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THE JOURNAL OF LATIN AMERICAN GERIATRIC MEDICINE ORIGINAL ARTICLE

Mexican Hip Fracture Audit (ReMexFC): Pilot phase report

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Abstract

Introduction: *Hip fracture (HF) has a high morbidity and mortality. Audits have been developed in other countries. In Mexico, we do not have a national HF audit.* **Objective:** *The objective of the study was to know HF care characteristics Mexico as the first phase of a national HF audit.* **Methodology:** *We conducted a prospective, multicenter, observational, and descriptive pilot phase study y 4 hospitals in Mexico. We included patients 60 years and older with HF. We measured the variables of the Fragility Fracture Network. We used descriptive statistics reporting means and medians.* **Results:** *Fifty-four patients were included, 64.8% were women and the mean age was 78.4 years. The most frequent fracture was the transtrochanteric. The mean surgical delay was 140 h. Only 18.5% were operated in the first 48 h. The most used device was dynamic hip screw. The main complications were delirium and sore ulcers. Only 42% received treatment for osteoporosis at discharge. At 30 days, 76% were not able to walk yet.* **Conclusions:** *We have a low compliance rate to key performance indicators and our outcomes are worse than other countries. This audit could help to increase awareness of our current status and focus on quality improvement policies and obtain better outcomes.*

Key words: *Hip fracture. Audit. Fragility fractures.*

Registro Mexicano de Fractura de Cadera (ReMexFC): reporte de la fase piloto

Resumen

Introducción: *La fractura de cadera tiene una alta morbilidad y mortalidad. Se han realizado registros de en otros países. En México no existe un registro nacional sobre fractura de cadera.* **Objetivo:** *El objetivo es conocer las características sociodemográficas de la fractura de cadera en México, apego a indicadores de calidad y resultados asistenciales***. Metodología:** *Realizamos un estudio prospectivo, multicéntrico, observacional y descriptivo en fase piloto en 4 hospitales de México. Participaron cuatro hospitales. Incluimos a pacientes mayores de 60 años. Se midieron las variables sugeridas por la Fragility Fracture Network. Se usó estadística descriptiva.* **Resultados:** *Incluimos 54 pacientes. El 64.8% fueron mujeres y la edad media fue de 78.4 años. La fractura más frecuente fue la transtrocantérica. La mediana de demora quirúrgica fue de 140 horas. El 18.5% no tuvo demora. Las principales complicaciones fueron el delirium y las úlceras por presión. El 42% de los casos recibió tratamiento para la osteoporosis. A los 30 días, el 76% no caminaba.* **Conclusiones:** *Tenemos una baja adherencia a los indicadores de calidad y nuestros resultados son peores que en otros países. Un registro nacional nos ayudará a conocer nuestro estado actual en la asistencia de fractura de cadera y generar políticas de mejora en la atención para mejorar resultados.*

Palabras clave: *Fractura de cadera. Registro. Fractura por fragilidad.*

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INTRODUCTION

Hip fracture (HF) is the most serious consequence of osteoporosis due to his high mortality, costs, and increases the risk of developing functional decline[1,2]. It has been estimated that Asia and Latin America will have the highest growth rate in the number of HF s in the following years[3]. In Mexico, between 8.5% and 18% of women will have a HF throughout their life[4], meanwhile the International Osteoporosis Foundation has considered that the incidence of HF in Mexico ranges from 200 to 300 cases per 100,000 inhabitants[5,6].

HF also has repercussions at the public health level. Mortality rate after the 1st year is reported between 25% and 30%, and only three out of four of the survivors will recover the mobility they had prior to the fracture[7]. On the other hand, it has a negative impact on the quality of life[8]. Another issue that makes the HF catastrophic is its costs. In our country, the Mexican Institute of Social Security spent at the beginning of the 21st century the equivalent of $ 2 million United Sates dollars in HF care[9].

In the past decades scientific and academic instances released clinical practice guidelines, key performance indicators (KPI)[10] and audits[11-15] as part of the efforts to improve outcomes of patients with HF. In the first decade of the 21st century, England launched the first of these registries, the National HF Database (NHFD), and more than 60,000 FC[16] have been reported. It has been followed by other countries such as Norway[17], Australia and New Zealand[13], and Spain[18] among others.

After the implementation of NHFD, it was possible to increase the compliance to KPI such as surgery in the first 48 h, falls prevention, and geriatric assessment, among others. This kind of registries helped to decrease the mortality rate in United Kingdom[19]. In Mexico there is no regional or national HF audit, the Mexican HF Audit (ReMexFC) responds to this need. The main objectives and the project methodology were published in 2019[20]. We followed the recommendations of the Fragility Fracture Network (FFN). FFN is an international scientific society with global representation dedicated to improve outcomes after fragility fractures. The FFN has endorsed and supported several audits worldwide[21].

Objective

The main objective of Mexican HF audit is to know the demographic characteristics, compliance to KPI and outcomes, both in the acute phase and after 30 days of follow-up in Mexican patients with fragility HFs.

METHODOLOGY

The Mexican HF Registry (ReMexFC) is a national project with representatives in different states of the Mexico. Eleven public and private hospitals were invited to participate.

We conducted a pilot phase, multicenter, prospective, cross-sectional, and observational study in the four hospitals that accepted the invitation in Mexico. The public hospitals included were Hospital Regional ISSSTE Leon, Hospital Regional PEMEX Reynosa, and Hospital General de Zacatecas. Only one private hospital was included, the Hospital HR in León, Guanajuato. All hospitals received authorization from the local research and bioethics committee. Patients signed informed consent.

We included patients 60 years and older with a diagnosis of fragility HF, defined as those who suffered a low energy trauma or fall from their own standing position. We measured variables suggested by the FFN through the Minimum Common Dataset (MCD) (Table 1). Gait was evaluated through the Functional Ambulatory Category[22], the cognitive status at admission with the Pfeiffer questionnaire[23], the preoperative risk with the American Society of Anesthesiology (ASA) scale[24]. Functional status was measured with the Barthel index[25], and delirium with the confusion assessment method (CAM)[26].

The MCD includes socio-demographic characteristics, health-care system whether it is public or private, gait before the fracture, functionality, and cognitive status. It also measures the KPI in terms of surgical delay, treatment for osteoporosis at discharge, mobilization out of bed, and weight bearing, in addition to mortality in the acute phase, as well as after 30 days. Finally, the main complications such as delirium and sore ulcers were measured. The data were captured on a digital platform, only the data manager had access to the results and their sources. This study received authorization of each one of local ethics committee.

Each hospital received an identification letter (A, B, C, and D) that would guarantee anonymity at the time of publication. Only the person responsible for analyzing the information knows the identity of each hospital.

Table 1. Minimum common database or MCD

In-hospital phase	
Patient's general information	**Pre-fracture characteristics**
	Place of residence
Gender	Mobility$^{\Psi}$
Age	Gait aids
City and State	Mental status$^{\alpha}$
Hospital	Surgical risk$^{\beta}$
Private or public hospital	Side of the fracture
	Type of fracture
	Osteoporosis treatment$^{\Sigma}$
	Functional status$^{\chi}$
In-hospital	**Discharge**
Date and time of arrival to emergency room Date and time of admission to traumatology ward Sore ulcers prior to admission Delirium$^{\pi}$ Date and time of surgery Orthopedic implant used in surgery Surgical delay in hours Use of femoral blocking Anesthesia modality used Specialist Weight bearing the day after surgery	Destination after discharge Date of discharge Hospital length of stay Osteoporosis treatment In-hospital mortality
	30-day follow-up
	Readmission
	Surgical reintervention
	Mortality
	Gait and need for aids
	Osteoporosis treatment$^{\Sigma}$
	Functional status

Ψ Functional Ambulatory Category (FAC)[22] FAC 0= Unable to walk FAC 1= Requires great help from one person.
FAC 2 = Requires little help from one person. FAC 3 = walks independently in interiors but needs supervision.
FAC 4 = Walks independently in interiors without supervision. FAC 5= Walks in interiors and exteriors independently.
α Pfeiffer's scale[23]
β American Society of Anesthesiology (ASA)[24]
Σ calcium, Vitamin D, and antiresorptive or anabolic drugs
χ Barthel index[25]
π Confusion assessment method[26]

Statistical analysis

Descriptive statistical analysis of the evaluated variables was performed, qualitative variables in frequency, proportions, and percentages were reported; while quantitative variables were reported in means and standard or medium deviation and interquartile range (Q1-Q3), which depended on the distribution of the data; evaluated by the Kolmogorov–Smirnov test or its equivalent according to the sample size. For the statistical analysis, we used SPSS software for Windows (SPSS, Inc., Chicago, IL, version 24).

RESULTS

From the 11 hospitals invited, only four accepted. The main barriers that prevented the participation of the remaining seven hospitals were related to a delay in the authorization of the ethics and research committees at (it was not approved by the time the study begun).

After being accepted, the four hospitals included a total of 54 patients between April and December 2018. About 90.7% of the subjects were treated in a public hospital. No technical problems were reported on the digital data capture platform.

The main pre-fracture characteristics are shown in table 2. We found that 64.8% of the patients were women, the mean age was 78.4 (± 10.4) years, most of them had an independent gait and did not use walking aids, 53.7% of the cases had a high surgical risk, according to the ASA classification. The most frequent fracture was the transtrochanteric with 57.4%

Table 2. Pre-fracture characteristics, type of fracture, surgical risk, and mental status on admission

	General (n = 54)	Hospital A (n = 31)	Hospital B (n = 10)	Hospital C (n = 8)	Hospital D (n = 5)
Age	78.4 ± 10.4€	76.3 ± 10.8€	79.0 ± 11.4€	86.1 ± 4.7€	77.8 ± 10.2€
Female gender	35 (64.8)	20 (64.5)	6 (60)	5 (62.5)	4 (80)
Functional status$^{\Delta}$	90 (80-100)£	90 (60-100)£	90 (87.5-98.5)£	80.0 ± 19.2€	85 (82.5-92.5)£
Walked independently$^{\Phi}$	44 (81.5)	26 (83.9)	8 (80)	7 (87.5)	3 (60)
Walking aids					
Cane	13 (24.1)	10 (32.3)	1 (10)	2 (25)	-
Crutch	1 (1.9)	-	1 (10)	-	-
walker	11 (20.4)	7 (22.6)	2 (20)	-	2 (40)
Cognitive status at admission (Pfeiffer scale > 3)	9 (16.7)	6 (19.4)	3 (30)	-	-
High surgical risk$^{\vartheta}$	29 (53.7)	20 (64.5)	4 (40)	1 (12.5)	4 (80)
Type of fracture					
Intracapsular non-displaced	13 (24.1)	5 (16.1)	2 (20)	5 (62.5)	1 (20)
Intracapsular displaced	4 (7.4)	3 (9.7)	1 (10)	-	-
Transtrochanteric	31 (57.4)	17 (54.8)	7 (70)	3 (37.5)	4 (80)
Subtrochanteric	6 (11.1)	6 (19.4)	-	-	-
Osteoporosis treatment	6 (11.1)	2 (6.5)	2 (20)	1 (12.5)	1 (20)

Values reported in N (%) unless otherwise specified.
€: Mean ± standard deviation; £: Median (interquartile range); ϑ: American Society of Anesthesiology (ASA) III-IV;
Φ: Functional ambulatory Category (FAC) 3-5; Δ: Barthel Index

and 11% of the patients received osteoprotective treatment before the fracture.

Compliance to KPI is shown in table 3. The emergency room median length of stay was 54 h and the mean surgical delay was 140 h, 18.5% of cases were operated within the first 48 h (Fig. 1A). A total of 55.6% of the patients were assessed by a geriatrician during the hospital stay, 35% sat the day after the surgery and 7.4% initiated weight bearing as tolerated the day after surgery. The hospital stay was 8.8 (± 4.5) days (Fig. 1B). The most commonly used implant was dynamic hip screw (DHS) in 42.6% of cases. Figure 2 shows the type of fracture and the device used. At the time of discharge, only 42.6% of patients received osteoprotective treatment.

During the acute phase, four patients died, all of them after surgery and from in-hospital infections. The main complications were delirium which occurred in 33.3% of patients and sore ulcers in 29.6%. The most frequent cause of the surgical delay was lack of available surgical theatre. After 30 days of follow-up, 12 patients were lost. Of the 42 remaining, there was a rate of 11.9% readmission and 7.4% reoperation, 76.2% of patients do not walk and only 42.8% receive osteoprotective treatment. Mortality at 30 days was 14.3% (Table 4).

DISCUSSION

The main barrier that prevented hospitals from participating was the delay in the response time from local ethics and research committees. It is expected that these hospitals will receive the corresponding authorization from their committees and be included in 2019.

Regarding the health-care outcomes, ReMexFC showed us that patients in Mexico with HF are younger than developed countries. In the United Kingdom, patients were 83 years old[16], Ireland 81 years[14], Spain 86 years[18], and Germany 84 years[27]. This is due to the demographic transition that happened in these countries earlier than in Mexico.

The KPI, in our country, are way bellow international recommendations[10]. The mean surgical delay was 140 h, compared with 33 h in England[12] and 25 h in Germany[27]. In our registry, 18.5% of the patients underwent surgery in the first 48 h of their stay, which contrasts with 89% in Germany and 40.3% in Spain. Other points that contrast significantly are the sore ulcers which occurred in Mexico at 29.6% versus 3% in Ireland. Both surgical delay and post-surgical complications impact hospital mortality. ReMexFC found that our mortality rate is higher than in Spain (7.4%) and England (4.4%)[27].

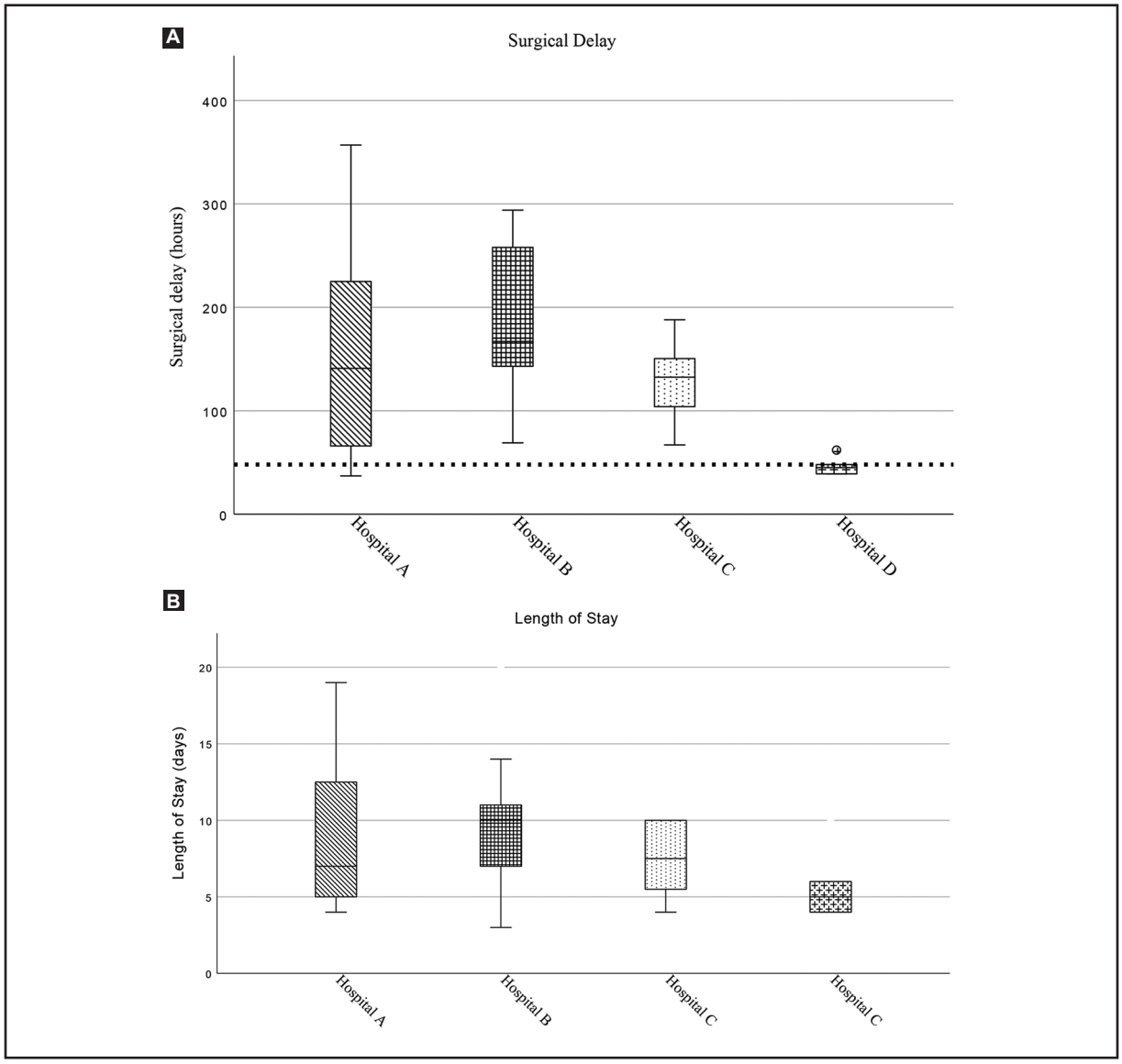

Figure 1. *Surgical delay and hospital stay.* **A:** *surgical delay in hours of each hospital.The dotted line represents the goal of surgery in the first 48 h of hospital stay.* **B:** *hospital stay is shown in days. Both graphs show the minimum and maximum ranges.*

The most frequent fracture in ReMexFC was transtrochanteric with 57%. Spain reported in 2108 a 52% of transtrochanteric fractures[18]; however, Nordic countries have a prevalence of these fractures between 20% and 35%[27]. This difference may be due to the prevalence of Vitamin D deficiency and the latitude of each country[28]. A study in Chile found that intracapsular fractures are associated with Vitamin D deficiency and extracapsular usually have higher levels[29]. Other paper from the Buenos Aires, Argentina found a prevalence of 52% of transtrochanteric fracture[30]. Other studies in Mexico published a prevalence of transtrochanteric fractures between 41 and 83%[31].

The most frequent type of surgery were the DHS system in 42% of the patients, this differs from countries with developed economies in which the use of centromedullary nails is more frequent in transtrochanteric and subtrochanteric fractures[16]. In the case of intracapsular fractures, the NICE recommendations suggest using cemented prostheses or hemiprostheses[10]. In Mexico, most patients with these fractures received DHS and the second most frequent were hemiprosthesis.

Another important KPI that has shown to improve perioperative pain management, decreases opioid use, and postoperative complications is femoral blocking[32,33]. However, in Mexico only 1.9% of patients

Table 3. Key performance indicators, type of surgery, and hospital stay

	General (n = 54)	Hospital A (n = 31)	Hospital B (n = 10)	Hospital C (n = 8)	Hospital D (n = 5)
ER length of stay (h)	54 (3-59)£	50 (41-70)£	1 (0.75-3)£	10 (2.75-30.2)£	3 (2.5-3)£
Surgical delay (h)	140 ± 82.2€	141 (66-226.5)£	183.5 ± 78.3€	128.6 ± 3.8.2€	46.6 ± 9.4€
Surgical delay (days)	5.96 ± 3.4€	6 (3-9.2)£	7.6± 3.1€	5.5 ± 1.6€	2.2 ± 0.4€
Surgery in < 48 h	10 (18.5)	4 (12.9)	1 (10)	-	5 (100)
Type of Surgery					
Total prosthesis	2 (3.7)	1 (3.2)	1(10)	-	-
Hemiprosthesis	15 (27.8)	8 (25.8)	1 (10)	2 (25)	4 (80)
DHS	23 (42.6)	9 (29)	7 (70)	6 (75)	1 (20)
Intramedullary nail	1 (1.9)	1 (3.2)	-	-	-
Cannulated screw	-	-	-	-	-
other∞	11 (20.4)	11 (35.5)	-	-	-
Non-surgical	2 (3.7)	1 (3.2)	1 (10)	-	-
Femoral blockage	1 (1.9)	1 (3.2)	-	-	-
Evaluated by a geriatrician	30 (55.6)	24 (77.4)	1 (10)	1 (12.5)	3 (60)
Sat the day after surgery	19 (35.2)	16 (51.6)	-	-	5 (100)
Weight bearing the day after surgery	4 (7.4)	2 (6.5)	-	-	2 (40)
Osteoporosis treatment after being discharged	23 (42.6)	18 (51.6)	-	1 (12.5)	4 (80)
Length of stay (days)	8.80 ± 4.5€	7 (5-13)£	10.2 ± 4.9€	7.5 ± 2.3€	5.8 ± 2.4€

Values reported in n (%) unless otherwise specified.
ER: emergency room; €: mean ± standard deviation; £: Median (interquartile range or Q1-Q3); ∞: Angulated screw or other less frequent devices; DHS: dynamic hip screw

Table 4. Cause of surgical delay and outcomes in the acute phase and after 30 days of follow-up

	General (n = 54)	Hospital A (n = 31)	Hospital B (n = 10)	Hospital C (n = 8)	Hospital D (n = 5)
Cause of surgical delay					
No theater available	32 (59.3)	22 (71.0)	4 (40)	6 (75)	ND
Material not available	4 (7.4)	2 (6.5)	1 (10)	1 (12.5)	ND
Anticoagulation	1 (1.9)	-	1 (10)	-	ND
Unstable clinical status	5 (9.3)	1 (3.2)	3 (30)	1 (12.5)	ND
Complications					
Delirium	18 (33.3)	13 (41.9)	1 (10)	3 (37.5)	1 (20)
Sore ulcers	16 (29.6)	16 (51.6)	-	-	-
Mortality	4 (7.4)	3 (9.7)	1 (10)	-	-
Outcomes after 30 days of follow-up					
Readmission	5 (11.9)	2 (8.3)	-	2 (33.3)	1 (25)
Mortality	6 (14.3)	4 (16.7)	1 (12.5)	-	1 (25)
Surgical reintervention	3 (7.14)	1 (4.2)	-	1 (16.7)	1 (25)
Indication for surgical reintervention					
Prosthesis luxation	2 (4.7)	-	-	1 (16.7)	1 (25)
Surgical site infection	1 (2.3)	1 (4.2)	-	-	-
Unable to walk	32 (76.2)	19 (79.2)	6 (75)	4 (66.7)	3 (75)
Place of residence					
Home	40 (95.5)	23 (95.8)	8 (100)	6 (100)	3 (100)
Long term care	1 (2.3)	1 (4.2)	-	-	-
Osteoporosis treatment	18 (42.8)	12 (50)	3 (37.5)	-	3 (100)

ND: no surgical delay.
Values reported in n (%) unless otherwise specified.
FAC: Functional ambulatory category

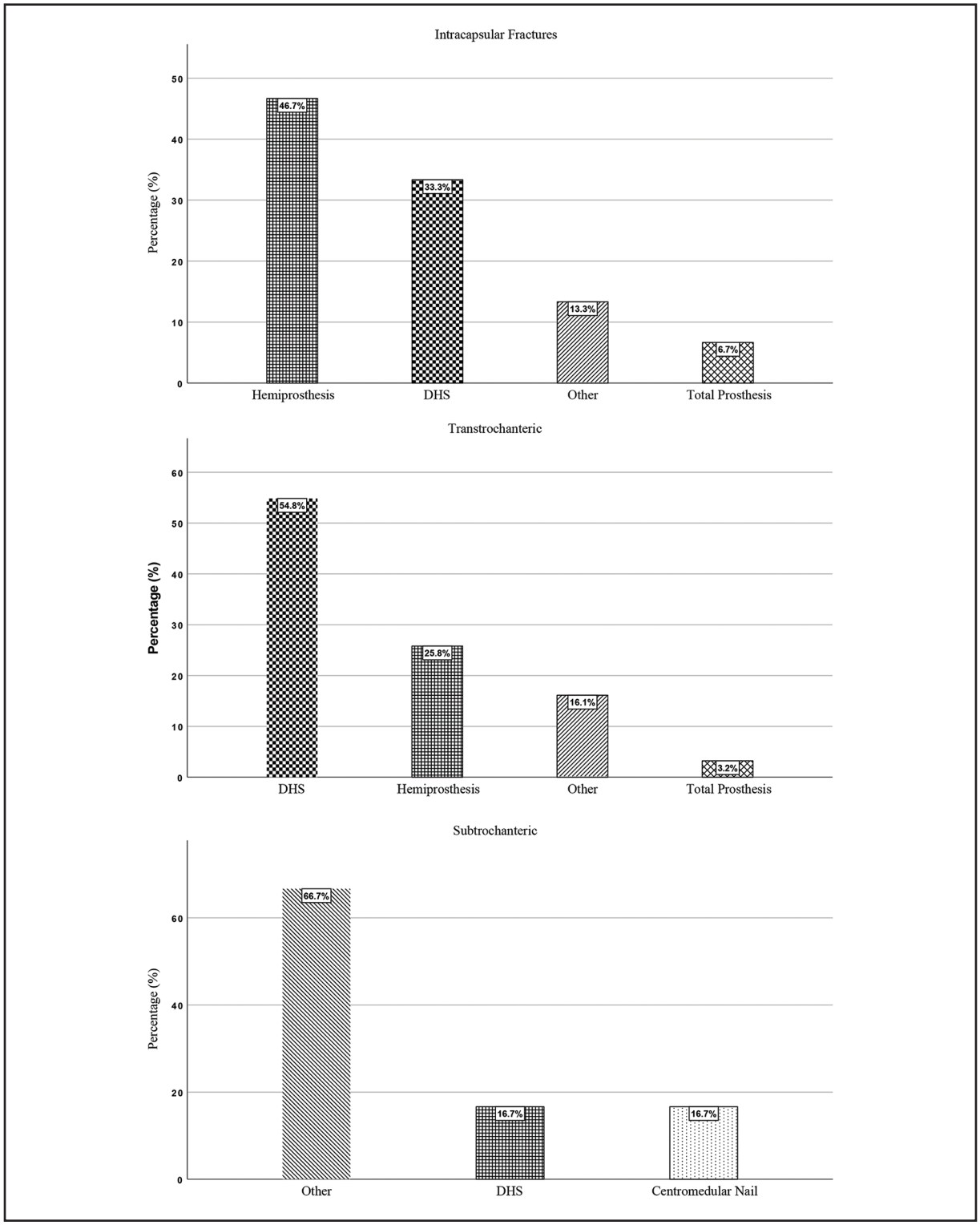

Figure 2. *Type of fracture and implants used. The "subcapital" group includes displaced and non-displaced patients. DHS: dynamic hip screw or sliding hip plate. "Other" includes angular screw and less frequent implants.*

received this type of analgesia. Multidisciplinary teams and the inclusion of the anesthesiologist in the decision-making model could make it more frequent. Within these multidisciplinary teams, the role of the geriatrician has improved delirium, management of comorbidities, and improvement in health-care outcomes[2,34]. However, orthogeriatric units have not yet become widely used in Mexico[35,36]. One of the biases

of this study is that most of the participants are geriatricians and work in HF units, so there are a large number of hospitals without similar co-management models. This makes us think that percentage of patients in assessed by geriatrics is underestimated.

Surgical delay in Mexico is way below the reports of other countries, but unlike them, the main causes are administrative or organizational. Only 18% of patients had surgery in the first 48 h, the rest of patients with delayed surgery, the main cause was due to lack of surgical time. This problem does not always correspond to saturation of the operating rooms, but to the false belief that HF is not an urgent procedure and can be deferred or give more importance to scheduled surgery. At Hospital Gregorio Marañon in Spain 45% of patients underwent surgery in the first 48 h. Of the patients with surgical delay, 60% did not undergo surgery on time due to lack of surgical time[37]. Another study in Alicante, Spain had 49% of patients operated in the first 48 h. From the patients with surgical delay, 54% were due to administrative issues and 46% due to clinical instability[38].

The lack of early mobilization in Mexico, the surgical delay, the lack of standardized processes and orthogeriatric wards which increases KPI, explains the poor health-care outcomes and complications, such as sore ulcers. We noticed important differences between hospitals regarding this complication. This may be explained by internal process and hospital resources. Nevertheless, the general results considering this particular complication are extremely high. If we compare our results with other audits it contrasts enormously, Spain reported sore ulcers in 6.7% and England 4% in their last annual reports[27].

The mean length of stay in ReMexFC was 8.8 days. However, almost six of these days were part of the pre-surgical phase and on average 2 postsurgical days. Other registries have a much higher length of stay, but they have a robust in-hospital rehabilitation period[27], in addition to the model of medium stay wards which facilitate functional recovery[7]. It is a huge point of opportunity. We could increase the in-hospital phase and try to improve mobility and functionality through rehabilitation. This would decrease the medium and long-term complications.

After 30 days of follow-up, we found that mortality was 14%. If we compare it with other countries, it is 2 times those reported in Spain, England, or Ireland[27]. We insist that the lack of compliance to KPI influences that three out of four patients after the first postsurgical month are not able to walk. Another important KPI is osteoporosis treatment, which is a worldwide known problem[39]. In the pilot phase of ReMexFC, 48% have osteoprotective treatment, but there are hospitals with no treatment at all. It would be worth to know in the future the refracture rate of these hospitals.

Finally, one of the last NICE KPI[10] is the return of patients to their homes. In other countries, 25% of surviving HF patients develop a high level of functional decline are admitted to long-term care facilities. In our study, only 2.3% of patients go to this type of health-care models; however, we attribute this phenomenon the lack of these centers, also the sociocultural negative beliefs and stigmata in Mexico about nursing homes.

The main limitations of our study are the sample size, 54 patients are a small universe of patients. Nevertheless, we wanted to have a first phase of a more ambitious project, to know if we would have problems with the digital platform for submitting data. Another limitation is that there were hospitals that were invited but they did not have the authorization in time for being included. We are confident that they will be included in the next year of the audit. Our main strength is that, to the best of our knowledge, this is the first report of a multicenter audit and that the project will continue in the next years, so we are expecting to have a much higher number of HFs.

CONCLUSIONS

The compliance to KPI in HF care Mexico seems to be way below developed countries. This has a negative impact on outcomes. We should develop policies regarding KPI, particularly surgical delay and osteoporosis treatment, which can modify the prognosis and are relatively easy to modify. The audit must continue, and we need to increase the number of hospitals so we could have a more realistic scenario of HF in Mexico.

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CONFLICTS OF INTEREST

The authors declare that they have no conflict of interests.

FUNDING

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ETHICAL DISCLOUSURES

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

Confidentiality of data. The authors declare that they have followed the protocols of their work center on the publication of patient data.

Right to privacy and informed consent. The authors have obtained the written informed consent of the patients or subjects mentioned in the article. The corresponding author is in possession of this document.

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THE JOURNAL OF LATIN AMERICAN GERIATRIC MEDICINE ORIGINAL ARTICLE

Prognostic index for 4-year mortality in older community-dwelling Costa Ricans

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Abstract

Objective: *The objective of the study was to develop a 4-year mortality predictive index for the Costa Rican community-dwelling older people.* **Materials and methods:** *It is an observational cohort study, using the Costa Rican Longevity and Healthy Ageing Study (CRELES) (waves 1, 2, and 3) that includes Costa Rican representative community-dwelling persons at least 60 years old.* **Results:** *Overall mortality was 19% in the development cohort and 17% in the validation cohort. In the development cohort, six independent predictors of mortality were identified and weighted using logistic regression models to create a point scale. Scores on the risk index were strongly associated with 4-year mortality in the validation cohort, with 0-3 points predicting a 4% risk, 4-5 points 14% risk, 6-9 points 23% risk, and 10 or more points a 58% risk.* **Conclusions:** *This 4-year prognostic index, incorporating age, sex, and self-reported functional measures, accurately stratifies community-dwelling elder Costa Ricans at varying risk of mortality.*

Key words: *Mortality. Prognosis. CRELES. Index.*

Pronóstico de mortalidad a 4 años en adultos mayores de la comunidad en Costa Rica: desarrollo de un índice

Resume

Objetivo: *Desarrollar un índice para prevenir la mortalidad a 4 años en personas adultas mayores de la comunidad en Costa Rica.* **Materiales y métodos:** *Se desarrolló un estudio de cohorte observacional utilizando la base de datos del estudio Costa Rican Longevity and Healthy Ageing Study (CRELES) (olas 1, 2 y 3), que incluye una muestra significativa de adultos mayores de la comunidad de 60 años o más.* **Resultados:** *La mortalidad general fue del 19% en la cohorte de desarrollo y del 17% en la cohorte de validación. En la cohorte de desarrollo, se identificaron las seis variables de mayor peso como predictores de mortalidad, con el fin de crear una escala con puntaje. Entre 0-3 puntos, la mortalidad predicha fue del 4%; entre 4-5 puntos, del 14%; entre 6-9 puntos, del 23%, y 10 o más puntos, del 58%.* **Conclusiones:** *El índice de pronóstico desarrollado que incorpora variables como edad, sexo y funcionalidad autorreportada estratifica de forma precisa a adultos mayores de la comunidad en Costa Rica en distintos riesgos de mortalidad.*

Palabras clave: *Índice. Pronóstico. Mortalidad. Costa Rica. Adulto mayor.*

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INTRODUCTION

Estimating patient survival is very important in the decision-making process, especially in frail older people with multiple comorbidities. Patient preferences and life expectancy estimates play an important role when considering chronic disease treatment goals, disease screening such as for colon cancer, interventions such as hemodialysis, or major elective surgeries[1-3]. Life expectancy estimates, goals of care and potential benefits should also be taken into account when prescribing or discontinuing certain medications for chronic conditions. For example, some medications that should not be used in late life are statins, aspirin, or other prescribed for preventive reasons[4]. Regarding cancer screening, the most common tumors in older adults are susceptible to screening. However, the benefit of these interventions is not completely known. Obtaining a prediction of 5-10 year life expectancy is appropriate for screening decisions, considering a time lag to benefit[3].

The American Society of Clinical Oncology (ASCO) guidelines for Geriatric Oncology recommended that clinicians use either the Lee[5] or the Schonberg[6] indices when considering chemotherapy treatments to help determine whether a patient is expected to survive 4 years or more. The variables considered in both indices include age, sex, comorbidities, functional status, health behaviors and lifestyle factors, and self-reported health[7].

Yourman et al. conducted a systematic review of prognostic indexes developed in different countries, under different clinical settings such as community, nursing homes and hospitals, and addressing different morbidities and conditions[8]. Most predictive indexes for community-dwelling elderly populations have been created with data from the United States, Canada, South Korea, Scandinavia, and other developed countries. As others have pointed out, such indexes may only be generalizable to developed countries with similar population structures[9,10]. The 10-year survivability Suemoto index was developed using data from five different cohorts comprising information from 16 developed and developing countries[11].

At this time, early 2020, there are no prognostic indexes specific for community-dwelling older Latin American people. A physician considering chemotherapy for an older Costa Rican person, for instance, is advised to work with a prognostic calculator developed with the Lee index. However, in a previous study, we found that the Lee index does not accurately forecast 4-year survivability for the community-dwelling Costa Rican elderly population, particularly for people 70-85 years old.

The goal of this research is to develop and validate a new prognostic index for 4-year mortality in a cohort of community-dwelling older Costa Rican people. The index is based on demographic and functional measures predictors. We chose functional measures as the basis for our prognostic index for several reasons. First, this information can be gathered directly from the patient without requiring laboratory data or specialized testing. In addition, as other researchers have reported, functional status reflects the end-effect of illness on a patient. Furthermore, patients with worse functional impairments tend to experience negative health outcomes such as hospital readmissions, more extensive and costly healthcare, and death[12,13]. Finally, other prognostic tools have found functional measures to be strong predictors of death[9,14,15].

METHODS

Participants

We used data from the Costa Rican Longevity and Healthy Ageing Study (CRELES, or Costa Rica Estudio de Longevidad y Envejecimiento Saludable) cohort which is described elsewhere[16]. Briefly, CRELES is a cohort constructed in 2005 of approximately 2800 community-dwelling Costa Rica residents drawn from the 2000 population census, who were 60 years or older, selected randomly from across all regional health districts in the country. There was an oversampling of people older than 95 years. Data were collected at baseline in 2005 (Wave1) and subsequent interviews in 2007 (Wave2) and in 2009 (Wave3).

CRELES data included: demographics such as age, sex, marital status, education, number of children, type of housing, and geographic region, self-reported physical health, psychological health, living conditions, health behaviors, health care utilization, social support, and socioeconomic status, and objective measures such as anthropometrics, observed mobility, and biomarkers from fasting blood (such as cholesterol, glycosylated hemoglobin, and C-reactive protein). A full listing of CRELES data can be found elsewhere[16]. Data regarding participants' deaths were collected from interviews of surviving family members and are included in Wave2 and Wave3. Validation

of death was done by linkages to the Costa Rica death registry. The time between Wave1 and Wave3 interviews was approximately 4 years, making the CRELES cohort data suitable for this study.

Measures

Predictors of mortality

We selected the following variables to include in our new prognosis index: age, gender, and self-reported functional status measures at the time of the baseline interview. We categorized age into 5-year intervals: 60-64, 65-69, 70-74, 75-79, 80-84, and ≥ 85. Previous studies have shown that age can be categorized with minimal loss in discrimination[5].

Eleven functional status variables were selected from activities of daily living (ADL), instrumental activities of daily living (IADL), and other measures of physical function. For the purpose of this study, the ADLs included: eating, toileting, bathing, and walking across a room. The IADL's included: shopping, preparing meals, managing medications, and managing finances. Other measures of functional included: walking several blocks, pushing/pulling heavy objects, and climbing stairs.

CRELES interviewers asked whether individuals had no difficulty completing any of the functional tasks. Individuals having no difficulties were classified as independent, and those unable to or needing assistance to complete the task were classified as dependent.

Definition of outcome

Death was detected during the Wave2 and Wave3 follow-up interviews and validated through linkages to the Costa Rican Death Registry. Previous research suggested that the registry is 100% accurate for ages 60 and over[17].

Statistical analyses: model development and validation

The CRELES database was divided into development (75%) and validation (25%) cohorts. The split was random but stratified by regional health districts (Area of Health variable). We measured the bivariable relationship between each risk factor and 4-year mortality in the development cohort using logistic regression models containing only the risk factor of interest. We then constructed a multivariable logistic regression model with the functional status variables, age group, and gender. A final logistic regression model was prepared with statistically significant risk factors ($p < 0.10$). This final model was used to construct a point scoring system. Each predictor in the final logistic regression model was assigned a number of points by dividing its respective β-coefficient by the lowest β-coefficient in the model and rounding up to the nearest integer. We assigned a risk score to each individual by adding the points for each risk factor present.

To validate the index, we applied the point scoring system created in the development cohort to the validation cohort, thereby determining risk scores for each participant in the validation cohort. We assessed the predictive accuracy of the final model by looking at the two components of accuracy: calibration and discrimination. We determined the calibration of the index by comparing the predicted mortality from the development cohort to the observed mortality in the validation cohort. We evaluated the discrimination of the index by calculating the receiver operating characteristic (ROC) curves and C-statistic for the final model in both the development and validation cohorts.

RESULTS

Characteristics of participants

Of the 2826 participants in the CRELES database, 2751 (97.3%) had complete data for the purpose of this study and were included in the study. Of these, 507 (24.6%) died within 4 years. Data from 2063 participants were used for the development cohort and 688 for the validation cohort. The mean (SD) age of participants in the development cohort was 76.2 (10.3) years. Fifty-four percent were women. Nineteen percent were dependent in 1 or more ADL, 37% were dependent in 1 or more IADL, and 68% had difficulty with 1 or more additional measures of physical function. The overall 4-year mortality in the development cohort was 19% (Table 1).

The mean (SD) age of participants in the validation cohort was 76.8 (10.3) years. Fifty-seven percent were women. Nineteen percent were dependent in 1 or more ADL, 40% were dependent in 1 or more IADL, and 67% had difficulty with 1 or more additional measures of physical function. The overall 4-year mortality in the development cohort was 17% (Table 1).

Table 1. Characteristics of patients in development and validation cohorts

Characteristic	Development (n = 2063)		Validation (n = 688)	
	n	(%)	n	(%)
Demographics				
Age, y				
60-64	261	12.7	81	11.8
65-69	371	18.0	116	16.9
70-74	345	16.7	110	16.0
75-79	336	16.3	117	17.0
80-84	316	15.3	99	14.4
≥ 85	434	21.0	165	24.0
Male	945	45.8	299	43.5
Functional Measures				
Activities of daily living difficulty				
Bathing	326	15.8	103	15.0
Eating	150	7.3	46	6.7
Toileting	244	11.8	76	11.0
Walks across room	253	12.3	73	10.6
Instrumental activities of daily living difficulty				
Shopping	676	32.8	239	34.7
Preparing meals	518	25.1	174	25.3
Managing medications	512	24.8	184	26.7
Managing finances	446	21.6	147	21.4
Other measures of functional status difficulty				
Walking several blocks	994	48.2	338	49.1
Pushing or pulling heavy objects	944	45.8	308	44.8
Climbing stairs	1294	62.7	415	60.3

Bivariable results

Bivariable analyses indicate that all functional status risk factors under consideration are associated with 4-year mortality ($p < 0.05$) (Table 2).

Multivariable results

Thirteen risk factors were used as independent variables to create a logistic regression model to predict 4-year mortality: age (treated as a categorical variable with 6 labels), sex, and the eleven functional status variables. Eight risk factors were positively associated with 4-year mortality after multivariable analyses, including age, gender, dependence in bathing, eating, shopping, preparing meals, handling medications, and difficulty walking several blocks (Table 3).

Point scoring system

Risk stratification by points

The points assigned to each of the final 12 predictors are listed in Table 3. A risk score was calculated for each participant by adding the points for each risk factor present. For example, a 78-year-old (2 points) man (1 point) with difficulty shopping (1 point) would have a total risk score of 4 points. Development cohort risk scores ranged from 0 to 14, with a mean of 4.8 and SD of 3.7. Validation cohort risk scores ranged from 0 to 14, with a mean of 4.9 and SD of 3.6.

The point score effectively divided the cohort into groups at varying risk of 4-year mortality. In the development cohort, the mortality risk ranged from 6% in those with 0 to 3 points, 12% in those with 4 or 5 points, 27% in those with 6-9 points, and 61% in those with 10 or more points. In the validation cohort, the mortality risk ranged from 4% in those with 0 to 3 points, 14% in those with 4 or 5 points, 23% in those with 6 to 9 points, and 58% in those with 10 or more points (Fig. 1 and Table 4). The point-based index showed excellent discrimination, with a C-statistic of 0.82 in the development cohort and 0.83 in the validation cohort.

When the point score (excluding the points assigned to age) was evaluated in different age groups, we found that our index discriminated well in all 3 of the age subgroups (60-69, 70-79, and ≥80) with C-statistics ranging from 0.70 to 0.76.

Table 2. Risk factors and 4-year mortality bivariable association in the development cohort

Risk factor	No. of Deaths	(%)	Odds Ratio (95% CI)
Age, y			
60-64	12	4.6	1.0
65-69	28	7.5	1.7 (0.9-3.4)
70-74	38	11.0	2.6 (1.3-5.0)
75-79	43	12.8	3.0 (1.6-5.9)
80-84	78	24.7	6.8 (3.6-12.8)
≥ 85	191	44.0	16.3 (8.9-30.0)
Sex			
Female	199	17.8	1.0
Male	191	20.2	1.2 (0.9-1.5)
Functional measures			
Bathing			
Independent	208	12.0	1.0
Dependent	182	55.8	9.3 (7.1-12.1)
Eating			
Independent	292	15.3	1.0
Dependent	98	65.3	10.5 (7.3-15.0)
Toileting			
Independent	252	13.9	1.0
Dependent	138	56.6	8.1 (6.1-10.8)
Walks across room			
Independent	247	13.6	1.0
Dependent	143	56.5	8.2 (6.2-10.9)
Shopping			
Independent	112	8.1	1.0
Dependent	278	41.1	8.0 (6.2-10.2)
Preparing meals			
Independent	142	9.2	1.0
Dependent	248	47.9	9.1 (7.1-11.6)
Managing medications			
Independent	152	9.8	1.0
Dependent	238	46.5	8.0 (6.3-10.2)
Managing finances			
Independent	175	10.8	1.0
Dependent	215	48.2	7.7 (6.0-9.8)
Other measures of functional status			
Walking several blocks			
No difficulty	82	7.7	1.0
Difficulty	308	31.0	5.4 (4.2-7.0)
Pushing or pulling heavy objects			
No difficulty	105	9.4	1.0
Difficulty	285	30.2	4.2 (3.3-5.3)
Climbing stairs			
No difficulty	55	7.2	1.0
Difficulty	335	25.9	4.5 (3.4-6.1)

DISCUSSION

We developed and validated a prognostic index using age, gender, and self-reported functional status that effectively stratifies community-dwelling Costa Rican elders into groups at varying risk of 4-year mortality. For example, individuals with scores of 3 points or less have low (< 6%) risk, while individuals with 10 points or more have a significantly higher (> 50%) risk of mortality in 4 years. Our index also shows good predictive capability across specific subgroups based on age.

The index exhibits good calibration based on the similarity between mortality rates for different ranges of risk in the development and validation cohorts. C-statistics of 0.82 in the development cohort and

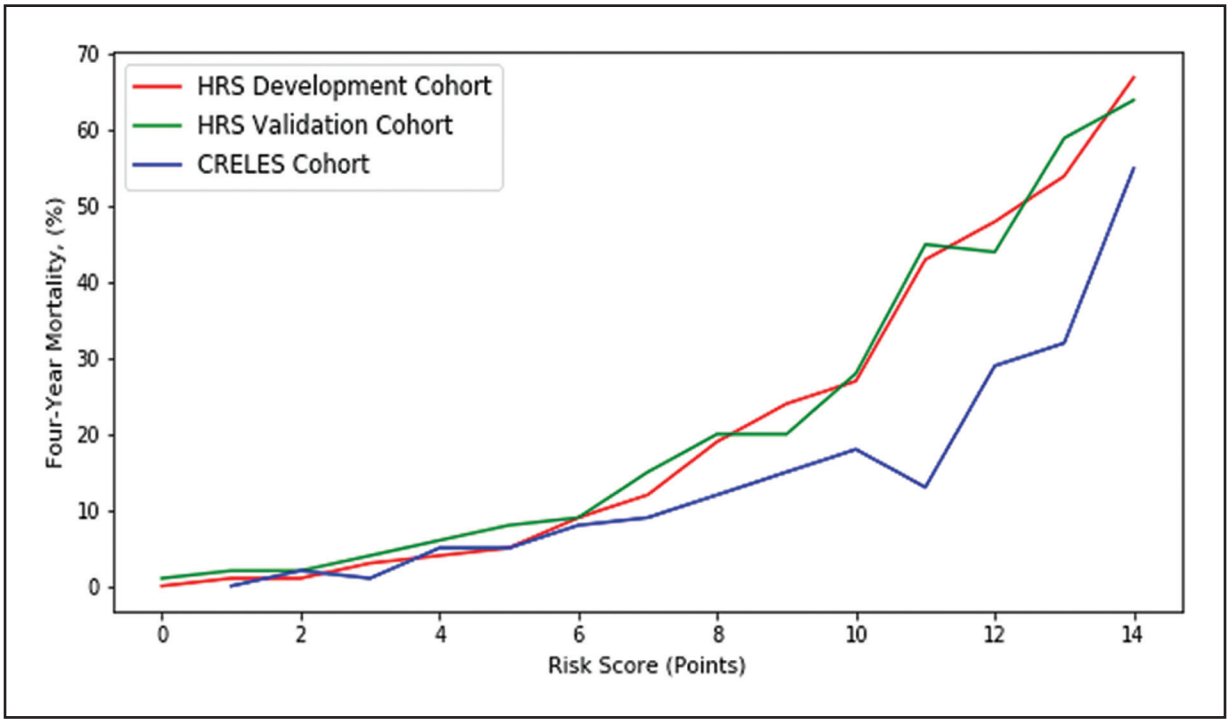

Figure 1. *Four-year mortality by risk score: Development and validation cohorts. Reported by Cohort Database.*

Table 3. Independent risk factors for 4-year mortality in the development cohort in the multivariable analysis

Risk factor	Points
Age, y	
65-69	1
70-74	2
75-79	2
80-84	4
≥ 85	4
Male gender	1
Dependence in bathing	2
Dependence in eating	2
Dependence in shopping	1
Dependence preparing meals	1
Dependence managing medications	2
Difficulty walking several blocks	1

0.83 in the validation cohort indicate that the index also has good discrimination. The discrimination was comparable to indices considering multiple domains of risk, including self-reported comorbidities and behavioral risks[5,12].

The tool's prognostic value provides further evidence for the importance of assessing functional status as it reflects the end-impact of illnesses and psychosocial factors on a given patient. Our index includes risk factors from each of the three groups of functional variables evaluated: dependence in ADL (bathing, eating), dependence in IADL (shopping for groceries, preparing meals, managing medications), and difficulty with additional measures of physical function (walking several blocks). The results of our study coincide with other researchers' findings regarding the prognostic value of functional status[9,12].

In the bivariable analyses, every functional variable under consideration was associated with a 4-fold or greater increase in mortality. Functional variables that remained independently predictive of mortality in the final multivariable model evaluate multiple areas of function simultaneously. For instance, unassisted grocery shopping is a complex task that requires cognitive and physical functioning to identify a need, get to the store, reach for items, push a cart or lift a basket, manage money for payment, and carry. Likewise, bathing requires the ability to walk in a room, turn knobs, handle soap, and dress/undress oneself.

CONCLUSION

Our index is the first 4-year prognostic index developed specifically and exclusively with a database

Table 4. Four-year mortality rates by risk score

Risk score	Development cohort			Validation cohort		
	Group size	Deaths	Percent	Group size	Deaths	Percent
0-3	1032	63	6	327	12	4
4-5	347	40	12	125	17	14
6-9	383	102	27	139	32	23
≥ 10	301	185	61	97	56	58

of Costa Rican –and in fact, Latin American, older people. Hence, it can more accurately forecast 4-year survivability for the Costa Rican elderly population. For clinical purposes, our index may be useful in identifying both high- and low-risk patients so that specific interventions can be targeted to each group. The index can help identifying older low-risk patients that may benefit from cancer screening, as well as younger high-risk patients for whom the benefits of screening are outweighed by the harms.

ARTICLE INFORMATION

Contributions

Both authors had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

Study concept and design: GV and LV

Analysis and interpretation of data: LV

Drafting of the manuscript: GV and LV

Critical revision of the manuscript for important intellectual content: GV and LV

Statistical analysis: LV

Administrative, technical, or material support: GV and LV.

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CONFLICTS OF INTEREST

None reported.

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ETHICAL DISCLOSURES

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

Confidentiality of data. The authors declare that they have followed the protocols of their work center on the publication of patient data.

Right to privacy and informed consent. The authors declare that no patient data appear in this article.

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THE JOURNAL OF LATIN AMERICAN GERIATRIC MEDICINE ORIGINAL ARTICLE

Teaching of geriatrics and gerontology in Latin America and the Caribbean

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Abstract

Objective: *Important differences are identified in the teaching of geriatrics and gerontology in schools and medical schools in Latin America and the Caribbean.* **Materials and methods***: Observational, descriptive, and cross-sectional study. A descriptive survey was carried out applied in two ranges of dates, the first in 2019 and the second in 2020. The data obtained from one of the authors (Dr. Fernando Morales-Martinez) survey in 2004 during the courses of the Latin American Academy of Medicine for the Elderly (ALMA, 2004) are compared with those of the Association Latin America of Faculties and Schools of Medicine (ALAFEM, 2020).* **Results:** *A response was obtained from 33% of the faculties and schools of ALAFEM. The current conditions of teaching and services of geriatrics and gerontology in Latin America and the Caribbean are evident.* **Conclusions:** *The challenges for the Latin American region are great. Actions are urgently needed to improve the quality of life of current and future older adults.*

Key words: *Demographics. Results. Achievements. Geriatrics. Medical education. Challenges.*

Enseñanza de la geriatría y la gerontología en Latinoamérica y el Caribe

Resumen

Objetivo: *Se identifican diferencias importantes en la enseñanza de la Geriatría y la Gerontología en las escuelas y facultades de medicina de Latinoamérica y el Caribe.* **Material y métodos:** *Estudio observacional, descriptivo y transversal. Se realizó una encuesta descriptiva aplicada en dos rangos de fechas, la primera en el año 2019 y la segunda en el año 2020. Se comparan los datos obtenidos de una encuesta realizada por uno de los autores (Dr. Fernando Morales Martínez) en el año 2004 en los cursos de la Academia Latinoamericana de Medicina del Adulto Mayor (ALMA, 2004) con los de la Asociación Latinoamérica de Facultades y Escuelas de Medicina (ALAFEM, 2020).* **Resultados:** *Se obtuvo respuesta de un 33% de las facultades y escuelas de ALAFEM. Se evidencian las condiciones actuales de la enseñanza y de los servicios de Geriatría y Gerontología de Latinoamérica y el Caribe.* **Conclusiones:** *Los retos para la región latinoamericana son grandes. Urgen acciones en la docencia con el objetivo de aumentar las mejoras en la atención integral del adulto mayor actual y del futuro.*

Palabras claves: *Demografía. Resultados. Logros. Geriatría. Educación médica. Retos.*

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INTRODUCTION

The aging population is a worldwide phenomenon that has affected, in an accelerated manner, the Latin American countries through the last 50 years. Costa Rica is the first country in Latin America with the highest life expectancy rate. Costa Rica also has a percentage of elderly people which characterizes it as an aged country. This tendency, toward an accelerated ageing population, forces government and non-government organizations to develop strategies to solve this group's needs.

Against this background, the teaching of geriatrics and gerontology is one of the most important pillars in the formation of medical professionals[1]. Geriatrics represents the medical specialty with the capacity to advise the development of effective-attention systems that cover the necessities of the elderly in all aspects (psychosocial, medical, recreational, political, and environmental).

"According to United Nations estimates, in 2017, there were 76.3 million of elderly people in Latin America and the Caribbean, which represents 12% of the total population for the region. By 2030, there will be 121 million elderly, representing 17% of the total population. By 2060, this percentage will ascend to 30% and a population of 234 million elderly"[2] (Figs. 1 and 2).

The recently finished XX century witnessed an unprecedented event that radically changed the coexistence of developing countries, their economic perspective, and the development of social protection systems: the demographic transition caused by the aging population[3].

The dawn of the XXI century contemplates this same phenomenon in developing countries. Right now, 60% of the elderly live more than 60 years in these countries. By 2025, this percentage will ascend to 75% which means that 3 out of every 4 elderly will live in developing countries.

Regarding the health field, the consequences of an ageing population are especially evidenced. This is due to the coincidence, alongside the demographic transition, of epidemiological changes that have replaced infectious diseases for non-infectious diseases, commonly chronic, linked to certain lifestyles that are preferred by the elderly. This way, as they age, not only is there more elderly, but there is also a greater need for health services. However, even though larger parts of the ill are elderly, aging and illness cannot be put on the same level because many elderlies do not suffer major illnesses during this stage of life.

In this context, the elderly have begun to predominate among the patients who, up to now, are being attended by Latin American medical doctors. This will constitute the majority of whom will have to be attended to soon.

Objective

The objective of this study is to acknowledge the fundamentals of modern geriatrics and consider it in the process of teaching-learning, especially at the university level in Latin America and the Caribbean.

Materials

Modern Geriatrics comes from the word "geriatrics" (from the Greek geras = ageing and atrics = curing) coined by Doctor Ignatz Leo Nascher who realized various papers on the topic, including "Geriatrics: the illnesses of the elderly and their treatment" in 1914. Afterward, in 1930, at the Middle Essex Hospital of the United Kingdom, Dr. Marjorie Warren showed that many disabled elderly who were considered irrecoverable benefited from clinical and rehabilitation care given, being able to return to their family and community.

In 1964, Dr. James Williamson, professor of Geriatrics at the University of Edinburgh, Scotland in important and historic publishing, described the unregistered necessities of the elderly, identified their health threats, and showed how the welfare of this population group was being ignored. Dr. Williamson also documented heart and neurological problems, incontinences, joint problems, and osteopathies, as well as mobility, visual, auditive, mental, social, living, and financial problems.

In 1965 the first Department of Geriatrics at the University of Glasgow, Scotland was opened with Dr. Sir Ferguson Anderson giving birth to Modern Geriatrics by use of an integral assessment by the interdisciplinary team with the idea of considering the elder person in his or hers medical, psychic, functional, and social aspects.

Even though, in 1959, in point 8.2 of the World Health Organization (WHO) report that stated: "in the academic programs of the Medicine and Nursery Faculties a very important place has to be given to the aging problems;" it was not until 1975, according to report number 507 when the WHO would favor of the development of a specialized medical branch that would attend the elderly.

In 1982, by summoning from the United Nations, the first World Assembly of Ageing was held. Twenty years later, in 2002, the second World Assembly of Ageing

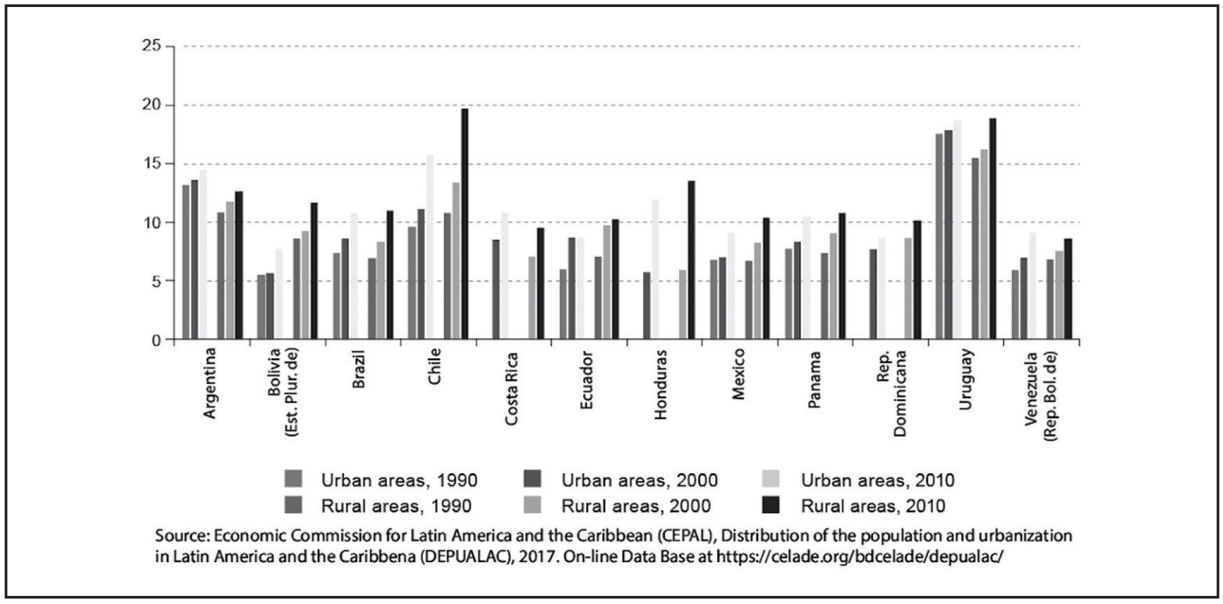

Figure 1. *Latin America and the Caribbean (12 countries): population 60 years or more in urban and rural areas, 1990, 2000, 2010 census (percentages). Source: Aging, elderly, and 2030 agenda for sustainable development: regional perspective and human rights. Mexico: CEPAL, 2018, p. 58.*

was held. On that forum, the bases for the training and execution of programs in the benefit of the elderly.

The basis for training programs on Geriatrics and Gerontology around the world were first outlined on the WHO World Report on Age and Health in October 2015.

FUNDAMENTALS OF MODERN GERIATRICS

Elements of the integral attention network

The focus of attention in Geriatrics allows to assess the problems of the elderly in all aspects of life. This permits a recovery that not only involves the stabilization or resolution of physical illnesses but also the integration of the elderly to his or her family and community most independently. It also includes an opportunity for the family to actively participate in the illness process of their elderly member, which means better home-care attention.

By integrating different aspects of the individual, a better quality of life and functionality is achieved. This is a result from a successful intervention than that that only sees the biological aspects of the illness.

Integral assessment network service

Geriatric assessment goes further than the health establishment (Figure 3). It should involve informal community networks as part as progressive attention for the elderly, not only on the patient's regard, that complements the formal health attention with recreational resources and basic community care (day-care centers, clubs, among others) but also in aspects of promotion and prevention of health. Geriatrics and gerontology promote the organization and formation of these supporting resources, basically, on the attention that is given to the elderly[4].

Formative and investigation aspects

Investigation regarding the elderly must be encouraged in all aspects, from the medical to the gerontological. It is required to:

- Foment the study of the aging process in its biological, psychological, and social aspects
- Emphasize the study and assessment of the great geriatric syndromes
- Promote the study of the most prevalent pathologies adapted to the specifics of the elderly and the national epidemiology
- Integrate the functional condition as an essential aspect in the assessment of the illnesses that affect the elderly
- Train students in the organization of different kinds of geriatric attention
- Teach students in the development and involvement of educational programs on elderly caring for the patients, families, and community
- Develop basic skills on the student for the realization of research regarding the elderly

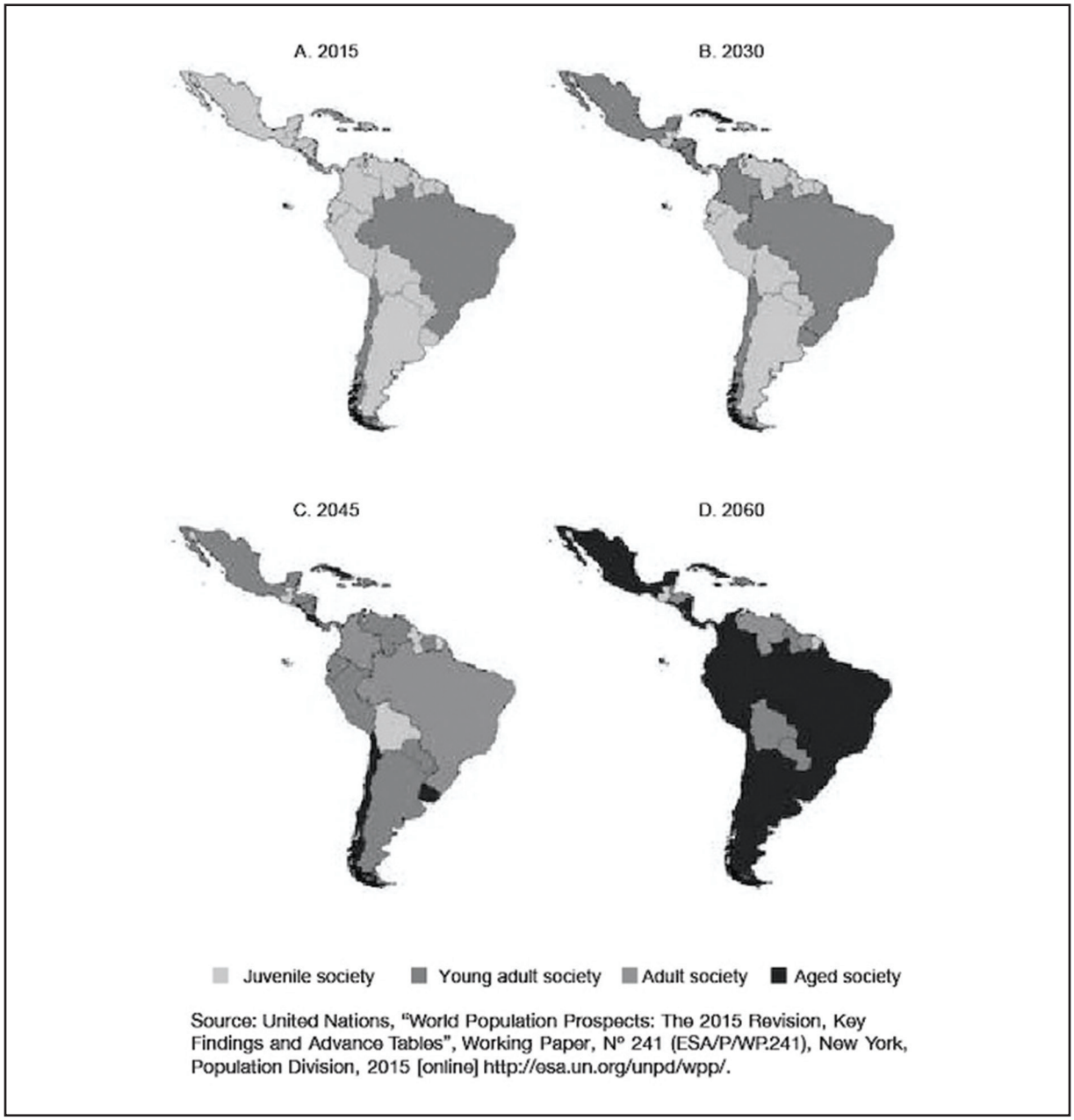

Figure 2. *Latin America and the Caribbean; transformation of the age population structure, 2015-2060. Source: Ageing, elderly, and 2030 agenda for sustainable development: regional perspective and human rights. Mexico: CEPAL, 2018, p. 36.*

- Encourage research and investigation on geriatrics
- Develop skills on the student regarding interdisciplinary teamwork

An example of academic achievements is what Costa Rica has accomplished in the graduate and postgraduate formation in geriatrics and gerontology, as shown in Table 1.

There are also fellowships that health-care professionals from different countries in Latin America, United States, and Europe have taken through the collaborative center of the WHO-PAHO (2008-2020) (Table 2). The table shows the distribution by country of the professionals that have realized the fellowship at the National Geriatrics and Gerontology Hospital.

To determine the state of teaching in geriatrics and gerontology in the rest of Latin America and the Caribbean, Dr. Fernando Morales-Martinez, realized an exploratory study in 2004 partnered with the Latin American Academy of Elderly Medicine (ALMA) 12 countries were analyzed to understand the reality of training and the services of geriatrics and gerontology which are shown in Table 3.

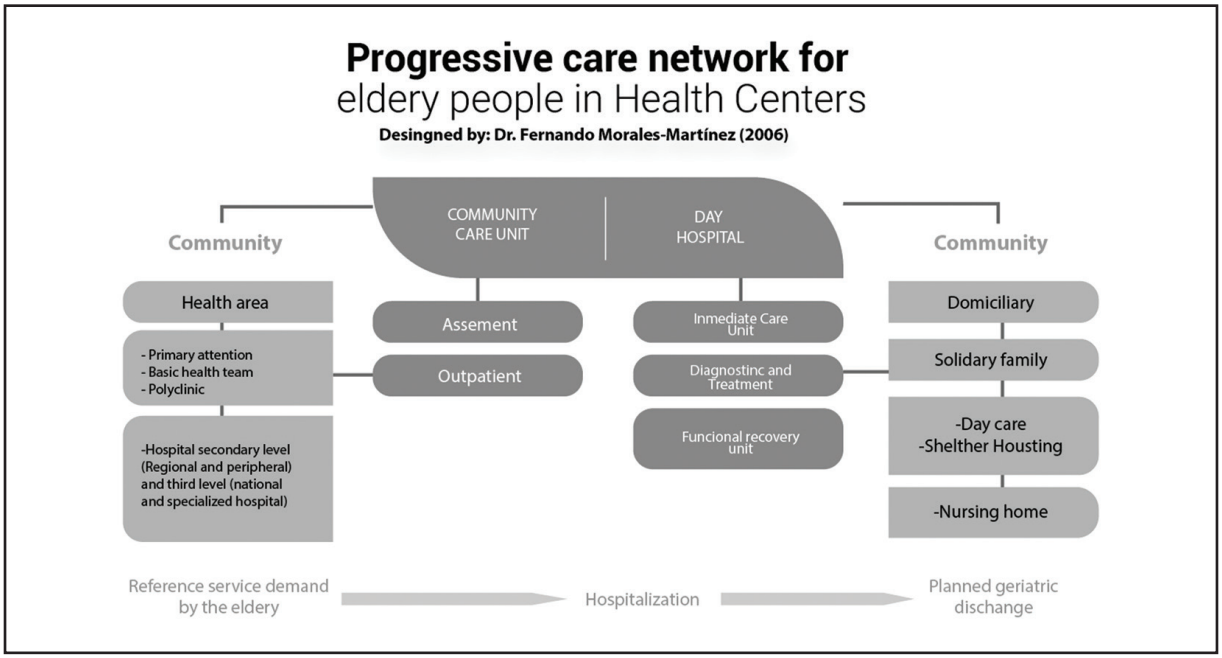

Figure 3. *Attention systems for the care of the elderly in hospitals. Source: Principles and Practice of Geriatric Medicine, Pathy. J, 2006.*

Table 1. Training program, National Hospital of Geriatrics and Gerontology 1984-2019 University of Costa Rica

Program	Total
Graduated Geriatricians (5 year program)	142
Residents of Geriatrics and Gerontology (currently on training – 5 years)	57
Residents of Family and Community Medicine (Geriatric training–4 months)	186
Geriatric update courses for general practitioners (National geriatrics week and Congress, 40 hrs)	4805
Fellowships at the Collaborative Centers WHO/PAHO (latín american countries) (1 to 3 months)	112
Latín American Academy of Elderly Medicine (ALMA) (Costa Rican graduates)	21
Undergraduate course University of Costa Rica (Physiopathology, Internal Medicine I, Geriatrics and Gerontology I and II, Internship, 1999-2019)	3004

Source: National Geriatrics and Gerontology Hospital, University of Costa Rica, 1984-2019

Table 2. Distribution by benefited countries rotating at National geriatrics and Gerontology Hospital

Country	Medical doctors n	(%)
Bélgium	4	3,6
Canada	12	10,7
Chile	10	8,9
China	12	10,7
Colombia	2	1,8
Cuba	2	1,8
Dominican Republic	2	1,8
Ecuador	11	9,7
El Salvador	1	0,7
Guatemala	25	22,2
Mexico	4	3,6
Nicaragua	5	4,2
Panama	10	8,7
Peru	7	6,2
United States of America	6	5,3
Total	112	100

Source: Collaborative Center WHO/PAHO, National Hospital of Geriatrics and Gerontology, 2018.

The results of the study concluded that most countries had partial effective training in geriatrics, taking into account the presence of specialized services in the region. When health and care centers are considered, a variety of answers are presented, ranging from specialized hospitals, care centers, and the presence of caregivers. The results evidence the vision that each country has regarding specialized health for the elderly.

Table 3. Availability of training and services of Geriatrics on participating countries, 2004

Country	University formation on geriatrics	Geriatric unit	Department of geriatric medicine	Geriatric hospital	Care center	Caregivers
Argentina	Yes	Yes	Yes	No	Yes	Yes
Brasil	Yes	Yes	Yes	No	Yes	Yes
Costa Rica[b]	Yes	Yes	Yes	Yes	Yes	Yes
Colombia	Yes	Yes	Yes	No	Yes	Yes
Cuba	Yes	Yes	Yes	Yes[a]	No	Yes
Ecuador	Yes	Yes	Yes	Yes[a]	No	Yes
El Salvador	Yes	Yes	No	No	No	Yes
Mexico	Yes	Yes	No	No	Yes	Yes
Panama	Yes	Yes	Yes	Yes	No	Yes
Peru	Yes	Yes	Yes	No	Yes	Yes
Uruguay	Yes	Yes	Yes	No	No	No
Venezuela	Yes	Yes	No	No	Yes	Yes

Survey realized by Dr. Fernando Morales-Martinez (2004). aOnly acute care service for the elderly. Costa Rica has a Geriatric hospital with specialized service. (Day-care hospital, homecare, and in-patient service). Geriatricians with university training in recognized academic centers. P. 1995.

METHODS

During the Latin American Congress of Medicine Schools and Faculties (ALAFEM) 2020 and the first Central American and Caribbean Medical Education Congress, it was decided that the present study be done. ALAFEM assembles the main schools and faculties of medicine of the region. Its objective is to encourage, strengthen, and update all academic programs that each country offers. This congress was held at the Faculty of Medicine of the University of Costa Rica in March 2020. It was decided to realize a comparative and updated study to understand the progress and academic reality of the different countries of Latin America. The recollected information was compared with the previous study done in 2004.

The research instruments used for this study were an applied descriptive survey with two date ranges: the first from December 2019 through February 14, 2020. The second range of dates for the application of the descriptive survey ran through May 2020, after the ALAFEM 2020 Congress.

RESULTS

There were 21 participant countries that answered the survey. Countries included Brazil, Colombia, Costa Rica, Ecuador, United States, Guatemala, Honduras, Mexico, Nicaragua, and Peru; all associated countries to ALAFEM. To acknowledge the actual conditions of training and the services of geriatrics and gerontology in Latin America, a total of 20 complete surveys were received out of 64 institutions, representing an approximate total of 33% of all affiliated to ALAFEM (Table 4).

Results show that there are countries that have had notable development in training programs mainly due to the extension of related topics in official graduate and postgraduate programs. Countries that have shown progress include Costa Rica, Mexico, and United States. The results also allow for the presentation of a proposal for the inclusion and strengthening of topics on geriatrics in academic programs and formation of general medicine in the Latin American region.

Proposal: an educational approach requires

The formation of university students, especially in medicine, has to take into account general professional skills such as:

- Learn to learn
- Integrate and expand knowledge
- Communication
- Think and reason critically
- Relate with the health team and society
- Responsibility of themselves, their learning, and their social role

The training of specialized disciplines such as geriatrics requires an improvement of the capability of every postgraduate student to elaborate on the

Table 4. Geriatric and Gerontology Education in Latin America and the Caribbean, 2020

University of Costa Rica, ALAFEM Congress, 2019-2020

Country	¿Do you have a Geriatric and Gerontology Hospital?	¿How many Geriatric and Gerontology specialists do you have in your country?	¿In your country, what is the ratio of Geriatricians per 1000 elderly?
Brazil	No	More than 400	1 geriatrician per every 15.000 elderly
Colombia	No	From 51 to 199	1 geriatrician per every 15.000 elderly
Guatemala	Yes	Less than 50	1 geriatrician per every 10.000 elderly
Honduras	No	Less than 50	Only 4 geriatricians for the entire country
Mexico	Yes	More than 40	1 geriatrician per every 10.000 elderly
Nicaragua	No	Less than 50	1 geriatrician per every 15.000 elderly
Peru	No	From 51 to 199	1 geriatrician per every 15.000 elderly
Costa Rica[a]	Yes	From 51 to 199	1 geriatrician per every 4.500 elderly
Panamá	Yes	Less than 50	1 geriatrician per every 32.000 elderly
United States	Yes	Dk/Dr	Dk/Dr

Source: Survey realized by the Faculty of Medicine of the University of Costa Rica (2019-2020).

comprehensive geriatric assessment and to realize the physical and mental examination of the elderly patient as well as to be able to evaluate their functional capability and the social resources available. Other capabilities have to be created on the student that allows them to use the information to formulate a differential diagnosis, identify the problems that the patient presents and elaborate a comprehensive and integral plan for their attention and control. Finally, the student must learn to understand the need to work as part of an interdisciplinary team to be able to fully assess the elder patient.

Within the objectives that each program that expects to train students as geriatricians is the support on the training of the following concepts and capabilities:

- Demographic and epidemiological aspects of aging and its implications
- The normal ageing process and its relationship with illness and disability of the elderly, the difference between aging, illness, and functional impairment.
- The natural history of frailty and dependence, its manifestations, etiology, and means of prevention
- Forms of presentation of illnesses in the elderly
- Assessment of the illness and disabilities of the elderly
- Interaction between physical, social, and mental factors in the generation of disability
- Fundamentals of assessment of the elderly and the importance of care continuity and early interventions
- Appropriate use of medications
- Importance of rehabilitation
- Caring of patients with chronic illnesses
- Caring of patients terminally ill
- The value of interdisciplinary teamwork
- Necessary resources and organization of a Geriatric Care Unit
- Promotion of active and healthy aging.

To help transmit a positive image of aging and of geriatric medicine, it is convenient that all students take the opportunity to observe and discuss assessment issues of the elderly in out-patient, in-patient, homecare, and community care.

As mentioned before, to achieve the goals, at the School of Medicine of the University of Costa Rica, a composite, theoretical-practical, 2 semester courses on geriatrics in the 5th year of undergraduate studies in medicine is taught. In schools of medicine of other countries, such courses are not compulsory. This results in limited topics and training, making them mostly theoretical.

Regarding the tutors, these must meet other conditions, such as:

- Having received formal training in geriatrics
- Be able to summarize and transmit knowledge
- Be able to work as part of an interdisciplinary team
- Be able to do research and evaluate them

All tutors must comply at least with the first two requirements from the previous list. However, it is desirable that they also meet the latter two of that list. The necessities of qualified tutors in geriatrics and gerontology must be covered gradually. There is a need to train tutors in other schools and faculties of medicine in this discipline to strengthen and expand the educational programs.

The specialty program, from the methodological standpoint, stands out as a dynamic process where learning by doing is a fundamental core.

The student by "doing" of the tutor-doctors, learns procedures, discusses concepts, assesses differential diagnosis, analyzes, and evaluates results. The thinking process that they develop responds to higher levels of clinical cognitive difficulties as it should be expected from a medical specialist in a determined health area.

The support of the medical-tutors becomes an interactive way to learn alongside the student, creating a mutual teaching-learning experience that allows professional, scientific growth for both actors.

The specialty program evolves around the training concept of clinical learning with the support of the tutors who define the topics of study, references to discuss, and clinical practice. The capability of clinical decision making by active and constant supervision is always favored.

Teaching with practical activities means working with specific cases instead of formal theoretical lectures that always conduct toward a systematic evaluation of performance.

It is important to mention that the maximum learning and advantages of geriatric teaching depend on the interest that the students present in his or hers proper preparedness, topic revisions, special case interest as well as thoughts on the matter.

Finally, the general medical education, particularly in geriatrics, should be always ready to change and face the challenges that society brings forth.

DISCUSSION

It is evident that a major effort in the academic offer in this field is required pursuant to the great demographic and epidemiological changes that the Latin American population is experiencing. This makes urgent all notable efforts that translate into benefits for the integral attention and quality of health services for the elderly.

The challenges for every country are great and urgent. It is necessary to articulate all efforts to make them a reality o increase the quality of life for all elderly now and in the future.

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CONFLICTS OF INTEREST

The authors claim no conflicts of interest.

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ETHICAL DISCLOSURES

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

Confidentiality of data. The authors declare that no patient data appear in this article.

Right to privacy and informed consent. The authors declare that no patient data appear in this article.

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THE JOURNAL OF LATIN AMERICAN GERIATRIC MEDICINE REVIEW ARTICLE

Review of treatment goals in modifiable risk factors for dementia

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Abstract

Dementia has become a health priority issue due to its social, economic, and clinical impact in families, countries, and health systems. In consequence, and due to the absence of effective treatments, prevention and management of risk factors is fundamental. The intervention toward not only a single risk factor but to an individualized combination, will bring the most benefit. In early life, education is the modifiable risk factor to target; it is known that < 6 years of education leads to increased dementia risk. In midlife, hearing loss, hypertension, obesity, and physical inactivity are well-established factors. At last, in later-life, diabetes, smoking, depression, and social isolation have demonstrated an increased risk of developing dementia. Some are still controversial such as dyslipidemia. In this review, we will study the most recent recommendations and evidence about modifiable risk factors on the prevention and management of dementia.

Key words: *Risk factors. Dementia. Cognitive impairment.*

Revisión sobre las metas de tratamiento en factores de riesgo modificables para demencia

Resumen

La demencia representa una prioridad en salud en el mundo debido a su impacto en los aspectos sociales, económicos y clínicos de las familias, países y sistemas de salud. Por lo anterior, y ante la ausencia de tratamientos curativos, es importante conocer las medidas de prevención y tratamiento de los factores del riesgo modificables. La intervención, no solo hacia un factor de riesgo único sino hacia una combinación individualizada, traerá un mayor beneficio. En la etapa temprana de la vida, el principal factor de riesgo modificable es la baja escolaridad, con mayor riesgo asociado a haber cursado menos de 6 años. En la etapa intermedia de la vida, hipoacusia, hipertensión, obesidad y sedentarismo son los principales factores de riesgo modificables; y en edad avanzada, diabetes, tabaquismo, depresión y el aislamiento social. Otros factores, como el control estricto de la dislipidemia, resultan aún controversiales. Esta revisión pretende analizar las recomendaciones actuales respecto al control de los factores de riesgo modificables para la prevención del deterioro cognitivo y la demencia en las diferentes etapas de la vida, así como su tratamiento en este grupo de pacientes.

Palabras clave: *Factores de riesgo. Demencia. Deterioro cognitivo.*

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INTRODUCTION

Dementia has become a health priority issue. According to the World Health Organization (WHO), around 50 million people are living with dementia worldwide, with the number of people burdened with the disease expected to increase by 2030 and 2050 to 82 million and 152 million, respectively, with a growth ratio of 10 million new cases per year[1]. In Mexico, by 10/66 Dementia Research Group, there is an estimated prevalence of 7.4-9.0%[2], with the Encuesta Nacional de Salud y Nutrición (ENSANUT) 2012 reporting prevalence of 7.3%, with an incidence of 27.3 cases per 1000 person-years[3].

It is important to remember that the diagnosis of dementia not only affects the patient but also their families, society, and health systems, due to the economic toll it has. Due to the lack of a curative or effective treatment to delay the progression, it is vital to focus on preventive measures.

Unlike other chronic illnesses, dementia patients require additional care since the early stages of the disease, since the patient often suffers from other comorbidities, increasing health care costs up to 300%. By 2018, the global cost of dementia was estimated to be US$1 trillion annually, being the non-medical care the grossest[4].

Our review looks to analyze the effect of optimal care goals of the modifiable risk factors in healthy elderly individuals as well as in the different stages of the dementia spectrum.

Risk factors

The diagnosis of dementia is a convoluted interaction of different and diverse risk factors, as well as their relation to the time of exposure, severity, and genetic susceptibility. There are two types: non-modifiable and modifiable risk factors. The former considers both age and genetics, which are not the focus of this review.

It is considered that each of the following factors confers a particular risk in the development of dementia, represented by the population attributable fraction (PAF), which is the percentage reduction in new cases over a given time if a particular risk factor was to be eliminated. Recent studies suggest up to 12 modifiable factors, each related to a certain stage of life[4,5].

This classification includes three stages: early life (< 45 years), in which less education was the main factor studied; midlife (45-65 years) with a focus on hearing loss, hypertension, and obesity; and late-life (≥ 65 years) with smoking, depression, social isolation, low physical activity, and diabetes with the greater effect. The control of this nine modifiable factors (in addition to traumatic brain injury, alcohol consumption, and air pollution) could prevent up to 40% of new cases worldwide, while in Latin America, the number could rise up to 56% since the metabolic and cardiovascular risk factors are more prevalent[4,5] (Fig. 1).

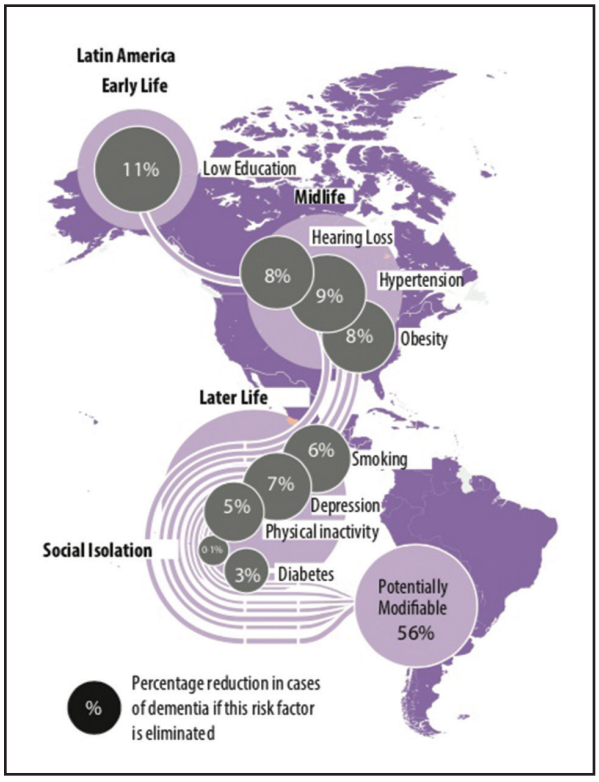

Figure 1. *Image adapted from Mukadam N, Sommerlad A, Huntley J, Livingston G. Population attributable fractions for risk factors for dementia in low-income and middle-income countries: an analysis using cross-sectional survey data. The Lancet Global Health. 2019; 7(5): 596-603. doi: 10.1016/S2214-109X(19)30074-9.*

EARLY LIFE RISK FACTORS FOR DEMENTIA

Education

High education level is the most well-studied factor in lowering the risk of dementia. This includes completed elementary, middle, and high school. Cognitive impairment is 5.6 times more common with low-level education[6]. The importance of the factor relates to the four stages of cognitive development.

The first stage, sensorimotor, from birth up to 2 years, includes the acquisition of knowledge; the

Table 1. Modifiable risk factors in the elderly with dementia

Risk Factor	Patient group (Stage of Life)	Recommendation
Education	Early life	– > 6 years of education
Low Hearing	Midlife	– Early detection – Timely intervention
Obesity	Midlife	– BMI < /m^2
Hypertension	Midlife Late-life MCI/Mild Dementia Moderate-severe Dementia	– < 120/80mmHg – Avoid hypotension – Systolic BP < 130 mmHg – Not < 140/90 mmHg

*Early life, midlife, and late-life refers to prevention in patients without cognitive impairment.

second stage or preoperational (from 2 to 7 years) includes symbolism (language development) without concrete or logic understanding; the third stage or concrete operational (7-11 years) develops concrete and logic thinking; and the last stage or formal operational (around 11-12 years) the student develops abstraction, strategic, and methodic problem solving (number, mass, volume, etc.)[7].

A high education level translates in both direct and indirect cognitive effects. A direct effect of higher education is an increase of synapsis, vascularization, and the creation of cognitive reserve[6]. The latter is defined as the dynamic capacity of the brain to resist the cognitive demand, which means the healthy neurons will compensate to maintain cerebral homeostasis[8]. On the other hand, higher education will lead to a better understanding of the underlying diseases and their complications, as well as better adherence to treatment and follow-up[9].

Due to the former, an educational level of 6 years (elementary school) is considered as protective factor. This cutoff is among the most studied, being either the control or limit between low and high-level education. Worldwide, the PAF is 7%, while in Latin America, it grows up to 11%[4,5]. With all this in mind, elementary school should be reinforced in the early stage (Table 1).

MIDLIFE RISK FACTORS FOR DEMENTIA

Hearing loss

Hearing loss is a recently studied risk factor. Since its development rounds 55 years old (y/o), it is included as a midlife factor[10]. Even though the pathophysiology is not well understood, there are two hypotheses: a vulnerable state related to social isolation and depression derived of poor communication with more cognitive demand, a vascular factor associated with both dementia and stroke. Both of this associate hearing loss with a faster rate of cerebral atrophy[11,12]. Hearing loss has a PAF 8% in both Latin America and worldwide[4,5]. It has been studied that in a 12-year span, moderate-severe hearing loss (> 40 decibels [dB], it is associated with an increase of dementia by 27% per 10 dB lost (HR 1.27 per 10-dB lost, 95% CI: 1.38-2.73)[4].

Hearing aid devices help restore communication, increase quality of life, and reduce behavioral symptoms related to dementia, which in turn reduce the stress level in the caregiver. Nonetheless, evidence remains limited, so the need of further studying the impact of hearing aid devices in delaying dementia remains a need. At this moment, the first step is to focus on patient's education to promote better treatment attachment and acceptance of the devices[13]. With the former in mind, the screening for hearing loss, timely testing, and correction should be a priority in the health care of the elderly.

Hypertension

Hypertension prevalence in young adults is up to 9%. In Mexico, according to ENSANUT 2016, for adults 40-49 y/o is 24.2% and for 50-59 y/o increases up to 39.8%[14]. This relates to an increase in dementia incidence, with a PAF of 2% worldwide versus 9% Latin America[4,5].

The effect of hypertension in cognitive impairment is largely associated with its relation to cardiovascular disease. It is a role in heart failure, arrhythmias, and ischemic heart disease results in reduced heart contractility, which in turn leads to a diminished cardiac output, which results in cerebral hypoperfusion, one of the early signs of Alzheimer's Disease (AD)[15].

Hypertension induces a deficit in ATP synthesis, which triggers alternative energy sources, increasing oxidative stress, poor neuronal signaling, neurodegeneration, and neuronal death, mainly in ischemic susceptible areas of the brain, like the hippocampus[15]. The oxidative stress reduces both vasodilator and vasoconstrictor factors at the endothelium, as well as disturbs the blood-brain barrier (BBB), maintaining a cerebral hypometabolism[16]. Finally, in patients with hypertension, it has been observed a larger accumulation of amyloid plaques, cerebral atrophy, and neurofibrillary tangles[17].

Other factors to consider are the age of presentation and a fluctuating pattern. For this, neuroimaging techniques allow us to observe these structural patterns. To begin with, in isolated systolic hypertension, there is a generalized cerebral volume reduction. On the other hand, in elderly adults with low systolic and diastolic blood pressures (BP), there is a reduction in the cortex, which demonstrates the importance of the age of onset of the hypertension. With the recent evidence, it is more evident that hypertension leads to worse brain outcomes it commonly AD affected regions, and that the pattern of the disease (midlife onset with late-life hypotension) increases said risk[18].

It is important to highlight the importance of adequate control of systolic blood pressure in the adult. In 2019, a study demonstrated the hypertension pattern of 4761 patients ranged between 45 and 65 y/o during a follow-up of 24-30 years. In this study, the young adults with hypertension (>140/90 mmHg) that persisted during late-life develop more dementia than the normotensive ones (HR 1.62 [CI 95%, 1.11-2.37]). The other interesting result was that those young hypertensive patients that in late-life had hypotensive values (< 90/60 mmHg) developed an increased risk of dementia as well (HR 1.49 [CI 95%, 1.06-2.08])[19]. Another recommendation is to maintain a goal of < 140/90 mmHg in elderly patients with microalbuminuria, chronic kidney disease, or diabetes, with some guidelines with tighter goals of 130/80 mmHg[20].

There are studies with a preventive intent in an elderly adult with a risk of cognitive impairment, such as the SPRINT-MIND. In this study, they compared strict control (systolic BP < 120mmHg) versus standard control (systolic BP < 140mmHg). Although it was not possible to demonstrate the relation between BP control and dementia, it was demonstrated for mild cognitive impairment (MCI) (HR 0.81 [CI 95%, 0.69-0.95]). However, it is important to mention the early stopping of the SPRINT study, due to the other cardiovascular benefits of BP control[21].

Even though of the former studies described, there is not a consensus of the optimal goals of control of BP in dementia patients. The European guidelines advise for 65 y/o or older, non-strict targets of 140/90mmHg. For octogenarian, the goals are even looser with systolic BP no less than 160 mmHg[22]. With the SPRINT results in mind, it is contradictory to be so lax, and some authors suggest sticking with the AHA guidelines[23] since their goals categorize according to comorbidities. For healthy independent elders, their recommendation is systolic BP < 130 mmHg, while those with multimorbidity, it is advised to tailor the therapy according to both life expectancy and patient choices[24].

Physical activity and obesity

The definition of physical activity is the movement of skeletal muscles, which results in an increase of energy expenditure that exceeds the resting state[25]. Physical inactivity or a sedentary lifestyle can lead to an increase in abdominal fat tissue and body mass index (BMI)[26]. Because of this, obesity can be defined as an over-accumulation of body fat, measured as a BMI ≥ 30 kg/m^2[2,27].

There are different mechanisms proposed for obesity to lead to brain damage[27]. Adipose tissue secretes adipokines, which in excess can lead to structural brain changes. In addition, the chronic inflammatory state derived of obesity increases leptin and cytokines levels; this can lead to neuronal excitability, decrease in β-secretase activity, and microglia signaling[28]. In midlife, obesity is associated with an increase of dementia incidence (RR 1.41 [CI 95%, 1.20-1.66])[29].

When translating these changes to cognitive performance, obesity impacts three main domains: memory, processing speed, and executive functions. The latter are especially vulnerable for the aging brain, with both hypertension and adiposity worsening the impairment, which can be measured with a decrease of grey matter focused at the left orbitofrontal cortex. On the other hand, an obese elderly adult has a worse episodic memory performance, which is related to larger atrophy of the temporal lobe, as well as an inverse relationship between abdominal adiposity and hippocampal volume. Finally, the processing speed shows the worst performance in the *Trail Making Test A* and verbal fluency when compared with non-obese patients[27].

Table 2. Continued – Modifiable risk factors in the elderly with dementia

Risk Factor	Patient group (Stage of Life)	Recommendation
Physical Activity	Midlife Late-life	– 30 min, 5 times a week – Multimodal exercise program
Smoking	Late-life	– Complete cessation
Depression	Late-life Mild to severe dementia	– Early detection – Individualized treatment
Social Isolation	Late-life	– Encourage social interaction

*Early life, midlife, and late-life refers to prevention in patients without cognitive impairment.

Physical activity, on the other hand, follows a positive association reducing MCI and dementia risk. With this preventive measure, we tackle two risk factors with a combined PAF of 13% (physical inactivity 5% and obesity 8%) in Latin America[4]. Aside from the cognitive improvement in can lead to, it also tackles other factors, such as depression. Due to this benefit, physical activity should be encouraged not only in young adults but also the elderly, giving us two groups of intervention[8,30]. A California-based cohort with 27 years of follow-up demonstrated that elderly adults > 60 y/o whom maintain a physical activity (defined as any type of exercise 3 times a week) had a better performance on *MMSE*, *Trail Making Test B,* and verbal fluency when compared with the non-active[31]. Another study based in Sweden, with a follow-up of 44 years, including 800 women 38-54 y/o, demonstrated a lower risk for developing mixed dementia or vascular dementia in the group that maintains low-impact physical activity (gardening, bicycle, or walking) at least 4 h/week[32]. Finally, the FINGER study, which included a multidomain and multicomponent intervention (nutrition, exercise, cognitive training, and cardiovascular risk factor control), showed an increase in executive functions and processing speed in patients in high risk of dementia[33].

With this in mind, how much physical activity should we recommend? The majority of the studies suggest an individualized program that includes: aerobic, resistance, balance, and flexibility exercises. Regardless of the program, the consensus is to include at least 30 min of aerobic exercise 5 times a week[34] (Table 2).

Dementia risk factors in the late-life

Smoking

With a prevalence of 27.4% and a PAF of 5% up to 13.9% worldwide and in Latin America, respectively, smoking is a well-known risk factor for cardiovascular disease, chronic obstructive pulmonary disease, and cerebrovascular disease as well as dementia[4,5]. There are several mechanisms related to cognitive impairment: premature vascular burden, inflammation, free radicals, and neurotoxicity (with over 4700 cigarette components), which impairs both cognitive test performance and brain morphology[35].

On the other hand, smoking has been associated with an increase of cognitive performance derived of nicotine receptors stimulation and acetylcholine. However, with continuous stimuli, the receptors desensitize, producing inflammation, and oxidative stress. Active smoking has been associated with all-cause dementia (RR 1.30 [CI 95%, 1.18-1.45]), vascular dementia (RR 1.38 [CI 95%, 1.15-1.66]), and AD (RR 1.40 [CI 95%, 1.13-1.73])[36].

Prevention and treatment are based upon complete cessation. It has been proven that not only active smoking but a history of consumption increases the risk for dementia (RR 1.25 [CI 95%, 1.05-1.47]), with 20 cigarettes a day increases 34% dementia's risk (RR 1.34 [CI 95%, 1.25-1.43]). The downside being the uncertainty of smoking-free years that lead to a lower risk[36].

Depression and social isolation

Depression model of risk is two-ways since it can lead to cognitive impairment, as well as a result of a patient living with dementia. INEGI 2012 showed prevalence in elderly Mexicans of 22.1% in women and 12.5% in men, while ENASEM 2012 showed a combined prevalence of 74.3% in this age group[37]. Among the preventable causes of dementia, it represents a PAF of 4% worldwide and 7% in Latin America[4,5].

Both the former and social isolation are tightly related, being prodromal symptoms of dementia. Social isolation can be defined as a state in which the individual has the minimum number of social

interactions with others in its community[37]. Its impact on dementia is a PAF of 4% worldwide and 0.1% in Latin America[4,5].

The physiopathology of depression and dementia correlates with an increase inflammatory state, with hypercortisolemia, increase levels of β-amyloid (βA), and neurofibrillary tangles[38]. In a study with a 2-year follow-up, they prove changes in magnetic resonance imaging in both atrophy and volume in the following regions: posterior cingulate, hippocampus, parahippocampus, and precuneus cortex[39]. On the other hand, depression and isolation increase cognitive inactivity, with a major depressive episode rising up to 14% the risk of developing dementia[40].

Literature suggests that social engaging could prevent or delay the onset of dementia, although there are not longitudinal studies on subject[5]. Due to this, early detection and timely intervention are key for prevention. For this purpose, appropriate screening tools are needed. The geriatric depression scale (GDS) with 15 items (with a score of 5 points suggesting depression and ≥10 highly correlated with a major depressive disorder) helps us to identify patients who benefit of an intervention or timely referral to and specialist[41].

For social isolation diagnosis, we can use the Lubben Social Network Scale-6, a 30-item scale with a threshold of 12 points[42]. Even though of the evidence of its relationship with cognitive impairment, social isolation is hard to study due to its complex nature, inconsistency among available data, lack of a unified definition, and, as a result, lack of resources to objectively measure it[37].

Treatment of depression is key in both the early and late stages of cognitive impairment. Recent clinical guidelines suggest pharmacological treatment of depression in dementia patients. It is important to stress the need of choosing the safest drug alternative, with selective serotonin reuptake inhibitors (SSRIs) being the best tolerated[43]. On the contrary, few studies measure the effect of psychotherapy alone, although it seems to be effective in early and mild stages of the disease, which is why it should support the other interventions[44].

Diabetes

According to ENSANUT 2016, diabetes prevalence in the Mexican elderly is 27.4%, almost 5 times higher than the rest of the world[45]. It has a PAF of 3% in Latin America, while in the rest of the world is 1.0%[4,5]. Recently, a third model of diabetes (type 3) has been suggested, which results of the relationship of insulin signaling at CNS as a pathogenic pathway to AD. This model refers to chronic insulin resistance, with a brain insulin deficit, which contributes to apoptosis[46].

The insulin receptor (IR) in the brain expresses mainly at the olfactory bulb, cerebral cortex, hippocampus, amygdala, and hypothalamus. One of the main tasks of brain insulin is to regulate hypothalamic energy metabolism, which in turn control food consumption, energy homeostasis, hepatic and muscular glycogenesis, and lipogenesis[47].

Recently studies suggest a bigger role of diabetes in both vascular and mixed dementia. With this in mind, it ties in with early-onset forms of dementia, usually in relationship with other comorbidities such as hypertension, dyslipidemia, and obesity, which justifies glycemic control in these patients[48,49].

Although data favors strict glycemic control to prevent cognitive impairment and its progression in younger adults (< 70 y/o), this cannot be recommended in octogenarian, multimorbid, or dementia patients since it leads to worst outcomes in relationship with hypoglycemia and lack of treatment compliance due to lower independence[50,51]. Serum glucose of ≥190 mg/dL in the diabetic patient correlates with a higher risk of developing dementia[52]. The ACCORD-MIND study did not find the difference among intensive care (HbA1c < 6%) versus standard care (HbA1c 7-7.9%) in cognitive test performance[50].

Due to the former, treatment goals remain controversial, with the need to individualize according to functional status, comorbidities, and life expectancy. The current framework suggests three groups of patients for intervention: healthy, complex/intermediate, and very complex/poor health. Biomarker goals (HbA1c) are chosen between < 7.5%, < 8.0%, and < 8.5% accordingly. Nonetheless, HbA1c measures should not be the only decision-maker, with other instances such as treatment compliance and drug adverse effects playing a bigger role in continuous monitoring. With these goals in mind, a MCI patient can be considered complex/intermediate with HbA1c goal < 8.0% (or < 183 mg/dL blood glucose), while a dementia patient is very complex/poor health with HbA1c goal < 8.5% (< 200 mg/dL blood glucose)[53,54].

Table 3. Continued – Modifiable risk factors in the elderly with dementia

Risk Factor	Patient group (Stage of Life)	Recommendation
Diabetes	Midlife	– HbA1c < 7.0%
	Late-life	– HbA1c < 7.5%
	MCI/mild dementia	– HbA1c < 8.0%
	Moderate-severe dementia	– HbA1c < 8.5%
Dyslipidemia	Midlife	– ↓50% of baseline LDL – LDL < 55 mg/dL
	Late-life	– Individual risk assessment
	MCI/mild dementia	– ↓50% of baseline LDL – LDL < 100 mg/dL
	Moderate-severe dementia	– Individual risk assessment – Consider drug adverse effects

*Early life, midlife, and late-life refers to prevention in patients without cognitive impairment.

Other factors

Dyslipidemia

High levels of cholesterol, specifically low-density lipoprotein cholesterol (LDL-C), are a major cardiovascular risk factor for coronary disease and stroke and have been studied for AD[55]. On the healthy individual, the BBB regulates lipoproteins transit, but in an injured vascular brain, there is a hypothesis that the oxidized forms 24S-hydroxycholesterol and 27-hydroxycholesterol, by activation of β and γ-secretase activity, upregulate βA levels[56]. On the other hand, this βA could interact within the cell membrane, favoring internalization and aggregation of cholesterol in the extracellular matrix[57].

With all that in mind, the treatment focus is to control blood cholesterol levels with statins, lipid-lowering drugs for the prevention of cardiovascular events. By competitively inhibiting 3-hydroxy-3-methyl-glutaryl-coenzyme A reductase (HMG-CoA reductase), they limit the production and entrance of LDL cholesterol to the peripheral circulation, which lowers LDL and triglycerides levels, as well as improving high-density lipoprotein (HDL) cholesterol levels[58].

To this day, there is not a consensus on the target goal of lipid control in cognitive impairment. The latest recommendation suggests an intervention according to the cardiovascular risk: for high-risk patients an LDL-C reduction of ≥50% and LDL-C goal of < 70 mg/dL and for moderate-risk patients an LDL-C goal of < 100 mg/dL. There is not an individual guideline for the elderly, even though statin use in ≥ 75y/o remains controversial since it is not recommended for the prevention of dementia in this age group[59] (Table 3).

In 2016, the *Food and Drugs Administration* (FDA) issued a post-marketing warning on statins, reporting a risk of transient and reversible cognitive impairment, as well as glucose disturbances[60]. On the other hand, systematic reviews on the subject have not proven this relationship, which begs to question this warning[61], with the latest reviews unable to prove neither benefit nor harm of the intervention in MCI. Due to this, statin use depends on the cognitive and cardiovascular risk of the patient[62].

CONCLUSIONS

Without a doubt, risk factor control should begin the earliest. A holistic approach to cognitive impairment is necessary due to the complex social and public health policies in Mexico. At this time, dementia continues to be a major health concern worldwide, and with the lack of a cure, it is imperative to control de modifiable risk factors to decrease the number of new cases and their progression from pre-clinical and MCI. Finally, there is still a lack of data regarding optimal target goals of care in the elderly in the spectrum of cognitive impairment, which needs to be addressed to improve the care of this vulnerable group.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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ETHICAL DISCLOSURES

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

Confidentiality of data. The authors declare that no patient data appear in this article.

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THE JOURNAL OF LATIN AMERICAN GERIATRIC MEDICINE REVIEW ARTICLE

Vaccination against pneumococcus and influenza in old age: Evidence-based geriatrics

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Abstract

Background: *Ageing presents a diminished function of the immune system which is known as immunosenescence; therefore, the elderly develop a greater susceptibility to infections such as influenza and pneumococcal pneumonia. Vaccines schemes are one of the most cost-effective strategies of preventing morbimortality in the older adults' population.* **Objective:** *The aim of this article is to present a review of the current scientific evidence of vaccination against pneumococcus and influenza in older adults.* **Methods:** *A research was conducted using the PubMed database with different search terms and covering articles from 2002 to 2018. Eligibility of each article was decided by at least two independent authors.* **Results and conclusions:** *Vaccination schemes against pneumococcus and influenza are an effective strategy to prevent negative outcomes in old age. Its impact goes beyond the reduction of morbidity and mortality, preventing even the occurrence of some geriatric syndromes. The geriatrician must actively participate in all levels of vaccination promotion.*

Key words: *Vaccination. Pneumococcus. Influenza. Aging.*

Vacunación contra el neumococo y la influenza en la vejez: geriatría basada en la evidencia

Resumen

Antecedentes: *El envejecimiento presenta una función disminuida del sistema inmune que se conoce como inmunosenescencia; por lo tanto, los ancianos desarrollan una mayor susceptibilidad a infecciones como la influenza y la neumonía neumocócica. Los esquemas de vacunas son una de las estrategias más rentables para prevenir la morbimortalidad en la población de adultos mayores.* **Objetivo:** *El objetivo de este artículo es presentar una revisión de la evidencia científica actual de la vacunación contra el neumococo y la influenza en adultos mayores.* **Métodos:** *Se realizó una búsqueda en la base de datos PubMed con diferentes términos, abarcando artículos desde 2002 hasta 2018. La elegibilidad de cada artículo fue decidida de manera independiente por dos autores.* **Resultados y conclusión:** *Los esquemas de vacunación contra el neumococo y la influenza son una estrategia efectiva para prevenir desenlaces negativos en la vejez. Su impacto va más allá de la reducción de la morbimortalidad, evitando incluso la aparición de algunos síndromes geriátricos. El geriatra debe participar activamente en todos los niveles de promoción de la vacunación.*

Palabras clave: *Vacunación. Neumococo. Influenza. Envejecimiento.*

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INTRODUCTION

People aged 60 and older are about 11% of the world population and it is expected to increase 22% by 2050[1,2]. Community-acquired pneumonia represents one of the most common causes of hospitalization and death in the elderly. Streptococcus pneumoniae causes 400,000 hospitalizations and 18,000 cases of the invasive pneumococcal disease every year with a case-fatality rate of 20%[3,4]. On the other hand, influenza virus is responsible for 250,000 deaths yearly and it is associated with 3-5 million cases of severe infection[5]. The risk of influenza-related death increases exponentially after the age of 65 years old, and in the elderly population represents more than 90% of overall influenza-related mortality annually[3-6]. Thus, seasonal influenza epidemics place a heavy socioeconomic burden on both adults and the elderly[7].

Demographic aging demands improvement in elderly care to prevent geriatric syndromes, which affect not only dependency but also the quality of life. Moreover, adults aged 50-60 years with underlying diseases have a higher risk of hospitalization in the influenza season[8,9]. Thus, the invasive disease is more common in patients older than 65 years and chronic conditions such as cardiovascular disease and lung disease. Pneumococcal and influenza diseases remain an important health challenge. A simpler way to reduce both infections would be to increase vaccination among children and adults. The most important effect of group immunity with influenza vaccines was found in the routine vaccination of children in Japan between 1962 and 1994, which produced a significant decrease in cases in adults[10,11]. Vaccines are one of the most cost-effective strategies because they offer a cheap alternative of preventing potential morbidity. Aging-related to the increase of infections among older people make vaccination and its research an imperative issue[4,7].

Vaccination in old age is not only an effective strategy in the prevention of infections but also in the promotion of healthy aging. The objective of this article is to present a detailed and exhaustive description of the current scientific evidence of vaccination against pneumococcus and influenza in older adults.

MATERIALS AND METHODS

Search strategy and selection criteria

For this review, we searched the PubMed database (http://www.ncbi.nlm.nih.gov/pubmed/) to find all published studies describing the health impacts of vaccination against pneumococcus and influenza in older adults. We used various combinations of search terms such as: "vaccination in old age," "vaccination scheme in adults," " immunosenescence," "vaccines and geriatric syndromes," and "chronic diseases and vaccination." The literature search covered articles published from 2002 to 2018 in English. At least two authors of the present article reviewed each paper and independently decided whether potentially eligible papers met inclusion criteria, assessed them for methodological quality, and extracted data. Data from experimental studies evaluating molecular mechanisms behind the protective properties of vaccination against pneumococcus and influenza in older adults were also included in this review.

RESULTS

Vaccines in old age

Immunization strategies are changing its objectives because of the new epidemiological profile of vaccine-preventable diseases. Adult's population is one of the most relevant new targets for vaccinations that used to be administered only to children[12]. Vaccine-preventable diseases such as influenza and pneumococcal infections and their sequelae may conduce to different kinds of disability or impaired mobility in older adults, that is why vaccination is a way to prevent both the infection and functional impairment[6,7,13,14].

Thus, vaccines can preserve health and quality of life in elderly patients. Lifelong vaccination should be considered because vaccine-preventable diseases can occur at any age and can be more serious in adult and elderly patients than in children. Age-based approach in vaccination strategies seems to be the best option to protect the aging population[12].

Immunosenescence

In older people, many of the clinical conditions are related to immunosenescence, a phenomenon that refers to the decline of the immune system associated with aging. There is an immune phenotype related to increased mortality: inversion in CD4/CD8 ratio, low count of B cells, poor T cell proliferative response, and CMV seropositive. These are associated with an increased susceptibility to infections such as influenza and pneumococcus[9]. The aging of the immune

system produces a chronic pro-inflammatory state that could be more severe in women. Genetic and epigenetic factors related to immune-related genes encoding proteins that are located in the X chromosome could be involved in the gender-associated response to vaccines[15].

Vaccination in the elderly based on evidence

Elderly population demonstrates a low effective response to vaccination[5]. Efficacy refers to the percent reduction in disease incidence in a vaccinated population under ideal conditions. It is measured by hospitalization and mortality rates post-vaccination. On the other hand, effectiveness refers to the ability of the vaccine to prevent disease in the real worldwide population[15]. Herd immunity is the protection of a certain population against infection due to the presence of a high percentage of immune individuals in it. Naturally, when an outbreak occurs, as in an epidemic, and increase the number of immune individuals decreases the probability of contact between a susceptible and infected until there comes a time when the transmission of the infectious agent is blocked[16].

Center for Disease Controls (CDC) recommendations for vaccination in older adults (60 years) include the annual trivalent inactivated influenza vaccine at a high dose and a booster of the pneumococcal vaccine, among other vaccines[11,15,17].

The CAPiTA study (Community-Acquired Pneumonia Immunization Trial in Adults, a Dutch clinical trial supported by the manufacturer) showed that PCV13 is efficacious in preventing two-thirds of bacteremic pneumococcal pneumonia BPP (75%) and around half the non-bacteremic pneumococcal pneumonia NBPP (45%) cases in older adults[4]. The Spanish CAPAMIS (Community-Acquired Pneumonia, Acute Myocardial Infarction and Stroke) cohort study (funded by public authorities) confirmed that PPV23 is effective against both BPP (62 %) and NBPP (48 %) in adults older than 60 years[4]. There was little evidence of an impact of PPV23 on the incidence of vaccine-type invasive pneumococcal disease (VT-IPD) in those aged ≥ 65 years old[18].

In contrast to the extensive information on the existing pneumococcal vaccine, studies about the positive effects of the influenza vaccine on outcomes other than influenza pneumonia are scarce. However, influenza vaccination is the most effective method for the prevention of influenza virus infection and its complications. In a study conducted in Taiwan, influenza vaccination in older adults reduced the rate of all causes for hospitalization[19].

Vaccines and chronic non-communicable diseases

Diabetes is common in the elderly population and is considered a risk factor for pneumonia; therefore, these patients have a higher risk of death and complications[13]. Vaccination in elderly people with diabetes reduces up to 50% the rate of hospitalizations and mortality[20].

Pneumococcal vaccination reduces the risk of death and hospital admissions in elderly patients with chronic lung disease and heart failure. The protective effect of the pneumococcal vaccine seems to be additional to the protective effect of the influenza vaccine[21]. Older adults who have been recently diagnosed with cancer receive influenza immunizations at much lower rates than older adults who have not been diagnosed with cancer[22].

Likewise, disability tends to be associated with a decrease in the likelihood of vaccination. In agreement with other studies, groups of older adults with less severe diseases who are not at high risk of death are more likely to be vaccinated, while another group with more severe diseases and a high risk of mortality do not tend to be vaccinated[23].

Patients with chronic cardiovascular disease have an increased risk of complications from influenza and pneumococcal infections[8]. It is estimated that more than half of the elderly population suffers from a chronic heart condition, in these patients hospitalized for pneumonia, an increase of acute myocardial infarction has been observed. Some of the pathophysiological mechanisms of such a situation are endothelial dysfunction, plaque instability, inflammation, sympathetic activation, volume overload, and arrhythmias[24].

Vaccines and outcomes other than the reduction of infections

The 80% of patients older than 65 years suffer from a chronic condition that indicates the need for the administration of influenza and pneumococcal vaccines[12].

Patients with pneumococcal vaccine have a lower risk of cardiovascular event and mortality (14% and 8%,

Table 1. Benefits of vaccination in the elderly

Author	Type of vaccine	Population	Outcome	Recommendation
Hebert et al. (2010)	TIV Influenza	Chronic cardiovascular disease in adults 60 years and older	Morbid-mortality reduction	Vaccination against influenza in subjects with high cardiovascular risk
Hedlund et al. (2003)	Pneumococcus	Chronic lung disease or heart failure in adults 60 years and older	Morbid-mortality reduction	Vaccination against pneumococcus in subjects 60 years and older
Kraicer-Melamed et al. (2016)	Pneumococcus (PPV23 or PCV13)	Adults 65 and over	There is no difference between applying PPV23 and PCV13 in people older than 65 years	Application of any of the two versions of the vaccine versus pneumococcus
Falkenhorst et al. (2017)	Pneumococcus (PPV23 or PCV13)	Adults 60 and over	Greater effectiveness of PPV23 versus PCV13	Routine application of PPV23
Chan et al. (2012)	TIV Influenza	Asylees	Vaccinated subjects have a lower risk of mortality versus not vaccinated	Routine application of the vaccine
Ho et al. (2012)	TIV Influenza	Older adults in Taiwan	Reduction of risk of hospitalization	Routine application of the vaccine
Raina McIntyre et al. (2014)	Influenza and pneumococcus	Older adults in Australia	Reduction of risk of permanent disability or reduced mobility	Routine application of both vaccines

respectively); this protective role of vaccine was more prominent in the elderly and in patients with high cardiovascular risk. It seems that the pneumococcal vaccine has an important role in the balance of supply and demand of oxygen in the heart, decreasing myocardial ischemia[24].

Influenza vaccination was associated with a 44% reduction in the risk of death during influenza season[23]. Patients who received the influenza vaccine after myocardial infarction or angioplasty showed a decrease in mortality and morbidity. A study in elderly patients with heart failure (HF) showed that influenza vaccination was associated with 44% lower risk of all-cause mortality and a 22% lower risk of cardiac death[8].

Thus, vaccination is associated with a decrease in all-cause mortality and associated with cardiac causes in HF patients. As a consequence, the American College of Cardiology and the American Heart Association recommend vaccination schemes in their guidelines for the diagnosis and management of heart failure in adults[8].

Disability and functional impairment are confounders of the association of influenza vaccination and risk of death[23]. Influenza vaccination was associated with reduced all-cause mortality in older nursing home residents with different functional status. Vaccine efficacy in reducing mortality declined with increasingly impaired functional status[25]. It was found a 61% reduction in the risk of mortality in the pre-influenza period, which indicates the presence of a healthy vaccine bias[23]. Vaccinated patients had the lowest all-cause mortality, whereas unvaccinated residents had the highest all-cause mortality[25] (Table 1).

Acceptance and rejection of vaccines in old age

Worldwide pneumococcal vaccination coverage was reported for 52.6% of adults over 60 years of age, higher in females than in males (54.8 and 50.0%, respectively) and for influenza, older male adults presented coverage of 51.4% versus 61.4% of women[26].

According to the literature, the decision to apply the influenza vaccine consists of the perception of the risk of contracting the disease, understanding the severity of the consequences, and the perception of preventive measures, including their safety and effectiveness[27]. One study found that minorities have basic information regarding the vaccine, but no enough

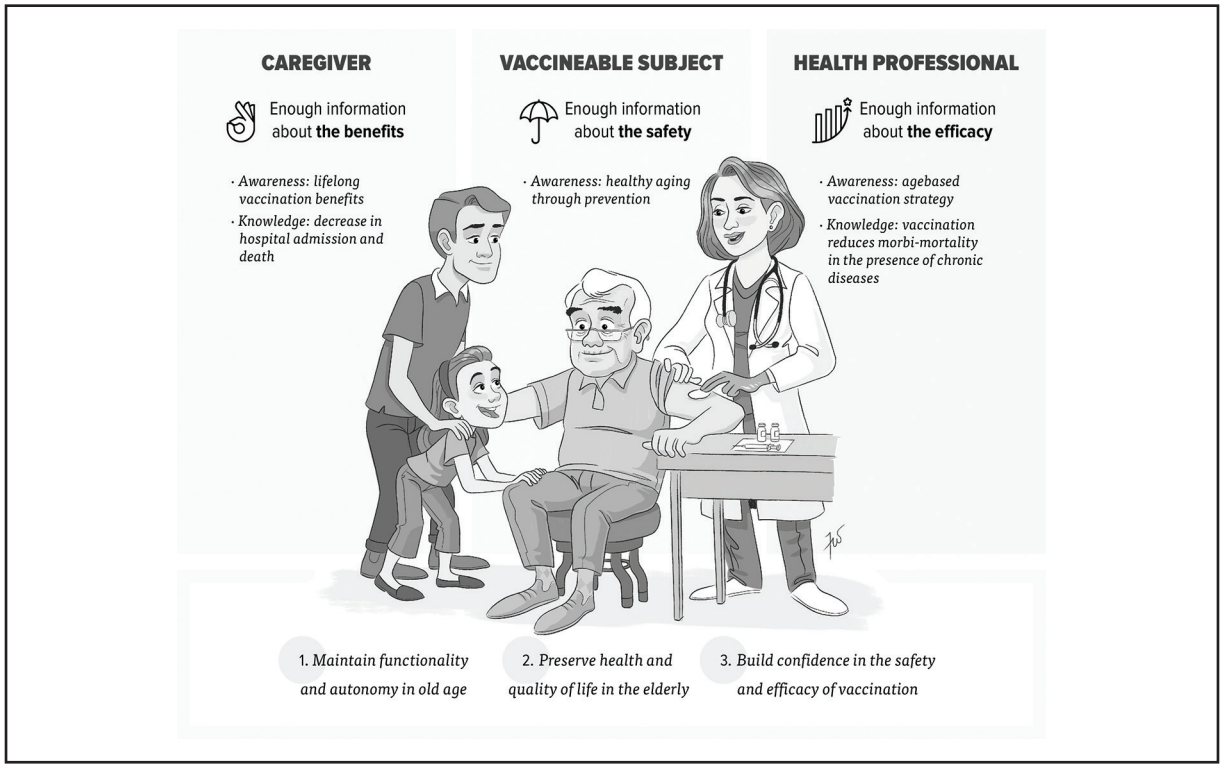

Figure 1. *Components and goals of the vaccination strategy in old age. The strategy of vaccination in old age should promote the interaction between subjects susceptible to vaccination, their careers, and health professionals. The objectives can be achieved if the intervention is based on education and respect (original of the authors).*

information about the benefits. Females report more adverse reactions and have more concerns about vaccine safety and efficacy than males[15].

The determination of vaccine eligibility in a target population is crucial for any vaccine program, and the use of electronic medical records (EMR) may significantly improve this process. However, it was seen that these templates missed some data, so the patients could not receive the vaccines[28].

The financial sustainability of new vaccine introduction remains a challenge because new vaccines have to compete with other health system priorities[29]. Variants of the vaccine are manufactured directed to the older population. The differences with common vaccines are the increased amount of antigen and the intradermal route of delivery instead of the intramuscular route[5]. Public health strategies must continue to improve the influenza vaccination rate among the elderly[19] (Figure 1).

CONCLUSIONS

The establishment of an effective strategy for primary prevention in the elderly population through vaccination against pneumococcus and influenza is one of the great challenges of geriatric medicine and public health policies throughout the world. We must underline the importance of monitoring vaccine schemes since they seem to have an impact on the overall health status of the elderly. We believe that a comprehensive geriatric evaluation that includes the identification of at-risk elderly people and the personal information of the vaccination schemes is an adequate tool to promote health through prevention and to avoid the development of negative outcomes other than morbidity and mortality in the elderly.

CONFLICTS OF INTEREST

The authors have declared no conflicts of interest for this article.

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ETHICAL DISCLOSURES

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

Confidentiality of the data. The authors declare that they have followed the protocols of their work center on the publication of patient data.

Right to privacy and informed consent. The authors declare that no patient data appear in this article.

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