	29.4	0.389	0.170
Type 2 diabetes mellitus Yes	17.4	14.8	0.307	0.580
Hypertension Yes	18.3	17.1	0.65	0.799
Cardiac disease Yes	8.3	9.8	0.158	0.691
Rheumatoid arthritis Yes	5.5	8.9	1.006	0.316

Table 5. Association between family functionality and nutritional status in adults aged 60 years and older

Family functionality	Nutritional status		Chi-square	p	RM	95% CI	
	Adequate nutritional status (n = 97)	Risk of malnutrition (n = 85)				Lower	Upper
	Percentages						
Functional	82.5	12.9	87.61	< 0.001	31.65	13.92	71.99
Dysfunctional	17.5	87.1					

CONCLUSION

The present findings provide evidence that family functionality is closely associated with the nutritional status of older adults.

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CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

ETHICAL CONSIDERATIONS

Protection of human subjects and animals. The authors declare that no experiments on humans or animals were performed for this research.

Confidentiality, informed consent, and ethical approval. The authors have followed their institution's confidentiality protocols, obtained informed consent from all patients, and secured approval from the Ethics Committee. SAGER guidelines have been followed as applicable to the nature of the study.

Declaration on the use of artificial intelligence. The authors declare that no generative artificial intelligence was used in the writing or creation of the content of this manuscript.

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THE JOURNAL OF LATIN AMERICAN GERIATRIC MEDICINE REVIEW ARTICLE

Chronicles of geriatric nephrology: historical evolution and contemporary advances

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Abstract

Background: *The aging global population underscores the need for specialized nephrology care in older persons (OP). Rising life expectancy and comorbidities increase renal disease prevalence, demanding tailored strategies to address these needs.* **Objective:** *To present a historical narrative of geriatric nephrology, emphasizing major advancements from the 1980s to the present, particularly within the framework of the World Health Organization's Decade of Healthy Aging and the regional context of Mexico and Latin America.* **Material and methods:** *A scoping review was conducted following the Preferred Reporting Items for Systematic Reviews and meta-analyses-ScR guidelines. Articles were retrieved from PubMed, Google Scholar, and Scopus using terms related to geriatric nephrology and renal aging. Studies were selected based on clinical, educational, or policy relevance, with attention to Mexico and Latin America.* **Results:** *Geriatric nephrology has evolved significantly over four decades, shifting toward a more nuanced, patient-centered approach. Key milestones include the integration of geriatric principles, the use of comprehensive geriatric assessment, and multidisciplinary care models. Regional efforts in Mexico and Latin America reflect substantial progress despite systemic barriers and align with the broader goals of the Decade of Healthy Aging.* **Conclusion:** *Continued research and cooperation are essential to improve outcomes and quality of life for OP with kidney disease.*

Keywords: *Geriatric nephrology. Renal diseases. Aging population. Mexico. Latin America. Decade of healthy aging.*

Crónicas de la nefrología geriátrica: evolución histórica y avances contemporáneos

Resumen

Antecedentes: *El envejecimiento poblacional a nivel global subraya la necesidad de atención nefrológica especializada en personas mayores (PM). El aumento en la esperanza de vida y las comorbilidades ha incrementado la prevalencia de enfermedades renales, lo que exige estrategias personalizadas para atender estas necesidades.* **Objetivo:** *Presentar una narrativa histórica de la nefrología geriátrica, destacando los principales avances desde la década de 1980 hasta la actualidad, particularmente en el marco de la Década del Envejecimiento Saludable de la OMS y el contexto regional de México y América Latina.* **Material y métodos:** *Se realizó una revisión exploratoria conforme a las directrices PRISMA-ScR. Se consultaron PubMed, Google Scholar y Scopus utilizando términos relacionados con nefrología geriátrica y envejecimiento renal. Los estudios se seleccionaron por su relevancia clínica, educativa o en políticas públicas, con énfasis en México y América Latina.* **Resultados:** *La nefrología geriátrica ha evolucionado significativamente en las últimas cuatro décadas, adoptando un enfoque más matizado y centrado en la persona. Entre los hitos clave destacan la integración de principios geriátricos, el uso de la valoración geriátrica integral y los modelos de atención multidisciplinarios. Los esfuerzos regionales en México y América Latina muestran avances notables pese a*

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las barreras sistémicas, y se alinean con los objetivos de la Década del Envejecimiento Saludable. **Conclusión:** *La investigación continua y la cooperación son esenciales para mejorar los resultados y la calidad de vida de las PM con enfermedad renal.*

Palabras clave: *Nefrología geriátrica. Enfermedades renales. Población envejecida. México. América Latina. Década del envejecimiento saludable.*

INTRODUCTION

The global shift toward an aging population has intensified the demand for specialized nephrological care for older persons (OP). With rising life expectancy, the prevalence and complexity of chronic kidney disease (CKD) in this group have grown significantly. Geriatric nephrology formally emerged in the 1980s and has since evolved into a dynamic, interdisciplinary field addressing the intersection of renal aging, multimorbidity, and person-centered care.

The World Health Organization's 2020 launch of the "Decade of Healthy Aging" reframed aging as a global health priority and emphasized the need for tailored approaches in subspecialties such as nephrology[1].

Latin America – particularly Mexico – exemplifies this demographic transition. The population aged 60+ doubled from 6.1% in 1990-12% in 2020, and is projected to reach nearly 25% by 2050[2]. Yet Mexico reports the world's highest rate of end-stage kidney disease (ESKD) (646 per million), with a nephrology workforce far below international benchmarks (9.3 vs. 20 pmp)[3,4].

This article offers a historical and regional narrative of geriatric nephrology from the 1980s to the present, highlighting evolving care models, the integration of geriatric principles, and innovations shaped by Latin American contexts within the framework of healthy aging.

MATERIAL AND METHODS

This scoping review was conducted and reported following the preferred reporting items for systematic reviews and meta-analyses (PRISMA)-ScR statement[2]. Eligibility criteria were defined a priori. Studies were included if they addressed renal aging, CKD in older adults, frailty, dialysis or transplantation in late life, geriatric assessment in nephrology, or ethical and clinical decision-making in OP. Eligible sources included original research, reviews, clinical guidelines, consensus statements, historical analyses, and relevant grey literature. Publications from 1976 to July 2024 in English, Spanish, French, or Italian were considered (Table 1).

Searches were conducted in PubMed/MEDLINE, Scopus, Web of Science, and Google Scholar using predefined keyword combinations and controlled vocabulary terms (e.g., "geriatric nephrology," "aging kidney," "CKD in older adults," "frailty," "dialysis in late life"). The search was completed in two rounds (March 15 and July 2, 2024). For Google Scholar, only the first 300 ranked results were screened, consistent with accepted scoping review methodology. All records were imported into Rayyan® for automated deduplication and blinded screening.

Two independent reviewers screened titles, abstracts, and full texts, resolving disagreements by consensus or third-reviewer adjudication. Data extraction used a structured template capturing study design, thematic focus, temporal context, and relevance to the evolution of geriatric nephrology. Due to heterogeneity across study types and timelines, findings were synthesized narratively and organized chronologically and thematically. A PRISMA-ScR flow diagram summarizing the selection process is provided (Table 2).

FOUNDATIONS AND ETHICAL TURNING POINTS: GERIATRIC NEPHROLOGY IN THE 1980S AND 1990S

The roots of geriatric nephrology are anchored in decades of clinical exclusion and ethical reckoning. During the 1960s and 1970s, dialysis programs commonly excluded OP, prioritizing younger individuals based on social value judgments. A notorious example was the Seattle "God Committee," which publicly rejected candidates over the age of 45 years[5]. Although the expansion of dialysis access in subsequent years helped mitigate overt age discrimination, restrictive policies persisted in some low-resource settings well into the 1980s[6].

The formalization of geriatric nephrology began in earnest during the 1980s, marked by key milestones such as the 1985 international meeting in Toronto and the 1987 publication of the first dedicated textbook[7]. Growing awareness of the distinct needs of OP with CKD catalyzed the development of a more structured approach to aging and renal care.

Table 1. Eligibility criteria

Criterion	Inclusion	Exclusion
Population	Adults ≥ 60 years OR documents explicitly addressing aging, renal senescence, or geriatrics	Pediatric or general adult nephrology with no aging focus
Publication type	Original studies, reviews, consensus statements, guidelines, historical records, educational frameworks, position papers, and grey literature relevant to the field	Editorials without scientific basis, non-medical news content, duplicated conference abstracts
Timeframe	1976-2024	None
Language	English, Spanish, French, Italian	Other languages
Setting	Global, with intentional inclusion of Latin American sources	Non-health related domains

OR: odds ratio.

Table 2. Study selection flow

PRISMA phase	Description
Identification	Records identified: 1,243 ⇒ After duplicates removed: 1,011
Screening	Records screened: 1,011 ⇒ Records excluded: 912
Eligibility	Full-text articles assessed: 99 ⇒ Excluded with reasons: 50
Included	Studies included in final synthesis: 49

PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

Scientific research on renal aging gained notable traction during the 1970s, focusing on structural changes in the glomeruli and renal tubules[8,9]. By the 1990s, academic discourse evolved to center on the ethical and clinical nuances of care in OP, including the growing emphasis on individualized treatment planning[10]. Groundbreaking discussions on dialysis withdrawal, quality of life, and patient autonomy further shaped the philosophical and clinical ethos of the discipline[11-13].

Calls for geriatric integration within nephrology began to resonate globally. Despite these intellectual and ethical advances, institutional development faced setbacks. A geriatric nephrology society, founded in 1985, was short-lived due to waning interest. Meanwhile, advances in dialysis technology during the 1990s expanded access, though inequities in implementation persisted. Ethical concerns increasingly revolved around fair allocation of resources, informed consent, and the potential overuse of intensive treatments in frail populations.

Clinically, the prevailing model of standardized dialysis protocols for all age groups came under scrutiny. Professionals and ethicists began advocating for treatment pathways that considered not only renal function, but also the functional status, comorbidities, and life context of OP. This period laid the groundwork for person-centered renal care that would become more widely embraced in the decades that followed.

CONSOLIDATION AND EMERGING CHALLENGES: GERIATRIC NEPHROLOGY IN THE 2000S

The 2000s marked the formal consolidation of geriatric nephrology as a recognized area of clinical expertise. Academic literature began explicitly addressing the need to incorporate geriatric principles into kidney care, particularly in response to the rising burden of ESKD among OP[14]. This shift emphasized early referral, individualized treatment planning, and specialized training in aging physiology and multimorbidity[15,16]. Key research efforts during this decade contributed to the conceptual distinction between normal renal aging and pathological CKD, cautioning against misclassification that could lead to overtreatment or undertreatment[17]. This epistemological clarification allowed for more precise and ethical management of older patients.

Multidisciplinary care models and geriatric units began to emerge, integrating acute and rehabilitative services. However, the incorporation of these innovations into routine nephrology practice remained limited. Clinicians increasingly recognized that dialysis,

once seen as a universal solution, could become burdensome for frail OP. As such, the paradigm began shifting toward prioritizing quality of life over life extension at any cost[13,14].

Training programs gradually introduced competencies in functional assessment, psychosocial support, and communication tailored to OP. These efforts acknowledged population heterogeneity and the need for person-centered approaches. Education also focused on addressing the complex interplay between CKD and common geriatric syndromes such as polypharmacy, cognitive impairment, and mobility loss[15,16].

Nutritional care gained prominence as a cornerstone of conservative management. In 2006, the European Society for Clinical Nutrition and Metabolism (ESPEN) published guidelines specific to OP, and in 2007, KDOQI issued recommendations on energy adequacy and protein intake (< 0.8 g/kg/day). Nevertheless, both guidelines acknowledged a significant evidence gap regarding patients aged 75 and older[17]. These limitations highlighted the need for age-stratified clinical research and more adaptive nutritional strategies.

Overall, the 2000s represented a transitional decade, one in which the clinical philosophy of geriatric nephrology matured, yet its systemic integration into nephrology services remained incomplete.

FUNCTIONAL PRECISION AND CLINICAL CONVERGENCE: GERIATRIC NEPHROLOGY IN THE 2010S

The 2010s brought a turning point for geriatric nephrology as clinical practice increasingly emphasized functional precision and interdisciplinary care. At the center of this evolution was the integration of the comprehensive geriatric assessment (CGA), which advanced the understanding of how aging affects renal physiology and patient vulnerability. Multidisciplinary approaches became central to the management of CKD, particularly as the prevalence of sarcopenia, frailty, and cognitive decline became more apparent in OP with renal dysfunction[18-20]. The conceptual emergence of "senescent nephropathy," an intersection of renal aging and geriatric syndromes, shifted the focus from disease-centered to function-based therapeutic goals[21].

This was reinforced by the formalization of the so-called "nephrogeriatric giants," a set of common pathophysiological conditions in OP, such as low glomerular filtration rate (GFR), renal atherosclerosis, and tubular dysfunction, that heighten the risk of acute kidney injury and electrolyte imbalance[22] (Table 3).

Significant progress was made in diagnostic refinement. New GFR estimation tools, including CKD-EPI, BIS, FAS, and the HUGE equation, offered more accurate staging for older adults[23,24]. Concurrently, renal replacement therapy began to reflect a more patient-centered philosophy, guided by prognostic indices and shared decision-making frameworks.

The rising burden of CKD among older populations underscored the need for nephrologists with geriatric training[25]. CGA became a core strategy for managing complexity, facilitating structured communication about prognosis, care goals, and dialysis initiation[26,27]. Collaborative models between nephrology and geriatrics gained traction, particularly for frailty-focused care pathways[28,29].

Clinical evidence supported CGA's utility in improving outcomes among older patients receiving dialysis, especially regarding cognitive and physical function[30,31].

Sarcopenia and frailty also prompted broader integration of nutritional and physical function assessments. Pharmacist-led medication reviews, tailored exercise plans, and protein-energy monitoring were introduced as routine components in geriatric nephrology clinics. Recognizing the inadequacy of existing guidelines, the PROT-AGE consortium proposed specific protein and energy intake targets for OP with CKD, adjusting recommendations by renal function status[20,32-34].

Nonetheless, the expansion of CGA faced structural barriers, including disparities in training, lack of institutional protocols, and uneven implementation across systems[35]. Despite these limitations, the decade established a firm foundation for function-oriented, ethically grounded, and person-centered renal care.

Finally, training programs, especially in Latin America, began to reflect this shift. In Mexico, landmark educational events such as the 2014 geriatrics forum and SLANH's 2018 course catalyzed national efforts. These initiatives were accompanied by the formation of geriatric nephrology committees within professional societies, signaling the growing institutionalization of the field across the region[35].

PRECISION, PROGNOSIS, AND PLANETARY AGING: GERIATRIC NEPHROLOGY IN THE 2020S AND BEYOND

The decade of the 2020s has solidified geriatric nephrology as a pivotal field at the intersection of aging science, clinical complexity, and health systems

Table 3. Nephro-geriatric giants

Nephrogeriatric giant	Description	Clinical impact
Renal vascular atherosclerosis	Atherosclerotic changes in renal vasculature, potentially causing ischemic nephropathy or intrarenal atheroembolism	May result in acute or chronic renal failure. Requires aggressive cardiovascular risk management
Renal vascular dysautonomia	Impairment in renal vascular autoregulation, compromising protection from hypo- and hypertensive insults	Increases susceptibility to pressure-induced kidney injury
Senile hypofiltration*	Progressive age-related decline in glomerular filtration rate	Slow functional decline that may lead to chronic kidney disease
Tubular dysfunction	Reduced ability to secrete potassium and reabsorb sodium, calcium, and magnesium	Leads to frequent electrolyte disturbances (e.g., hyperkalemia, hyponatremia); requires close monitoring
Tubular fragility	Heightened susceptibility of tubular cells to ischemic or toxic injury, with delayed recovery from damage	Increases the risk of acute kidney injury and prolongs recovery from tubular necrosis
Medullary hypotonicity	Reduced renal medullary concentration gradient in older persons, impairing water reabsorption	Raises the risk of dehydration and hypernatremia due to poor urine concentration capacity
Obstructive uropathy	Common cause of renal impairment in older persons, often due to prostatic hypertrophy or malignancies	May lead to irreversible renal injury if unrelieved; often requires catheterization or surgical relief

*Although the term "*senile hypofiltration*" was historically used to describe this phenomenon, it is now understood as part of the spectrum of renal senescence, best described in clinically neutral and precise terminology.

Table 4. Principles of geriatric nephrology

Principle	Description	Key details
Prevention	Focus on preventive care in geriatric nephrology	Tailored nutritional interventions, physical activity prior to disease onset, and timely dialysis initiation
Documentation and measurement	Formal evaluation of living conditions, cognitive status, and functional capacity	Examples: Modified Karnofsky Index, Barthel Index, self-adapted functional scales
Planning	Strategic planning of healthcare services, institutional protocols, and personalized treatment plans	Acute care services, rehabilitation services, day hospital facilities
Patient participation	Voluntary enrollment and commitment for rehabilitation	Modification of treatment plans based on patient and healthcare team expectations
Advance directives	Recommendation to establish and regularly update advance directives, ensuring patient involvement in shared decision-making	Importance of patient involvement in discussions about advance directives
Process of dying	Integrating discussions of dialysis withdrawal within the broader continuum of care. Apply palliative care principles to improve end-of-life experiences	Applying palliative care principles to improve the process of dying

innovation. With frailty screening gaining ground in clinical settings, guided by the example of pioneering care teams, tools like the Clinical Frailty Scale have shown strong predictive value for hospitalization and mortality, supporting more proactive and individualized care[36].

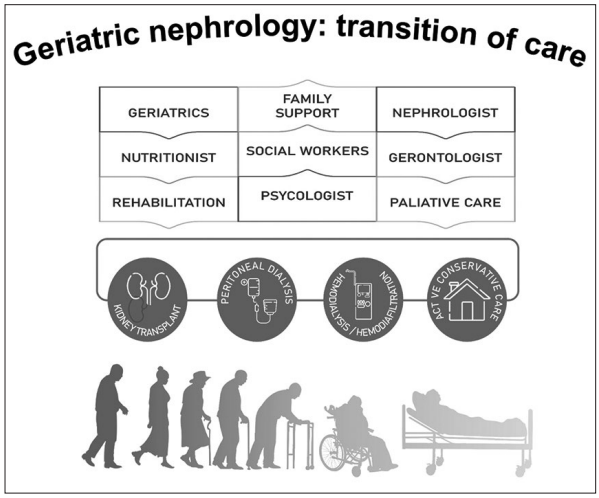

Figure 1. *Multidisciplinary coordination is essential for optimal transitions of care in older persons with kidney disease, involving nephrologists, geriatricians, and allied health professionals.*

Pharmacological innovation has extended to older populations through therapies such as SGLT-2 inhibitors and GLP-1 receptor agonists. While their use has proven effective in specific contexts, their application must remain grounded in evidence derived from aging cohorts. The progress of geriatric nephrology relies not only on new treatments, but also on the critical interpretation of research that truly reflects the OP[37]. Simultaneously, updates to KDIGO guidelines and the adaptation of dialysis protocols to frailty and functional reserve have aligned with this shift[38,39]. The growing integration of CGA further supports holistic evaluation of OP' needs (Fig. 1)[40].

Yet persistent disparities in implementation, outcomes, and institutional capacity remain barriers. Despite its proven value in transplant candidate evaluation, CGA is not yet routinely employed[41]. Global organizations such as the International Society of Nephrology have responded by promoting education and adoption of conservative and supportive CKD care pathways[42].

The COVID-19 pandemic intensified the transition toward person-centered care, particularly in end-of-life decisions[43]. Within this shift, CGA has become a critical tool—allowing clinicians to align treatment plans with patients' cognitive status, mobility, sarcopenia, and personal values. Early, culturally sensitive assessments are now considered essential to delivering appropriate and dignified care to older adults with ESKD[44,45]. The global momentum of geriatric

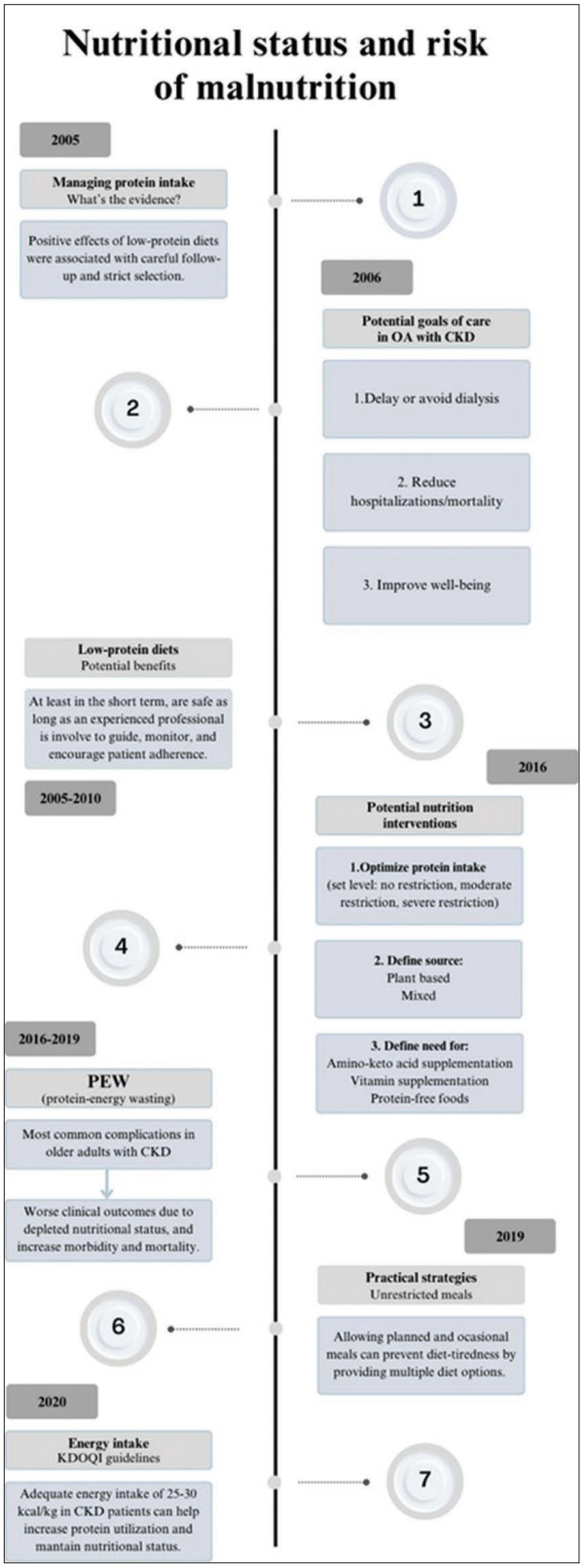

Figure 2. *Timeline of evolving strategies in protein-energy management in older persons with chronic kidney disease, highlighting key interventions and clinical implications.*

nephrology is reflected not only in growing demand but also in regional innovation. In Latin America, interest has surged, supported by initiatives aligned with the Decade of Healthy Aging, which have helped consolidate interdisciplinary, function-oriented care models[46,47]. Nutrition has also become a central focus. In 2023, ERA and ESPEN issued joint recommendations for individualized protein intake in older adults with CKD, aimed at preserving function and nutritional status[48]. Although protein-energy wasting remains a persistent challenge, recent evidence suggests that higher protein intake, when properly monitored and tailored, may improve outcomes in older patients with mild to moderate CKD (Fig. 2)[49].

CONCLUSION

Over the past four decades, geriatric nephrology has evolved into a patient-centered, ethically grounded, and clinically essential discipline. In Mexico and Latin America, the adoption of geriatric principles has driven measurable progress, despite persistent challenges such as a limited workforce and structural inequities (Table 4):

To meet the growing demands of renal aging, it is imperative to strengthen:

- Specialized training in geriatric nephrology,
- Routine use of CGA in clinical practice,
- Context-specific guidelines,
- Equity-based care models, and
- Multidisciplinary and regional collaboration.

Only through coordinated efforts can we deliver care that is not just clinically sound, but also inclusive, functional, and socially just.

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ETHICAL CONSIDERATIONS

Protection of human subjects and animals. The authors declare that no experiments on humans or animals were performed for this research.

Confidentiality, informed consent, and ethical approval. The study does not involve patient personal data medical records, or biological samples, and does not require ethical approval. SAGER guidelines do not apply.

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THE JOURNAL OF LATIN AMERICAN GERIATRIC MEDICINE LITERATURE REVIEW

Effect of multicomponent programs for prevention of delirium in surgical patients

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Abstract

Delirium is a highly prevalent condition among older adults undergoing surgical procedures, often exacerbated by pathophysiological mechanisms related to surgical and anesthetic interventions. It is frequently linked to fatal outcomes, increasing mortality, length of hospital stays, functional dependence, and elevated healthcare costs during hospitalization. Current evidence suggests that non-pharmacological interventions are the only measures that significantly impact delirium incidence. As a result, multicomponent programs based on these interventions have been developed and are employed in guidelines for perioperative elderly patients. This review aims to clarify the impact of implementing non-pharmacological multicomponent programs on the incidence of delirium, mortality, functionality, and costs in perioperative older patients.

Keywords: *Elderly. Multicomponent intervention. Delirium. Prevention. Non-pharmacologic.*

Efecto de los programas multicomponente para prevención del delirium en pacientes quirúrgicos

Resumen

El delirium es una enfermedad altamente prevalente en las personas mayores sometidas a cirugía, que se puede incrementar por diversos mecanismos fisiopatológicos involucrados con el acto quirúrgico y anestésico. Es asociado frecuentemente a desenlaces fatales en el paciente, aumentando la mortalidad, días de estancia intrahospitalaria, dependencia funcional y costos durante su estancia. Hasta el momento, las medidas no farmacológicas son las únicas que han demostrado impactar en su incidencia, por lo que se han creado programas multicomponentes basados en ellas, que actualmente se incorporan en las guías de manejo del paciente mayor perioperatorio. Esta revisión pretende esclarecer el impacto en la incidencia del delirium, mortalidad, funcionalidad y costos de la implementación de los programas multicomponente basados en medidas no farmacológicas en los pacientes mayores perioperatorios.

Palabras clave: *Adultos mayores. Intervención multicomponente. Delirium. Prevención. No farmacológica.*

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INTRODUCTION

Delirium is a highly prevalent acute neuropsychiatric disorder among hospitalized older adults associated with poor clinical outcomes: increased mortality, nosocomial complications, falls, functional dependence, prolonged hospitalization, institutionalization, and severe cognitive decline[1-3]. It is characterized by an acute and fluctuating disturbance in attention and awareness, often accompanied by perceptual disturbances or other cognitive impairments[1,2,4,5]. Diagnosis is based on the "*Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5)*" and can be confirmed with validated tools such as the confusional assessment method (CAM) or the rapid assessment test for delirium[2,5,6].

The pathophysiology of delirium remains incompletely understood, some theories implicate mechanism related to neurological aging. These include neurotransmitter dysregulation, cerebral hypoxia, ischemic or vascular dysfunction, increased production of pro-inflammatory factors, augmented immune activity mediated by microglia and astrocytes, and oxidative stress, all contributing to neuroinflammation and impaired neural network integration[5,7]. No single pathway fully explains this neural network failure, rather, there is an interplay between predisposing and precipitating factors, framing delirium as a multifactorial syndrome[2,3,7].

Delirium incidence varies by healthcare setting and population: 10-31% in general population, 10.5-39% in older adults, and even higher among postoperative, intensive care unit (ICU), and palliative care patients[5]. In contrast, significantly lower rates are observed in outpatient populations[5]. Among older surgical patients, the estimated prevalence is approximately 20% (95% confidence interval (CI): 17-24.43), which is associated with an increased risk of mortality[8,9]. Despite its prevalence and clinical significance, delirium remains with underdiagnosis rates as high as 60-76% in hospital settings[1,4,10].

Delirium is a potentially preventable condition by addressing modifiable risk factors, multicomponent programs have been developed and demonstrated to reduce incidence (Relative risk [RR] 0.57, 95% CI: 0.46-0.71)[2,11,12]. The most effective interventions include cognitive stimulation, orientation strategies and use of familiar objects, nutritional and hydration optimization, sleep hygiene promotion, oxygenation management, medication review, mood assessment, and bowel and urinary care[11]. These strategies have been incorporated into clinical guidelines for delirium prevention and perioperative care for older adults[13-15].

However, the routine clinical implementation of such programs remains challenging, with mixed outcomes concerning hospital length of stay, mortality, and functional decline[11,16,17]. Therefore, this review examines the application of multicomponent programs in surgical patients and explores their impact on delirium incidence, mortality, hospital length of stay, and functional decline, and the limitations associated with their implementation.

METHODS

A comprehensive literature search was conducted using the PubMed database. In addition, a manual search was performed using Google Scholar, including articles that had not been duplicate in other databases. The search was conducted in September 2024 and included clinical trials, reviews, systematic reviews, and meta-analyses published between January 2014 and June 2024. The search strategy employed the following medical subject headings terms: (multicomponent interventions) AND (postoperative delirium) AND (elderly), non-pharmacological interventions, and prevention.

All retrieved articles were organized using Zotero reference management software. Duplicates, abstracts without full-text availability, and articles published in languages other than English or Spanish were excluded. Further exclusions included studies that focused solely on pharmacological interventions, ICU patients, non-surgical patients, or single component non-pharmacological interventions (a multicomponent intervention requires at least three components).

The quality of clinical trials included was assessed using the Jadad scale. Studies scoring below 3 points were classified as low quality[18]. Findings from selected clinical trials were compared with the results of previously published reviews and meta-analyses. The search and selection process are illustrated in figure 1.

RESULTS

Delirium in surgical patients

In surgical patients, the highest prevalence of delirium occurs in individuals over 60 years old (65-85 years,

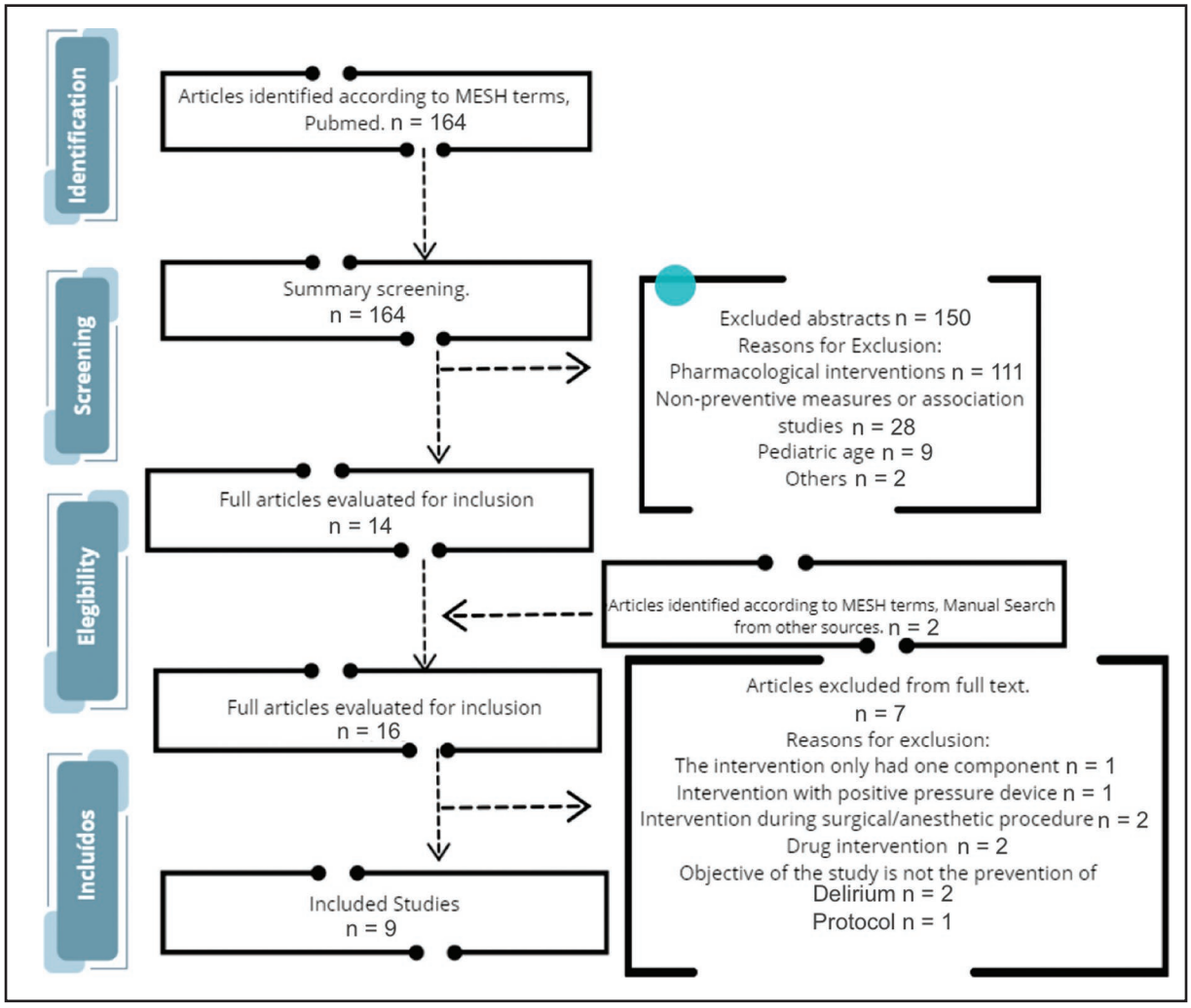

Figure 1. *Article selection process.*

odds ratio [OR] 2.67), the risk increases twofold in patients over 85 years (OR 6.24)[10]. A large multicenter study evaluating global prevalence and predictors of delirium in 13,179 non-cardiac surgical patients across Latin America, Asia, Europe, and North America reported a perioperative delirium prevalence of 20% (95% CI 17-24) among the geriatric population[9].

A sub-analysis revelated the highest prevalence rates among patients undergoing general surgery (23%, 95% CI 16-29), oncological surgery (19%, 95% CI 6-23), or orthopedic surgery (22%, 95% CI 15-28), with a 25% mortality rate in the elderly cohort (95% CI 7-44, n = 3,032)[9]. Another study on non-cardiac surgical patients found a 23.4% incidence of pre-operative delirium (n = 10,173) and a 23.8% incidence of post-operative delirium (n = 26,472)[19].

Over 112 precipitating risk factors for delirium have been identified[20]. Among surgical patients, the most frequent include anesthesia duration (OR 1.11, $p = 0.001$), American Society of Anesthesiologists 4 anesthetic risk classification (OR 2.43, $p = 0.001$), elevated serum C-reactive protein levels (> 10) (OR 3.56, $p \leq 0.001$), and polypharmacy (> 5 medications) (OR 1.83, $p \leq 0.001$)[10]. General anesthesia has also been implicated as a risk factor; leading to proposals for intraoperative electroencephalogram monitoring to avoid deep sedation, evidence supporting this intervention remains limited[21].

Other precipitating factors related to surgery include the type of surgery, intraoperative blood loss, hemodynamic instability, surgical duration, prolonged preoperative wait time, presence of complications, shock,

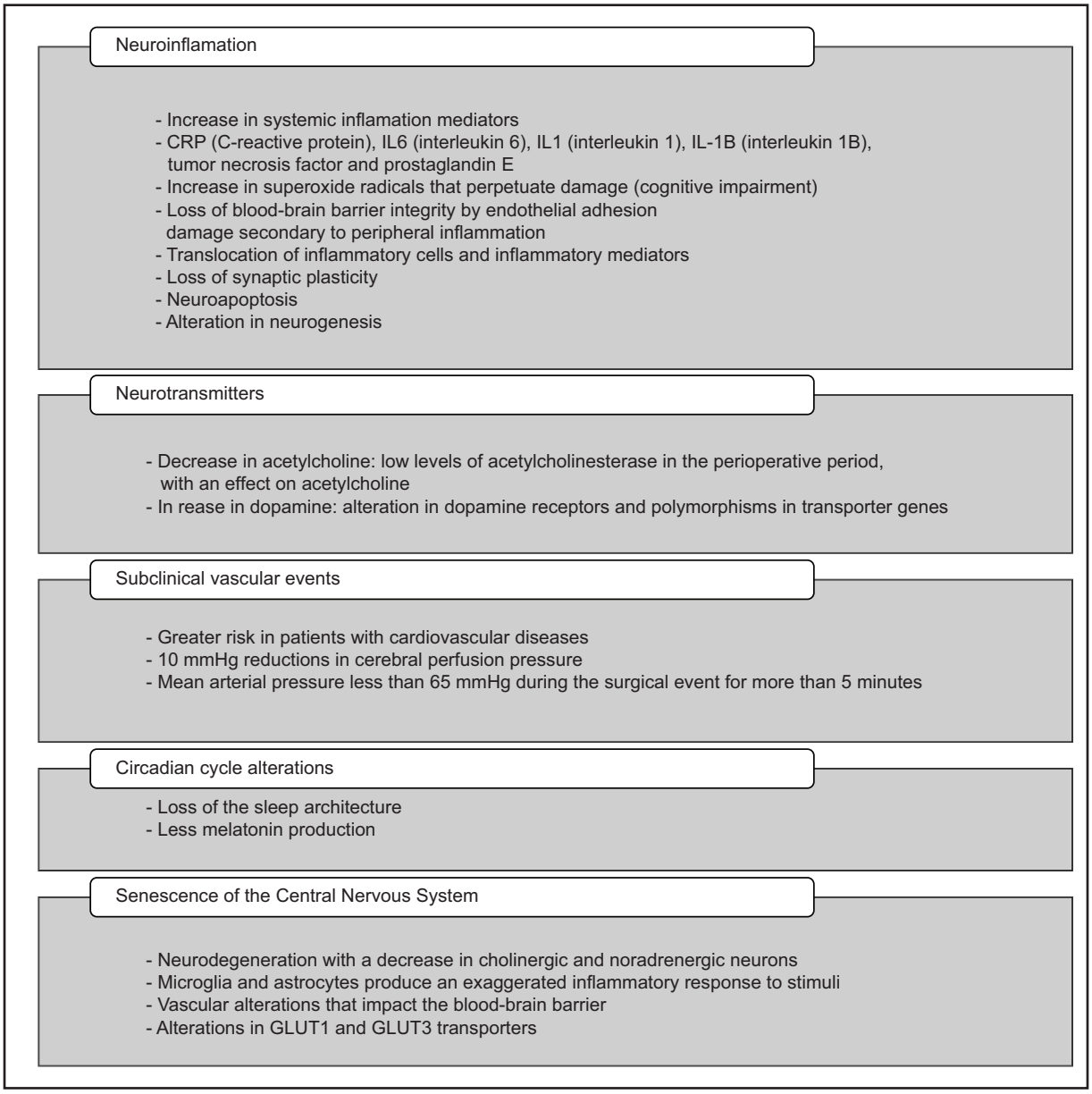

Figure 2. *Delirium pathophysiologic mechanism.*

and atrial fibrillation[20]. These factors are compounded by the presence of predisposing risk factors in older adults, explaining the increased frequency of delirium in this population.

The pathophysiological mechanisms underlying delirium are complex and still under investigation[7]. Current evidence points to neuroinflammation, neurotransmitter dysregulation, and subclinical vascular events as key mechanisms in surgical patients (Fig. 2)[5,7,21-23].

Other hypotheses involve amyloid-beta accumulation linked to anesthesia affecting GABA receptors, cortical thinning from repeated surgeries, medications that affect neurotransmitters, hypoxia, hypoglycemia, adenosine triphosphate depletion, glucocorticoid excess, and sodium imbalances[23].

Multicomponent programs for delirium prevention

Multi-component programs for delirium prevention were first introduced in 1999 with the Hospital Elder Life Program (HELP), designed for hospitalized older adults. This multidisciplinary approach

targeted modifiable risk factors such as cognitive impairment, dehydration, sleep deprivation, immobility, and sensory deprivation[24,25]. The program significantly reduced delirium incidence compared to usual care and has since been adapted worldwide[16,26,27].

Beyond reducing delirium incidence, these interventions have been associated with fewer falls, shorter hospital stays, and reduced rates of institutionalization[17,25-27]. However, evidence regarding improvements in cognitive function and activities of daily living is inconsistent due to diversity of the scales used abroad various studies to measure these variables[16,25,28,29].

Implementation challenges include obtaining institutional support and long-term funding, integrating interventions into existing workflows, sustaining program fidelity, overcoming organizational culture barriers, documenting program effects, and engaging leadership and front-line staff [16]. To date, HELP has been implemented in over 200 hospitals worldwide supported by resources and training from the American Geriatrics Society[30].

At present, non-pharmacological multi-component interventions are considered the most effective method for delirium prevention particularly in the ICU, palliative care, oncology, and surgical units[13,14]. These programs are also integrated into standard geriatric care guidelines[11,31,32]. Core components include reorientation strategies, cognitive stimulation, and sleep hygiene promotion[11].

Globally, hospitals implementing such programs have reported reduced hospital stays, improve patient-centered care perceptions, decreased costs, preserved functionality, and fewer complications[12,16].

Application of multicomponent programs in surgical patients

Given the high prevalence of post-operative delirium, multicomponent preventive programs have been widely adopted in surgical patients[2,3,9,13,15]. Positive results have been documented primarily in developed countries, especially when patient-centered care models have been implemented[33,34].

Table 1 summarizes the key characteristics of the analyzed studies, including the original HELP study, the most widely implemented program[2], as well as those conducted on various surgical areas such as general surgery, trauma and orthopedics, and cardiothoracic surgery.

Most programs were designed to address prevalent risk factors, creating interventions targeting the most prevalent ones while following guideline recommendations[24,25-38]. The types of interventions used in each study are outlined in table 2.

Incidence of delirium

Most studies demonstrated a reduction in delirium incidence following the implementation of multicomponent programs. However, some found no statistically significant differences, often attributed to contamination or low adherence (i.e., control group patients adopting some measures because they were in the same room or treated by the same healthcare staff)[35,38,39]. The most notable reductions were observed in non-cardiac surgeries[38], with some reporting decreases cumulative in incidence and delirium severity[35,38]. Table 3 summarizes the delirium incidence rates.

Mortality

Mortality rates did not differ significantly between intervention and control groups. In the original HELP study, mortality was 1.4% intervention group versus 1.6% control group ($p = 0.78$)[24].

In other studies, no significant differences were found between the groups at the baseline assessment (intervention 5% vs. control 3%), at 10 days (intervention 3.2% vs. control 4.6%), and 30 days (intervention 9.6% vs. control 6.8%)[35,40]. The losses reported in each study are summarized in table 4.

Length of hospital stay

While several studies reported no significant differences in hospital length of stay[24,35-37,41] or lack data on hospital stay duration[40], some showed reductions. Deekens reported a decrease from 11.1 versus 11.4 days ($p = 0.01$)[38], and Chen observed a reduction from 14 to 12 days ($p = 0.004$)[29]. The largest impact was seen in cardiac surgery patients[38], with a reduction of almost 50% (6.3 days vs. 12.10 days, $p = 0.34$ analysis of covariance)[39].

Patient functionality

Only four studies assessed functionality[35,36,38,39], and just two evaluated cognitive outcomes[37,41]. While heterogeneity in assessment tools

Table 1. Studies general characteristics

Studies	Publication Age/country	Type of study	Sample size	Population and average age	Delirium measurement scales	Jadad punctuation
Inouye et al.[24]	1999, NEJM/ United States	Controlled clinical trial.	n = 852	People over 70 years of age, admitted to a general medicine ward. Mean age 79 years.	CAM	1
Young et al.[35]	2020, Age and Ageing/ England and Gales	Multicenter, controlled, cluster-randomized clinical trial.	n = 713	People over 65 years of age admitted to geriatrics and traumatology and orthopedics services. Mean of 82.5 years.	CAM MOTYB AMT	5
Chen et al.[29]	2017, JAMA/ Taiwan	Clinical trial, monocentric, randomized by clusters.	n = 377	People over 65 years of age admitted in gastrointestinal surgery service. Mean age 74.3 years.	CAM	6
Unal et al.[36]	2022, Journal of Clinical Nursing, Wiley/Türkiye	Prospective, monocentric clinical trial.	n = 80	People over 65 years of age with hip fracture. Mean age 80.6 years	CAM-ICU	5
O'Gara et al.[37]	2020, Anesth Analg/United States	Randomized, monocentric clinical trial.	n = 45	Patients aged 60-90 years scheduled for cardiac surgery. Mean age 70 years	CAM MoCA	4
Deeken et al.[38]	2022, JAMA Surgery/ Germany	Multicenter randomized clinical controlled trial, by clusters, of a stepped type.	n = 1470	People over 70 years of age who underwent major elective surgery (more than 60 min). Average age 77.	CAM	6
Mailhot et al.[39]	2017, Nurse Critical Care/ Canada	Clinical trial, randomized, monocentric, by clusters.	n = 30	Men aged 75 years, after cardiac surgery.	CAM ICU	5
Jiang et al.[41]	2024, JAMA/ China	Clinical trial, multicenter, single-blind, randomized.	n = 218	Patients over 18 years of age scheduled for elective cardiac surgery. Mean age 66 years.	CAM CAM ICU	5
Fahimi et al.[40]	2020, Nurse Critical Care/ Iran	Randomized clinical trial.	n = 110	Patients undergoing coronary bypass. Average age 57.69 years.	CAM ICU	1

CAM: confusional assessment method; CAM-ICU: confusional assessment method intensive care unit; DOSS: delirium observational screening score; MOTYB: months of the year backwards score; AMT: abbreviation mental test; MoCA: montreal cognitive assessment.

complicates comparison; improvements in functionality were generally observed in intervention groups[35,36,39]. No cognitive benefits were detected a discharge or follow-up[37,41]. Table 5 summarizes the details.

Cost

Only the original HELP study presented a cost analysis, reporting a program cost $139,506 USD, averaging $327 USD/patient. Prevention cost totaled $6,341

Table 2. Non-pharmacological measures used in multi-component programs

Variables	Inouye et al.[24]	Young et al.[35]	Chen et al.[29]	Unal et al.[36]	O'Gara et al.[37]	Deeken et al.[38]	Mailhot et al.[39]	Fahimi et al.[40]	Jiang et al.[41]
Reorientation measures	X	X	X	X		X			
Cognitive stimulation	X	X			X	X			X
Sleep hygiene	X			X		X			
Insomnia drugs	X								
Adjustment of medication and procedure schedules (respect circadian rhythm)	X			X					
Early movilization	X	X	X	X		X			
Catheter removal	X			X					
Exercise program	X		X	X		X		X	
Use of hearing aid and communication techniques	X	X		X		X			
Use of visual aids	X					X			
Rehydration or nutrition protocol	X	X	X	X		X			
Pain control		X		X		X			
Familiar involvement			X			X	X		
Medication review and adjustment						X			
Bladder and intestinal (elimination protocol)				X					
Environmental measures		X		X		X			
Infection control		X							
Oral care and oral exercises			X						
Prevention of hypoxemia and use of oxygen				X					
Mindfulness or relaxation measures						X			
Training staff or educational measures for family members	X	X				X	X	X	
Comprehensive geriatric assessment									

USD[24], substantially lower than the estimated $9,000 USD/year/person cost associated with delirium[2].

Limitations in the implementation of multicomponent programs

Main limitations identified included:

- Difficulty in applying the CAM scale on patient admission to rule out prevalent delirium[35].
- Environmental factors and social factors (such as the patient's support network), influencing outcomes[35,40,41].
- Variable adherence to interventions, reducing overall impact[24,35,37,39].
- Recruitment challenges, difficulties in recruitment were identified[24,39]; most studies had to use cluster sampling, which may confer a lower impact compared to individual randomization[39,35,38,39].
- Sample contamination, particularly when control and intervention groups shared staff or protocols[29,35].
- Baseline group differences, introducing potential confounding, potentially under- or overestimating effects[38].

DISCUSSION

Pathophysiological background and need for multicomponent strategies

Despite significant advances in understanding the pathophysiology of post-operative delirium – where

Table 3. Delirium incidence

Study	Intervention group (%)	Control group (%)	Size of the effect	95% CI	p	NNT
Inouye et al.[24]	9.9	15	OR 0.6	0.39-0.92	0.002	
Young et al.[35]	7	8.9	OR 0.68	0.37-1.26	0.225	N/A
Chen et al.[29]	6.6	15.1	RR 0.44	0.23-0.83	0.008	11.8
Unal et al.[36]	0	15	χ^2 6.486	N/A	0.026	N/A
O'Gara et al.[37]	25	15	N/A	N/A	0.69	N/A
Deeken et al.[38]	19.9	23.4	OR 0.81 (0.63-1.04)	0.7-1.03	0.1	N/A
	Non-cardiac surgery	Non-cardiac surgery	RR 0.85	Non- cardiac surgery	Non-cardiac surgery	
	51	77	Non-cardiac surgery	0.48-0.93	0.008	
	Cardiac surgery	Cardiac surgery	0.63 (0.43-0.92)	Cardiac surgery	Cardiac surgery	
	35.2	36.5	RR 0.967 Cardiac surgery 0.95 (0.67-1.36) RR 0.97	0.77-1.22	0.79	
Mailhot et al.[39]	43.8	71.4	N/A	N/A	N/A	N/A
Jiang et al.[40]	27.5	46	OR 0.42	0.23-0.77	0.006	N/A
Fahimi et al.[41]	11.8	25.5	N/A	N/A	0.003	N/A

N/A: not applicable. It was placed in case the information was not referred to. CI: confidence interval; NNT: number needed to treat; OR: odds ratio; RR: relative risk; p = 0.05.

Table 4. Reported percentages of losses due to deaths in the study groups

Study	Losses in intervention group (%)	Losses in control group (%)
Inouye et al.[24]	1.4	1.6
Young et al.[35]	17.78*	14.32*
Chen et al.[29]	0.52	1.13
Unal et al.[36]	2.5	2.5
O'Gara et al.[37]	NR**	NR**
Deeken et al.[38]	NR**	NR**
Mailhot et al.[39]	NR**	NR**
Jiang et al.[40]	0.91	0.91
Fahimi et al.[41]	NR**	NR**

*The total percentage of losses by group was calculated by adding losses in the first evaluation, at 10 days and at 30 days (total losses during the study of the first group).
**No deaths were reported.

neuroinflammation, reduced oxygen reserve, and metabolic energy deficits play critical roles – a unified mechanism explaining the diverse clinical manifestations and severity of delirium remains elusive. Its multifactorial etiology supports the need for multicomponent prevention strategies. While several programs target known risk factors, their efficacy in modifying underlying physiological remains unclear, highlighting a crucial area for future research[5,7,23,29].

Impact on delirium incidence

This review is consistent with previous findings among non-surgical patient populations, where the HELP program or similar interventions reduce delirium incidence by 45-53%[16]. Other multi-component programs yielded a RR reduction of 0.73 (95% CI: 0.63-0.85)[42]. A meta-analysis of non-cardiac surgical patients undergoing preventive multi-component interventions showed a lower delirium incidence[43]. Programs incorporating a larger number of interventions demonstrated a more substantial impact in reducing delirium incidence[24,35,37,38].

Impact on mortality

The implementation of these programs may not significantly impact in-hospital mortality (RR 1.17, 95%

Table 5. Functional recovery of the patient reported in the different studies

Study	Measurement scale used	Results
Young et al.[35]	Nottingham for activities of daily living	Changes on the scale in the Intervention group 29.5 (± 20.3) versus control 33.1 (± 20.9).*
Unal et al.[36]	Barthel index	Improvement in intervention group vs control in Barthel score at discharge (64 ± 7.9) versus 61.4 (± 10.3).*
Mailhot et al.[39]	Sickness impact profile	Cardiac surgery patients in the intervention group showed improvement versus control (4.8 [± 3.2] versus 9.5 [± 6.3]).*
O'Gara et al.[37]	MoCA	There were no differences between groups in the scale score.
Jiang et al.[40]	MoCA Post-operative cognitive disfunction score Telephonic interview	There were no significant differences in the cognitive function of the patients at discharge.

*Mean (DE).
MoCA: Montreal Cognitive Assessment.

CI: 0.79-1.74), or mortality at 1 and 3 months (RR 1.26, 95% CI: 0.92-1.7)[11]. Nevertheless, few studies have assessed mortality as an outcome; in this review, only three studies evaluated mortality, consistently finding no significant difference between intervention and control groups[24,35,40].

Impact on hospital length of stay

Prior studies in non-surgical populations reported a modest reduction in length of stay (−0.24−1.3 days); however, due to high heterogeneity, the evidence remains weak[11,16]. In surgical patients, a mean reduction of −1.22 days (95% CI: −2.63-0.2, p = 0.01) was observed[42]. This review found the greatest impact on hospital length of stay cardiac surgery patients[29,38].

Impact on functionality and cognitive outcomes

Functionality outcomes remain challenging to interpret due to scale variability[11]. Although some earlier reviews found no improvements in activities of daily living (RR = 0.92, 95% CI: 0.82-1.04, p = 0.17), this review found improvements post-intervention in three studies[35,36,39]. Conversely, no cognitive function benefits were observed[37,41]. This may reflect underlying neuronal damage associated with delirium and potentially leading to chronic brain damage, a known risk factor for subsequent cognitive decline, that increases the risk of dementia syndromes by 62.5%[5,44], necessitating further pathophysiological research.

Implementation challenges and adherence strategies

One major limitation identified in this review is the lack of cost-effectiveness analyses in surgical settings. Future research should address this gap to better inform healthcare policy and resource allocation.

The generalizability of these programs remains limited, given the scarcity of large, multicenter studies assessing standardization, feasibility, and scalability, as proposed by Young[35].

Adherence remains a critical determinant of success. Strategies to enhance adherence could include:

- Educating all healthcare staff about delirium prevention
- Engaging family members through awareness campaigns
- Establishing hospital volunteer programs
- Integrating geriatric services into surgical care programs
- Creating interdisciplinary health teams dedicated to delirium prevention.

These strategies may help reduce the incidence, complications and costs associated with delirium[24,25,27,29,35].

Role of family engagement

Involving family members appears particularly promising: educational programs for caregivers not only improve early detection delirium, also reduce caregiver anxiety and foster proactive participation in

the recovery process care[29,38,39]. Family members may detect early-stage delirium more effectively; however, further research is needed, particularly in post-operative and intensive care settings.

Other findings: polypharmacy, social interaction, and safety

Some studies noted reductions in polypharmacy, particularly psychotropics, among intervention groups[38], potentially contributing to decreased post-operative delirium, although further evidence is needed to confirm this association.

Another relevant finding is that cognitive improvements reported in some interventions could be partially attributed to increased social interaction with health care staff[41]. Since social isolation is a known risk factor for cognitive decline and delirium, structured group social activities during hospitalization warrant further exploration.

Beyond the previously mentioned benefits, multicomponent programs have proven safe, with no new adverse events reported across the studies analyzed[38].

Integration into guidelines

Standardized delirium prevention programs have been incorporated into post-operative care guidelines for older adults and are now part of many perioperative cares[13,15], contributing to improved patient-centered, high-quality care.

CONCLUSION

Multi-component programs for the prevention of post-operative delirium significantly reduce its incidence. Some programs also decreased hospital length of stay and help preserve patient functionality, suggesting that their standardized implementation across surgical services would enhance patient-centered care and hospitalization quality.

However, effective implementation demands training and active participation from healthcare personnel, caregivers, and family members. Non-pharmacological interventions – such as socialization or the implementation of therapeutic playrooms – remain underexplored and should be further investigated.

Evidence regarding the cost-effectiveness of these programs remains limited, and most studies have not demonstrated a significant impact on mortality. Future research should focus on cost-benefit analyses, multicenter validation, and the long-term impact on functional and cognitive outcomes.

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CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

ETHICAL CONSIDERATIONS

Protection of human subjects and animals. The authors declare that no experiments on humans or animals were conducted for this research.

Confidentiality, informed consent, and ethical approval. The study does not involve personal patient data, medical records, or biological samples, and does not require ethical approval. SAGER guidelines do not apply.

Declaration on the use of artificial intelligence. The authors declare that no generative artificial intelligence was used in the writing or creation of the content of this manuscript.

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