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ORIGINAL RESEARCH

Clinical profile of patients with multimorbidity treated via telemedicine in Medellín, Colombia

Perfiles clínicos de pacientes con multimorbilidad manejados vía telemedicina en Medellín, Colombia

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Abstract

Introduction: Multimorbidity is defined as the coexistence of two or more chronic diseases in an individual. It poses a significant burden on public health care due to its association with an increased risk of premature death, a high degree of disability, and significant use of medical services. Grouping these patients into clinical profiles could help to optimize their management.
Objective: To establish the clinical profiles of patients with multimorbidity treated via the telemedicine home care program of the Hospital Alma Máter de Antioquia (HAMA) located in Medellín (Colombia).
Materials and methods: Cross-sectional study conducted using data from 2 035 adult patients with multimorbidity enrolled in the HAMA home care program who had access to health care services via telemedicine at least once between January 2017 and December 2023. Patients were grouped into clinical profiles (clusters) using the k-means clustering algorithm and based on the following variables: age, sex, diagnosis of arterial hypertension (AHT), type 2 diabetes mellitus (DM2), chronic kidney disease (CKD) and stage, chronic obstructive pulmonary disease, cancer, mental or neurodegenerative disease, disability, functional class, use of anticoagulants, type of telemedicine service used, and prior assessment by the internal medicine service via telexpertise. The optimal number of clusters (k) was determined using the elbow method.
Results: According to the elbow method, the optimal value of k in the K-means clustering algorithm was 4, so patients were grouped into 4 clusters or clinical profiles. Cluster 0 corresponded to men and women with CKD, AHT, and DM2, without a disability but with functional class 4. Cluster 1 was formed by men with mental or neurodegenerative disease and CKD, with a disability, and functional class 4. Cluster 2 included women with mental or neurodegenerative disease and CKD, with a disability, and functional class 4. Finally, cluster 3 was comprised of women and men with CKD, AHT, and DM2, with functional class 2.
Conclusion: Four clinical profiles were identified, characterized by sex, combination of chronic diseases, functional class, and presence of a disability. This classification may contribute to the use of specific program services such as evaluation by internal medicine specialists via tele-expertise.

Resumen

Introducción. La multimorbilidad es la coexistencia de dos o más enfermedades crónicas en un individuo y representa una carga significativa para la salud pública debido a su asociación con un mayor riesgo de muerte prematura, un alto grado de discapacidad y un uso elevado de servicios de atención en salud. Agrupar estos pacientes en perfiles clínicos permitiría optimizar su manejo.
Objetivo. Establecer los perfiles clínicos de los pacientes con multimorbilidad atendidos en el programa de atención domiciliaria por telemedicina del Hospital Alma Mater de Antioquia (HAMA) ubicado en Medellín (Colombia).
Materiales y métodos. Estudio transversal realizado con datos de 2 035 pacientes adultos con multimorbilidad inscritos en el programa de atención domiciliaria del HAMA y a los que se les brindaron servicios de atención en salud vía telemedicina al menos una vez entre enero de 2017 y diciembre de 2023. Los pacientes fueron agrupados en perfiles clínicos (clústeres) usando el algoritmo de agrupamiento k-medias y con base en las siguientes variables: edad, sexo, presencia de hipertensión arterial (HTA), diabetes *mellitus* tipo 2 (DM2), enfermedad renal crónica (ERC) y su estadio, enfermedad pulmonar obstructiva crónica, cáncer, enfermedad mental o neurodegenerativa, presencia de discapacidad, clase funcional, uso de anticoagulantes, tipo de telemedicina usada y si había tenido valoración por medicina interna a través de telexperticia. El número óptimo de clústeres (k) se determinó usando el método del codo.
Resultados. De acuerdo con el método del codo, el número óptimo de k en el algoritmo de agrupamiento K-Medias fue 4, por lo que los pacientes fueron agrupados en 4 clústeres o perfiles clínicos. El clúster 0 estuvo conformado por hombres y mujeres con ERC, HTA y DM2, sin discapacidad, pero con clase funcional 4; el clúster 1, por hombres con enfermedad mental o neurodegenerativa y ERC, con discapacidad y clase funcional 4; el clúster 2, por mujeres con enfermedad mental o neurodegenerativa y ERC, con discapacidad y clase funcional 4, y el clúster 3, por mujeres y hombres con ERC, HTA y DM2, con clase funcional 2.
Conclusión. Se encontraron 4 perfiles clínicos que se diferencian por el sexo, la combinación del tipo de enfermedades crónicas, la clase funcional y la presencia de discapacidad, y que, a su vez, pueden determinar el uso de servicios específicos del programa como la evaluación por especialistas en medicina interna mediante telexperticia.

Introduction

Caring for patients with chronic non-communicable diseases (NCDs) is one of the most important challenges for health care systems, especially in developing countries.[1] NCDs affect differently the population of low- and middle-income countries, where 73% of all the world's NCD deaths occur (approximately 32 million).[2] Cardiovascular diseases, cancer, chronic respiratory diseases, and diabetes are the leading NCDs and together account for 80% of premature deaths from this cause worldwide.[2] Their onset and progression are related to modifiable risk factors such as smoking, physical inactivity, unhealthy diets, and harmful alcohol consumption.[2]

In Colombia, as per the 2022 High Cost Account, 5 346 278 people were diagnosed with arterial hypertension (AHT), diabetes mellitus (DM), or chronic kidney disease (CKD), with increases in prevalence of 0.27% for AHT and 1.45% for DM compared to 2021.[3] Moreover, the total costs associated with caring for patients with NCDs in the country have risen steadily since 2019 and are expected to increase by 40% between 2022 and 2030.[4]

The increase in disease burden, together with various socioeconomic and psychosocial determinants, has led to a progressive increase in the frequency of multimorbidity,[5] which is defined as the coexistence of two or more chronic diseases in the same person.[5-8] Multimorbidity includes long-term noncommunicable diseases such as cardiovascular disease or cancer; long-term mental health disorders such as mood disorders or dementia; and long-term infectious diseases such as HIV or hepatitis C.[6,9] Worldwide, the prevalence of multimorbidity is 37.20%;[10] however, in low- and middle-income countries, it can vary between 13% and 87%.[11] In the case of Colombia, it is estimated that the prevalence of multimorbidity in people over 60 years of age was 62.30% in 2021.[12]

Multimorbidity is associated with medically important outcomes such as death,[13] decreased quality of life,[14] and disability.[15] The care provided to patients with multimorbidity leads to an increase in the demand for health services, and it has been suggested that its management should include comprehensive interventions to meet the different needs of individuals.[5] In this regard, the identification of multimorbidity profiles has been described as a strategy that allows the analysis of specific patterns of concurrent diseases to develop and implement care routes targeted to specific patient profiles or to reorganize the delivery of health services based on the needs detected in such profiles.[9,10,16]

Telemedicine has evolved as an innovative means for delivering health care services, particularly in the treatment of patients with NCDs.[17,18] The synergy between technology and healthcare has opened up new possibilities to improve access to healthcare services, minimize travel times, optimize resources, and individualize care.[19-22] However, even though telemedicine has made possible creating new possibilities for personalizing care, patient heterogeneity remains a challenge that must be addressed to better understand the effectiveness of these programs.[23-25]

The Hospital Álma Mater de Antioquia (HAMA), located in Medellín, Colombia, implemented a telemedicine-based home care program for patients with multimorbidity in 2015. However, during its implementation, a need to characterize these patients was identified so as to design personalized care strategies and make adjustments to the program. In view of the aforementioned, the objective of this study was to establish the clinical profiles of patients with multimorbidity treated in the HAMA telemedicine home care program by grouping them into clusters according to clinical and demographic characteristics as a means toward developing differentiated care strategies that improve clinical outcomes and the quality of health services provided to this population.

Materials and methods

Study type

Cross-sectional study conducted using secondary sources of information (medical records).

Setting

The HAMA is a tertiary care hospital that provides healthcare services in Medellín. It has a home care program for patients with multimorbidity who do not require ventilation, in which health services are provided through a combination of face-to-face and telemedicine consultations based on the modeling of the patients' clinical risk and the availability of resources. It is also worth mentioning that, depending on factors such as the opportunity for access to information and communication technologies (ICT) and the level of computer knowledge demonstrated by the patient, among others, telemedicine interventions are divided into interactive (remote relationship via ICT and synchronous communication between the professional and the user) and non-interactive (remote relationship via ICT and asynchronous communication that does not require immediate response). Moreover, telemedicine interventions include telexpertise with the internal medicine service, a modality of telemedicine in which an internal medicine specialist provides diagnostic or therapeutic guidance to the general practitioner without interacting directly with the patient.

Study population and sample

The study population consisted of all adult patients with multimorbidity (≥2 chronic diseases) enrolled in the HAMA home care program who received health care services via telemedicine at least once between January 2017 and December 2023 (N=2 035). This was verified by reviewing the information recorded in the electronic medical records available in the program's database. No exclusion criteria were considered, so all 2 035 medical records were included.

Variables

Based on the electronic medical records review, the following information was collected for each patient: age, sex, chronic disease diagnosed (AHT, type 2 diabetes mellitus [DM2], CKD and stage, chronic obstructive pulmonary disease [COPD], mental or neurodegenerative disease, cancer), functional class as specified using the functional classification method proposed by García-Arango *et al.*[26] (class 1: preserved functional status with stabilized comorbidity; class 2A: preserved functional status with stabilized comorbidity, but with presence of risk factors; class 2B: preserved functional status with uncontrolled comorbidity; class 3: altered functional status with uncontrolled comorbidity; class 4: lost functional status with uncontrolled comorbidity), presence of disability, use of anticoagulants, type of telemedicine service used (interactive or non-interactive), and whether follow-up consultations had been held with the internal medicine service via telexpertise.

The information was entered into a data collection form created in Microsoft Excel for this purpose. In addition, before extracting and entering the information from all the patients in the form, a pilot test was performed to verify that the data were included and organized appropriately.

Bias control

All patients with multimorbidity who had enrolled in the program were included to control for selection bias, which means that there was no preference for patients or diseases that demonstrated better performance for profile classification.

Information bias was controlled for by tabulating the information of the variables to be evaluated in the data collection form and confirming that it coincided with the information reported in the patients' medical record. The data confirmation process was carried out independently by two of the authors (ECM and VOO).

Finally, since the information was taken from the electronic medical records, some patients had missing data on some variables because they were not recorded by the treating physician upon program entry. Therefore, in an attempt to control measurement bias in these cases, medical notes from other medical visits during the course of the program were reviewed to complete this information.

Statistical analysis

Data are described using absolute frequencies and percentages for categorical variables and medians and interquartile ranges (IQR) for continuous variables as the data showed a nonparametric distribution (histograms and Shapiro-Wilk test).

In turn, machine learning methods were used to determine clinical profiles. Categorical variables were transformed into quantitative variables using the one hot encoding method. In addition, the elbow method was used to determine the optimal number of groups or clusters (K), which is a graphical method that allows finding the optimal value of K or clusters based on the relationship between the Within Cluster Sum of Squares (WCSS) values on the y-axis and the different values of K or number of clusters on the x-axis.[27] The number of clusters was selected starting from the point where the function starts to decrease, suggesting an optimal number of clusters and forming an elbow in the graph.

Subsequently, the K-means clustering method was used to establish the clinical profile groups based on the variables considered.[27] With this method, the number of clusters previously established was used and associated with a central point or centroid for each cluster. Patients were represented as points in space and were assigned to one of the previously selected clusters depending on their proximity to a centroid. All analyses were performed in the Python 3.12.0 software.

Ethical considerations

The study followed the ethical principles for biomedical research involving human subjects established in the Declaration of Helsinki,[28] as well as the scientific, technical and administrative standards for health research contained in Resolution 8430 of 1993 issued by the Colombian Ministry of Health.[29] Furthermore, it was approved by the HAMA Research Committee according to Minutes No. 227 of November 21, 2023.

Results

A total of 2 035 adult patients with multimorbidity who received health care services via telemedicine at least once between January 2017 and December 2023 as part of the HAMA's home care program were included. The median age was 79 years (IQR=71-78), 67.27% (n=1 369) were women, and CKD, AHT, and mental or neurodegenerative disease were the most frequent conditions (91.50%, 84.67%, and 72.63%, respectively). In addition, 53.91% had some form of disability and 50.22% were classified as functional class 4, that is, they had lost functional status along with an uncontrolled comorbidity. Finally, non-interactive telemedicine was the most frequently used telemedicine modality (76.56%; n=1 558) (Table 1).

Table 1. Demographic and clinical characteristics of patients with multimorbidity who received medical care services via telemedicine as part of a home care program at a university hospital in Medellín depending on their assignment to one of the four clinical profile clusters obtained using the K-means clustering method.

Characteristic		Total sample (n=2 035)	Cluster 0 (n=656)	Cluster 1 (n=463)	Cluster 2 (n=653)	Cluster 3 (n=263)
Age, median [IQR]*		79 [71-87]	83 [74-88]	74 [62-85]	79 [70-87]	81 [74-89]
Sex, n (%)	Female	1 369 (67.27)	519 (79.12)	0 (0)	653 (100)	197 (74.90)
	Male	666 (32.73)	137 (20.88)	463 (100)	0 (0)	66 (25.10)
Arterial hypertension, n (%)		1 723 (84.67)	594 (90.55)	343 (74.08)	555 (84.99)	231 (87.83)
Type 2 diabetes mellitus, n (%)		1 012 (49.73)	346 (52.74)	194 (41.90)	312 (47.78)	160 (60.84)
Chronic kidney disease,, n (%)		1 862 (91.50)	622 (94.82)	397 (85.75)	591 (90.51)	252 (95.82)
Chronic obstructive pulmonary disease, n (%)		698 (34.30)	255 (38.87)	134 (28.94)	195 (29.86)	114 (43.35)
Mental or neurodegenerative disease, n (%)		1 478 (72.63)	300 (45.73)	444 (95.90)	632 (96.78)	102 (38.78)
Cancer, n (%)		208 (10.22)	71 (10.82)	59 (12.74)	58 (8.88)	20 (7.60)
Functional class, n (%)	1	31 (1.52)	11 (1.68)	5 (1.08)	13 (1.99)	2 (0.76)
	2A	314 (15.43)	119 (18.14)	43 (9.29)	79 (12.10)	73 (27.76)
	2B	413 (20.29)	164 (25)	60 (12.96)	81 (12.40)	108 (41.06)
	3	253 (12.43)	105 (16)	63 (13.61)	69 (10.57)	16 (6.08)
	4	1 022 (50.22)	255 (38.87)	292 (63.07)	411 (62.94)	64 (24.33)
Chronic kidney disease stage, n (%)*	1	214 (11.49)	54 (8.68)	74 (18.64)	70 (11.84)	16 (6.35)
	2	554 (29.75)	171 (27.49)	109 (27.46)	172 (29.10)	102 (40.48)
	3	29 (1.56)	12 (1.93)	4 (1.01)	7 (1.18)	6 (2.38)
	3A	300 (16.11)	133 (21.38)	51 (12.85)	86 (14.55)	30 (11.90)
	3B	372 (19.98)	138 (22.19)	79 (19.90)	112 (18.95)	43 (17.06)
	4	228 (12.24)	86 (13.83)	26 (6.55)	66 (11.17)	50 (19.84)
	5	49 (2.63)	11 (1.77)	4 (1.01)	34 (5.75)	0(0)
	Not specified	121 (6.50)	17 (2.73)	50 (12.59)	44 (7.45)	10 (3.97)
Disability, n (%)		1 097 (53.91)	0 (0)	425 (91.79)	651 (99.69)	21 (7.98)
Use of anticoagulants, n (%)		319 (15.68)	121 (18.45)	73 (15.77)	106 (16.23)	19 (7.22)
Type of telemedicine modality used, n (%)	Interactive telemedicine	477 (23.44)	142 (21.65)	93 (20.09)	147 (22.51)	95 (36.12)
	Non-interactive telemedicine	1 558 (76.56)	514 (78.35)	370 (79.91)	506 (77.49)	168 (63.88)
Telexpertise by internal medicine, n (%)		552 (27.13)	0 (0)	131 (28.29)	158 (24.20)	263 (100)

IQR: interquartile range.
* The n of the subgroups is: Cluster 0: 622; Cluster 1: 397; Cluster 2: 591; Cluster 3: 252; and total: 1 862.

Regarding the K-means clustering algorithm, according to the elbow method, the point at which a change in WCSS was considered was 4, suggesting a grouping into 4 clusters or clinical profiles (Figure 1).

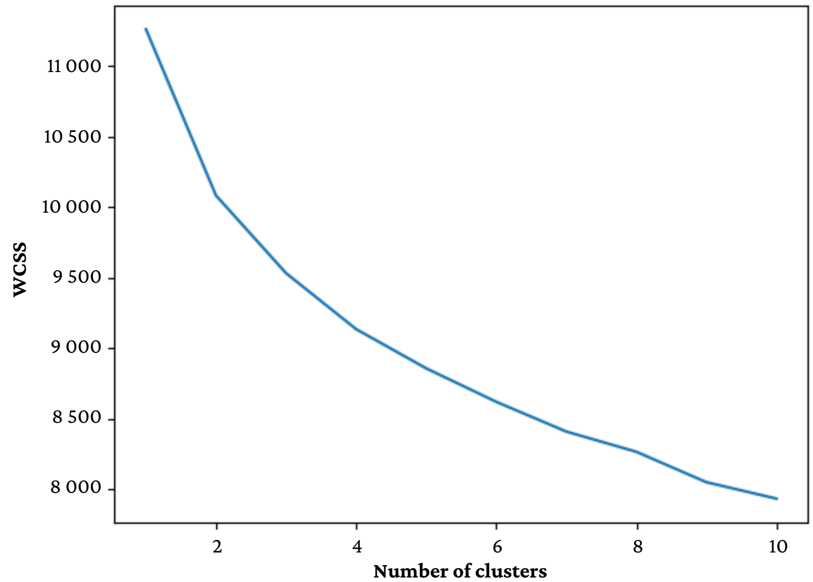

Figure 1. Elbow method to establish the number of clusters in a K-means clustering algorithm. The y-axis shows the Within Cluster Sum of Squares Values and the x-axis shows the different K values or number of clusters.

Cluster 0 included 519 women (79.12%) and 137 men (20.88%) with a median age of 83 years (IQR=74-88); the most common diseases were CKD (94.82%), AHT (90.55%), and DM2 (52.74%); and the most frequent functional class was class 4 (38.87%). This cluster did not include patients with disabilities or patients who had received medical care from internal medicine service professionals via telexpertise.

Cluster 1 was exclusively comprised of men (n=463) with a median age of 74 years (IQR=62-85) and a high prevalence of mental or neurodegenerative disease (95.90%), CKD (85.75%), and AHT (74.08%). In addition, 91.79% (n=425) had a disability and 63.07% were classified as functional class 4.

Cluster 2 was made up entirely of women (n=653) with a median age of 79 years (IQR=70-87), and the most frequent diseases were mental or neurodegenerative disease (96.78%), CKD (90.51%), and AHT (84.99%); in addition, 34 of the patients with CKD (5.75%) were at stage 5. In this cluster, almost all patients were disabled (99.69%) and 62.94% (n=411) were classified as functional class 4.

Cluster 3 had 197 women (74.90%) and 66 men (25.10%) with a median age of 81 years (IQR=74-89), with CKD (95.82%), AHT (87.83%), and DM2 (60.84%) being the most prevalent conditions. Regarding functional status, it was observed that most patients had a preserved functional status, with 41.06% (n=108) presenting functional class 2B and 27.76% (n=73) presenting functional class 2A. Other noteworthy characteristics in this cluster were that all patients had received medical care from internal medicine service professionals via telexpertise and that most of them (92.08%) did not have any disability.

Finally, it should be noted that the proportion of patients with cancer was low and similar in the four clusters (7.60%-12.74%).

Discussion

This study demonstrated that adult patients with NCDs who received medical care via telemedicine as part of their disease treatment in a tertiary care university hospital in Medellín (Colombia) can be grouped into four clusters or clinical profiles based on their demographic and clinical characteristics.

Cluster 0 was made up of non-disabled patients with a high prevalence of CKD, AHT, and DM2 who were not followed up by the internal medicine service through telexpertise and was predominantly female (>70%). Similarly, there was a high frequency of these 3 diseases and a predominance of women in cluster 3, but all patients had been followed up by internal medicine specialists via telexpertise; in addition, there was a higher proportion of patients with better functional status than in the other clusters. Cluster 1 consisted only of men with a high prevalence of mental or neurodegenerative disease, CKD, and AHT, and the majority (>90%) had a disability and a high proportion of lost functional status (>60%). In contrast, only women were assigned to cluster 2, but, similar to cluster 1, the majority had a disability and a high proportion of lost functional status. In this cluster, the most frequent conditions were also mental or neurodegenerative disease and CKD, but the third most common was DM2; furthermore, a much higher proportion of patients with stage 5 CKD was observed in this group than in the other clusters (5.75% vs 0-1.67%).

Clustering patients with multimorbidity into profiles based on demographic and clinical variables has become a growing area of study in recent years.[9,30] Analyzing these profiles partly stems from the need to think of diseases as conditions that may be related to each other in the same individual, rather than as independent entities.[31,32] It has also been proposed that the pathogenesis of multimorbidity may involve shared variables between diseases, or even factors apparently unrelated, that influence the clustering of these conditions in patients with chronic diseases.[31,33]

For example, it has been described that typical cardiovascular disease risk factors such as AHT, DM2, dyslipidemia, and smoking are highly prevalent in patients with CKD, meaning that both conditions or groups of conditions share these risk factors.[34] This is consistent with what was observed in our study, as many of the patients with CKD (85.75%-95.82%) had a high prevalence of AHT (74.08-90.55%) and DM2 (41.90-60.84%) in all clusters.

In the present study, it was found that there was a high prevalence of DM2 (41.90 and 47.78%) in the clusters with the highest proportion of patients with mental or neurodegenerative disease (profiles 1 and 2). In this regard, Frank *et al.*,[35] in a study using data from 240 433 adults obtained from 3 cohort studies conducted in the United Kingdom (UK Biobank: 130 652) and Finland (Health and Social Support Study [HeSSup]: 23 459; Finnish Public Sector Study [FPS]: 86 322), reported that severe/moderately severe depression was significantly associated with 29 health conditions requiring inpatient treatment, including DM (HR: 5.15, 95%CI: 2.52-10.50).

Likewise, it has been described that some drugs such as tricyclic antidepressants can cause insulin resistance,[36] leading to the development of DM2 in these patients. Another study conducted by Stubbs *et al.*[37] with data from 190 593 people from 43 middle and low-income countries, despite not addressing the direct association of mental disorders such as depression with diabetes, suggests that there are bidirectional associations between the presence of multimorbidity and the presence of any form of depression (subsyndromal depression, depressive episode, or brief depressive episode).

Disability was identified as a prevalent condition in clusters with a higher proportion of patients with mental disorders or neurodegenerative diseases (profiles 1 and 2). In this regard, Farfel *et al.*,[38] in a cohort study with 1 509 patients from the United States (Religious Orders Study or Rush Memory and Aging Project), observed that Alzheimer's disease, with and without dementia, was associated with impairments in basic activities of daily living (BADL) (OR: 1.52, 95%CI: 1.25-1.86) and instrumental activities of daily living (IADL) (OR: 1.64, 95%CI: 1.36-1.99), which are indicator variables of functional disability. In turn, van de Beek *et al.*,[39] in a study including 100 patients from Amsterdam (The Netherlands) with Lewy body dementia (DEmEntia with LEwy bOdies Project (DEvELOP) - Amsterdam Dementia Cohort), found that cognitive fluctuations and the presence of parkinsonism in these patients were associated with increased dependence for IADLs (β: 4.75, SD=1.15, and β: 3.42, SD=1.34, respectively).

It has also been described that NCDs are associated with alterations in functionality.[40] On this matter, Wong *et al.*,[41] in a systematic review and meta-analysis that included 26 observational studies and clinical trials, found that diabetes was associated with mobility disability (OR: 1.71, 95%CI: 1.53-1.91), as well as BADL disability (OR: 1.82, 95%CI: 1.63-2.04) and IADL disability (OR: 1.65, 95%CI: 1.55-1.74). Moreover, Lisy *et al.*,[42] in a systematic review (N=105 studies) that aimed to examine the frequency of disability in individuals with NCDs, reported that the prevalence of difficulties in performing ADLs varied between 10.40% and 34.50% in cancer survivors, between 21.10% and 64.10% in patients with cardiovascular disease, between 7.40% and 49.80% in patients with COPD, and between 12.20% and 54.50% in patients with diabetes.

Profiling analyses of patients with multiple chronic diseases have been described in the literature, but their practical application in medical care remains unclear.[9] In clinical practice, patient management usually focuses on treating each disease individually, targeting its characteristics and treatments independently.[43-45] However, the use of patient profiles allows for a more comprehensive perspective on health status by considering the coexistence of multiple factors that influence the course of a disease, the patient's clinical condition, and the use of health resources.[30,46,47]

One of the strategies implemented in several health systems to individualize care is grouping patients through models based on baseline risk characterization.[48,49] For example, Orueta *et al.,*[48] in a cross-sectional study conducted in primary care centers in Bizkaia, Basque Country (Spain), involving 78 130 patients, found that the adjusted morbidity groups, as a new population morbidity grouper, had an explained variability of 56.80% in a linear regression model for the visits to primary care medical centers outcome. Multimorbidity profiles, such as adjusted mobility groups, could be key tools for population stratification, with applications in both clinical management and resource administration,[49] in this case in patients under telemedicine management.

These profiles can be used as a basis for the design of specific follow-up strategies, prioritization of interventions, or allocation of resources by level of clinical complexity. Accordingly, although our study had an exploratory approach, it represents a first step towards more segmented and efficient models of care in the home care program, especially when the consultation has taken place at least once via telemedicine. This is highly relevant as the COVID-19 pandemic prompted a rapid adoption of telemedicine by health systems, not only for the care of patients affected by COVID-19, but also for chronic disease management.[50,51]

At the same time, the use of tools such as teleconsultation and telemonitoring has demonstrated a reduction in the number of hospital admissions among patients with chronic diseases.[52,53] For example, Martín-Lesende *et al.,*[52] in a randomized clinical trial that evaluated the impact of telemonitoring in home care vs. traditional management on 58 patients with heart failure or COPD treated in 20 health centers in Spain, found that the risk of all-cause hospitalization at 12-month follow-up dropped by 34% in the telemonitoring group (RR: 0.66, 95%CI: 0.44-0.99).

In the same vein, Steventon *et al.,*[53] who evaluated the effect of telehealth vs. traditional management on secondary health care utilization and mortality in a cluster clinical trial conducted in England in 3 230 people with diabetes, COPD, or heart failure (179 general practices), found that hospital admission and mortality rates at 12-month follow-up were lower in the telehealth group (42.90% vs. 48.20%; OR: 0.82, 95%CI: 0.70-0.97, and 4.60% vs. 8.30%; OR: 0.54, 95%CI: 0.39-0.75, respectively). Notwithstanding the above, Greer *et al.*,[54] in a randomized multicenter clinical trial comparing the use of telehealth vs. face-to-face care in terms of quality of life in patients with advanced lung cancer in palliative care, reported that there was no difference between groups in quality of life scores (99.70% vs. 97.70%; difference: 2, 90%CI: 0.10-3.90; p=0.40).

All of the foregoing makes evident the need to analyze the effectiveness of telehealth interventions in this population depending on their grouping into clinical profiles (e.g., whether patients with a certain profile might benefit more from these interventions than those with other profiles).

The present study has several limitations. First, it does not include variables that have been proven to modify the results obtained by morbidity clustering, such as socioeconomic level,[55,56] the need for a caregiver,[57] and polypharmacy,[58,59] so it is important to consider new hyperparameters within the clustering models. Second, there is a lack of cluster validation in other contexts or populations, restricting the generalization of the results.[60] Finally, there is scant evidence available on the characterization of older patients with chronic diseases using multimorbidity profiles, thus making it difficult to make comparisons in our context.[61]

Conclusions

Patients with multimorbidity treated via telemedicine (at least once) in a home care program delivered through telemedicine at a referral university hospital in Medellín can be grouped into four clinical profiles that differ from each other by sex, combination of chronic diseases, functional class, and presence of disability. Likewise, these profiles can be used to assess the use of specific program services such as evaluation by internal medicine specialists through telexpertise. Although the findings are not yet directly applicable in clinical practice, they provide a basis for further studies aimed at developing care strategies for these patients depending on the characteristics of each profile.

Conflicts of interest

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