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ORIGINAL

EFFECTS OF AN EXERCISE PROGRAM IN ADULTS WITH CHRONIC KIDNEY DISEASE

EFECTOS DE UN PROGRAMA DE EJERCICIO EN ADULTOS CON ENFERMEDAD RENAL CRÓNICA

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ABSTRACT

Objective: To determine the effect of an exercise program on functional status, pain perception and self-perceived health (SPH) in patients with and without chronic kidney disease (CKD) in primary care (PC). **Methodology:** Group pre- and postintervention, single-center study of adults with and without CKD in PC. The intervention was a 6-week multicomponent exercise program. Results were evaluated with scales of functional assessment, pain perception and SPH. **Results:** A total of 523 adults participated (256 with CKD and 267 without CKD). Significant increases were found for the Barthel index, the Short Physical Performance Battery

(SPPB) score, grip strength and calf perimeter. There was improvement in pain perception and SPH ($p < 0.001$) in all patients. **Conclusions:** In the studied sample, an exercise program produced improvements in functional status, pain perception and SPH.

KEYWORDS: Chronic kidney disease, physical exercise, adults, primary health care

RESUMEN

Objetivo: determinar el efecto de un programa de ejercicio en el estado funcional, la percepción de dolor y Autopercepción de Salud (APS) en pacientes con y sin enfermedad renal crónica (ERC) en Atención primaria (AP). Metodología: estudio de diseño de grupo antes y después de la intervención, unicéntrico, en adultos con y sin ERC en AP. Intervención con programa de ejercicio multicomponente por 6 semanas, evaluándose escalas de valoración funcional, percepción de dolor y APS. Resultados: Participaron 523 adultos (256 con ERC y 267 sin ERC). Se constató incrementos significativos en la escala de Barthel, la batería de desempeño Short Physical Performance Battery (SPPB), fuerza de agarre y perímetro de pantorrilla. Hubo mejoría en la percepción de dolor y la APS ($p<0{,}001$) en todos los pacientes. Conclusiones: Para la muestra estudiada, un programa de ejercicio produjo mejoría del estado funcional, la percepción de dolor y la APS.

PALABRAS CLAVE: Enfermedad renal crónica, ejercicio físico, adultos, atención primaria de salud

1. INTRODUCTION

Chronic kidney disease (CKD) is defined as structural damage to the kidney that is evidenced by markers of damage (urine, blood or imaging) for more than three months. It is stratified into five categories to identify patients with an early manifestation of the disease, establish measures to slow its progress, reduce morbidity and mortality, and, where appropriate, prepare patients for dialysis (Gámez Jiménez et al., 2013; Stevens et al., 2013)

The prevalence of CKD varies according to the region and the formula used to calculate the estimated glomerular filtration rate (eGFR). In reports from the United States, the prevalence without adjustment for age is 13%, which amounts to 37% when patients older than 70 years with category 3 or higher CKD are taken into account (Coresh et al., 2007). In Spain, the prevalence of CKD is approximately 20% in patients older than 60 years, which increases dramatically by up to 40% in patients older than 80 years and those with other associated comorbidities(Otero González et al., 2010). In Colombia, it is estimated that between 2% and 5% of the population has CKD, and 15.6% have category 3 to 5 disease (Lopera-Medina, 2016). The exact prevalence of CKD in older adults (OA) in Colombia is not known; nonetheless, it is clear that it increases with age (Acuña et al., 2016). Some studies estimate that the prevalence of CKD after 65 years is 7.93% in women and 5.26% in men and that this figure rises to 15.61% and 9.12%, respectively, after 80 years. The OA population especially prone to the development of renal diseases as a result of the changes of aging that generate structural and functional alterations of the kidney, as well as the presence of comorbidities that become more frequent in the OA (arterial hypertension, diabetes, cardiovascular diseases) and that produce a negative impact on renal function.

OA primary care patients and residents of geriatric homes who develop CKD have a higher risk of negative outcomes (Villanego et al., 2020). Among these, frailty, defined as a geriatric syndrome characterized by weakness, mobility problems, sarcopenia, balance and minimal reserve, is highly prevalent in patients with CKD and leads to greater vulnerability to stressful situations and an increased risk of falls, hospitalization, loss of functionality and death. Additionally, CKD leads to the deterioration of quality of life and perceived health(Pinillos-Patiño et al., 2019; Zazzeroni et al., 2017) and increased pain sensation (Villate et al., 2014). In addition to these negative clinical outcomes, OAs have a low level of physical activity (Martínez et al., 2010).In Colombia, the results of the National Survey of Health, Well-being and Aging (Encuesta Nacional de Salud, Bienestar y Envejecimiento (SABE)) indicate that only 20% of adults over 60 years of age engage in some type of physical activity, and this value decreases to 7% in those over 80 years. Although the benefits of physical activity for the general population are widely known, it was long believed that exercise was not recommended for patients with CKD because of the possibility of an increase in proteinuria, which would deteriorate renal function(Saeed et al., 2012). However, regular exercise is currently recommended for those in early categories of CKD as it has been shown that exercise improves patients' physical condition and function, pain perception, quality of life and perception of health; decreases the probability of developing affective disorders; and even reduces mortality(Cuesta-Vargas & Corpas, 2016; Pham et al., 2017; Zelle et al., 2017). The current literature on the benefits of physical exercise in adults with CKD is limited and focuses specifically on patients in advanced stages and those who are already receiving renal replacement therapy. For this reason, the objective of this research was to evaluate the effects of a multicomponent exercise program on the functional status, pain perception and general health status of adults with and without CKD in primary care.

2. MATERIAL AND METHODS

2.1 Design

A single-center group pre- and postintervention study conducted between June and December 2019. The study protocol included informed consent according to the institutional guidelines of the Ethics Committee of the Universidad Libre of Cali and the Gesencro Clinic of Palmira, Colombia.

2.2 Participants

Adult patients enrolled in a comprehensive primary care program for CKD. A total of 540 patients were included. The inclusion criteria were as follows: adults, sedentary (less than 3 hours of physical activity per week) and a Barthel index greater than 40 points. The exclusion criteria were life expectancy less than 6 months, severe dementia, unstable clinical condition (for example, a recent acute coronary event), moderate or severe heart valve disease, amputations, or neuromuscular disorders (for example, disabling motor diseases) or sequelae of a cerebrovascular accident (CVA). A total of 17 patients were excluded.

2.3 Intervention

The adults included in the multicomponent physical exercise program received a previous medical-sports assessment that determined their needs and then were evaluated by a physical educator in the program to determine whether they met the inclusion/exclusion and to make individualized medical recommendations. Baseline and final measurements of the pre-established variables were taken (Figure 1). In each exercise session, an athlete and a physical educator provided follow-up.

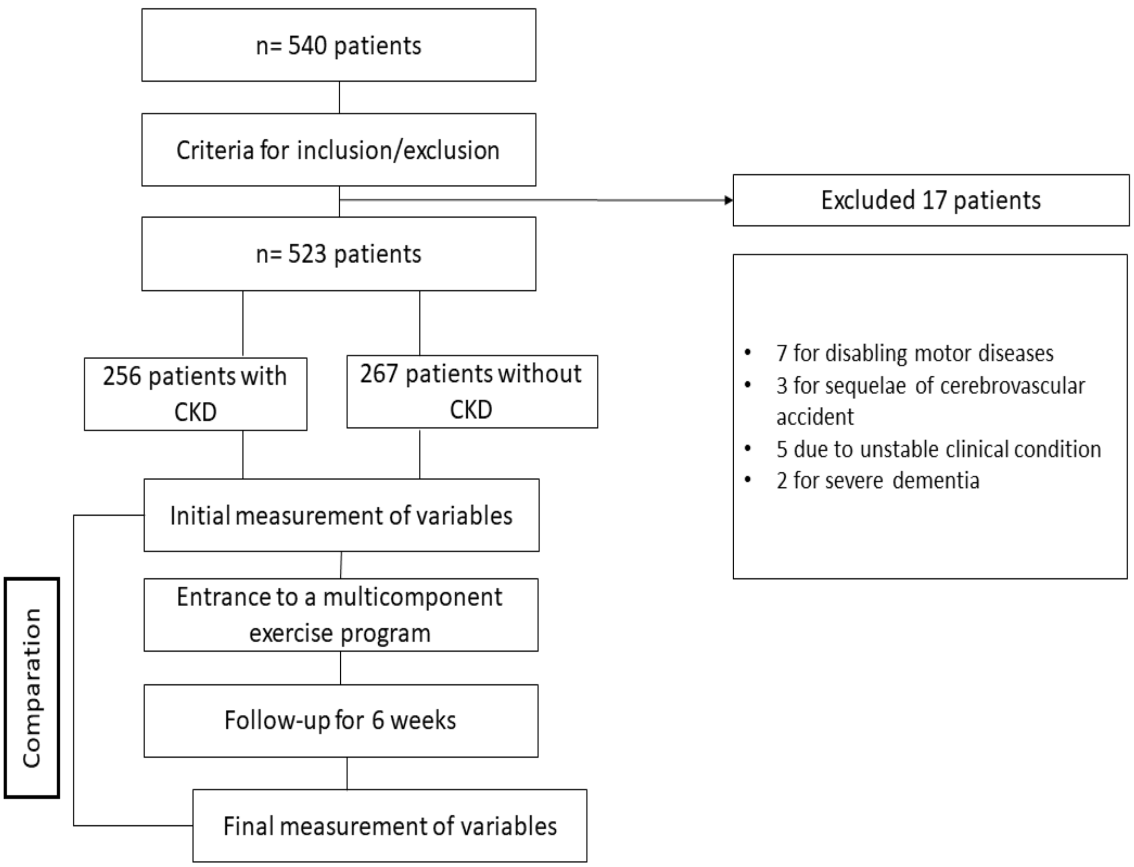

Figure 1. General outline of the protocol

Subsequently, the institutional database of patients was reviewed to obtain complete patient information. The multicomponent exercise protocol consisted of 12 sessions (twice a week for six weeks) following the guidelines of a validated protocol and was composed of four phases: warm-up, aerobic exercise, muscle toning and recovery (Table 1)(Todde et al., 2016).

Continuous heart rate monitoring, supervised by a physical educator, was performed. In addition, emphasis was placed on improving perceptual abilities (sensory discrimination, coordination, balance, orientation), fine motor skills and sociomotor abilities (body expression, dance, group play) (see supplementary material). All the patients included in the study completed at least 80% of the physical exercise sessions scheduled in the protocol.

Table 1. Exercise protocol used in the study.

Phases of the exercise protocol	Activities to practice
Warm-up (10 minutes)	Slow movements of the main muscles of the lower, middle and upper body, followed by stretching exercises.
Aerobic exercise and muscle toning (up to 45 minutes)	Continuous and interval dynamic exercises involving the large muscles, with increasing intensity. Rhythmic activities such as dance and body expression were included, along with walking circuits. For muscle toning, self-loading exercises and strength circuits were performed.
Recovery (10 minutes)	Stretching exercises, postural hygiene and relaxation techniques.

Source: *Adapted from Todde et al.* [16]

2.4 Variables

The independent variables included age, sex, sociodemographic factors, CKD and laboratory examination results such as albumin, glycemia, total cholesterol, triglycerides, creatinine and eGFR values.

The outcome variables (which were evaluated before and after the implementation of the exercise protocol) were functional variables that included the assessment of disability and dependence using the Barthel index; physical function using grip strength and the Short Physical Performance Battery (SPPB); anthropometric variables (weight, body mass index (BMI) and calf circumference); and clinical variables (blood pressure, heart rate and pulse pressure). Other dependent variables were pain, assessed using a visual analog scale (VAS) (none, mild, moderate, and severe) and self-perceived health (SPH) (poor, fair, good and excellent).

2.5 Definitions

CKD: Abnormalities of kidney function or structure for more than three months, indicated by either a glomerular filtration rate (GFR) lower than 60 ml/min/1.73 m^2, the presence of kidney damage due to proteinuria or persistent hematuria, structural abnormalities observed on radiological studies or chronic glomerulonephritis proven by biopsy.[1] For our study, the parameter eGFR < 60 ml/min/1.73 m^2, calculated with the Cockcroft-Gault equation, was used (Cockcroft & Gault, 1976).

Barthel index: This is an ordinal scale that assesses the patient's level of independence for the performance of certain basic activities of daily life. Different scores and weights are assigned according to the subject's ability to carry out these tasks. activities. The index is a predictor of functional deterioration, mortality, hospital stay, social support and institutionalization. Patients are classified according to the score obtained as having total (< 20), severe (20-35), moderate (40-55) or mild (60-95) dependence or as independent (100) (Cid-Ruzafa & Damián-Moreno, 1997). SPPB test or battery: This measure consists of three tests: balance (in three positions: feet together, semi tandem and tandem), gait speed (over 4 meters) and getting up from and sitting down in a chair five times. The average administration time, with training, is between six and 10 minutes. The total score on the SPPB is derived from the sum of the three subtests and ranges from 0 (severe limitation) to 12 (no limitation); a score below 10 indicates frailty and a high risk of disability and falls (Guralnik et al., 1994). Grip strength: This method is used to assess strength through static dynamometry and consists of the measurement or recording of isometric force. The flexor muscles of the fingers of the hand are evaluated. Grip strength is a reliable and safe measure of general muscle strength, and a direct association between grip strength and long-term mortality has been shown (Giraldo et al., 2003). Grip strength was measured using a hand dynamometer (Jamar Hydraulic Hand Dynamometer®). The average normal values described for this dynamometer are 40 kg (60 to 69 years) and 36 kg (70 to 79 years). Calf perimeter: This measure is an indicator of muscle and fat tissue. It has an important role in the determination of body composition in adults and has been evaluated as a marker of malnutrition or loss of muscle mass. A calf perimeter less than 31 cm indicates sarcopenia (López Lirola et al., 2016).

Pain measurement scale: This scale seeks to clinically measure pain through verbal or written information reported by the patient. For this purpose, the VAS was used, which consists of a straight line whose ends indicate the minimum (absence of pain) and maximum (the worst pain) values. The following categories were assigned to the VAS: no, mild, moderate, or severe pain. Patients are asked to indicate the point on the line that corresponds to their pain level. For the analysis, perceived pain was dichotomized into two categories: no or mild pain and moderate or severe pain (García Romero et al., 2002). SPH: SPH is a simple but complete measure for evaluating the health of individuals that takes multiple dimensions into account and constitutes a valid and relevant indicator of health status. It is associated with disease outcomes and health services use, and, according to some studies, can serve as a predictor of mortality (Navarro et al., 2020). Generally, the question “How would you describe your health today?” is asked, and the possible answers are “excellent”, “good”, “fair” or “bad”. For the analysis, SPH results were dichotomized into two categories: fair or poor and good or excellent (García, 2020).

2.6 Statistical analysis

For categorical variables, proportions (%) were estimated; the mean ± standard deviation (SD) was used for numerical variables. To descriptively analyze the differences between the groups with and without CKD, the chi-square test (chi^2) or Fisher’s test (for results with 5 cells or less) was used for categorical variables; for numerical variables, Student’s t test was used. A bivariate analysis of the independent variables (having or not having CKD) and the dependent variables (the

Barthel index, the SPPB scale, grip strength and clinical and anthropometric variables) measured before (initial) and after (final) the intervention was then performed using the paired t test. For the analysis according to pain and SPH categories before (initial) and after (final) the intervention, the McNemar test was used. The level of statistical significance selected was $p < 0.05$. All analyses were performed using the statistical program SAS version 9.4 for Windows (SAS Institute, Inc., Cary, NC).

3. RESULTS

In total, 523 patients who met the inclusion criteria participated in the study. The mean age of the study participants was 68.3 ± 10.5 years [range 33 to 96], with those 65 years or older comprising 62.9%, and there was a predominance of female patients (89.1%). The most frequent chronic diseases were arterial hypertension ((89.3%), diabetes (35.4%), chronic obstructive pulmonary disease (8.3%) and arthritis (5.4%). Most of the patients included presented category 2 and 3 CKD (Table 2). Of the total number of patients evaluated, 256 (49%) had CKD, and 267 (51%) did not. Of the analyzed clinical variables, the patients with CKD had a 1.74-mmHg decrease in systolic blood pressure, while in patients without CKD, the decrease was 1.56 mmHg.

Diastolic blood pressure showed a 1.04-mmHg decrease in patients with CKD compared to a 1.1-mmHg decrease in patients without CKD. The pulse pressure of the patients with CKD showed a decrease of 0.70 mmHg, while in the patients without CKD, the decrease was 0.44 mmHg. Additionally, the heart rate decreased by 0.69 beats per minute (bpm) in the group with CKD and by 0.25 bpm in the group without CKD (Table 3).

Table 2(a). General characteristics of the study population (n = 523)

Variable	All	Chronic kidney disease		p value
		Yes (n = 256)	No (n = 267)	
Age, years, mean ± SD	68.3 ± 10.5	74.4 ± 8.7	62.4 ± 8.7	<0.001 [a]
AGE GROUP, N (%)				
< 65	194 (37.1)	33 (17.0)	161 (83.0)	<0.001 [b]
65-74	177 (33.8)	93 (52.5)	84 (47.5)	
≥75	152 (29.1)	130 (85.5)	22 (14.5)	
GENDER, N (%)				
FEMALE	466 (89.1)	220 (47.2)	246 (52.8)	0.023 [b]
MALE	57 (10.9)	36 (63.2)	21 (36.8)	
CHRONIC DISEASES, N (%)				
AHT	467 (89.3)	237 (50.8)	230 (49.2)	0.017 [b]
DIABETES	185 (35.4)	82 (44.3)	103 (55.7)	0.117 [b]
COPD	43 (8.3)	22 (51.2)	21 (48.8)	0.761 [b]
ARTHRITIS	28 (5.4)	12 (42.9)	16 (57.1)	0.507 [b]
COMORBIDITY, N (%)				
0	21 (4.0)	0 (0.0)	21 (100.0)	<0.001 [c]
1	150 (28.7)	13 (8.7)	137 (91.3)	
2	240 (45.9)	143 (59.6)	97 (40.4)	
3	100 (19.1)	91 (91.0)	9 (9.0)	
4	11 (2.1)	8 (72.7)	3 (27.3)	

Table 2(b). General characteristics of the study population (n = 523)

Variable	All	Chronic kidney disease		p value
		Yes (n = 256)	No (n = 267)	
5	1 (0.2)	1 (100.0)	0 (0.0)	
CLINICAL VARIABLES, MEAN ± SD				
GLOMERULAR FILTRATIONRATE (GFR), ML/MIN	66.0 ± 27.3	45.3 ± 9.1	85.3 ± 24.2	<0.001 [a]
ALBUMIN, G/DL	4.4 ± 0.3	4.3 ± 0.3	4.4 ± 0.3	0.117 [a]
GLYCEMIA, MG/DL	107.8 ± 36.3	104.5 ± 26.4	111.3 ± 44.1	0.058 [a]
TRIGLYCERIDES, MG/DL	147.5 ± 74.2	140.4 ± 69.0	154.3 ± 78.4	0.035 [a]
TOTAL CHOLESTEROL, MG/DL	173.6 ± 40.8	173.8 ± 38.8	173.3 ± 42.7	0.886 [a]
CATEGORIES OF CKD ACCORDING TO GLOMERULAR FILTRATION RATE (GFR)				
G1 (> 90)	93 (17.8)			
G2 (60-89)	174 (33.3)			
G3A (45-59)	134 (25.6)			
G3B (30-44)	101 (19.3)			
G4 (15-29)	14 (2.7)			
G5 (< 15)	7 (1.3)			

P value obtained with a, t test, b, chi^2, c, Fisher
CKD = chronic kidney disease [GFR < 60 ml/min/1.73 m^2]; COPD = chronic obstructive pulmonary disease; AHT: arterial hypertension

In the analysis of the anthropometric variables, the calf perimeter increased by 0.65 cm in the patients with CKD and by 0.45 cm in the patients without CKD. Weight showed an increase of 0.37 kg in the patients with CKD and 0.04 kg in the patients without CKD; BMI showed an increase of 0.16 kg/m^2 in the patients with CKD and of 0.03 kg/m^2 in the patients without CKD (Table 3).

Table 3. (a) Bivariate analysis of chronic kidney disease and clinical and anthropometric variables before (initial) and after (final) the physical exercise program (n = 523)

	WITH CHRONIC KIDNEY DISEASE (N = 256)				WITHOUT CHRONIC KIDNEY DISEASE (N = 267)			
	BEFORE MEAN ± SD	AFTER MEAN ± SD	DIFFERENCE BETWEEN GROUPS (95% CI)	P VALUE	BEFORE MEAN ± SD	AFTER MEAN ± SD	DIFFERENCE BETWEEN GROUPS (95% CI)	P VALUE
CLINICAL VARIABLES								
SAT (MMHG)	125.1 ± 17.5	123.4 ± 17.9	-1.74 (-3.81 a 0.32)	0.097	122.1 ± 16.8	120.5 ±15.9	-1.56 (-3.54 a 0.42)	0.122
TAD (MMHG)	72.6 ± 9.4	71.6 ± 9.3	-1.04 (-2.24 a 0.17)	0.092	76.9 ± 10.3	75.8 ± 9.6	-1.11 (-2.22 a 0.00)	0.050
PP (TAS-TAD)	52.5 ± 15.7	51.8 ± 15.0	-0.70 (-2.48 a 1.07)	0.433	45.2 ± 13.0	44.8 ± 12.5	-0.44 (-2.02 a 1.15)	0.589
HR (BEATS/MIN)	76.3 ± 11.7	75.4 ± 11.1	-0.69 (-2.04 a 0.66)	0.315	78.0 ± 12.1	77.6 ± 12.1	-0.25 (-1.51 a 0.99)	0.687
ANTHROPOMETRY								

Table 3. (b) Bivariate analysis of chronic kidney disease and clinical and anthropometric variables before (initial) and after (final) the physical exercise program (n = 523)

CALF PERIMETER (CM)	**32.7 ± 3.5**	**33.4 ± 4.6**	**0.65 (0.17 a 1.13)**	**0.007**	**36.1 ± 4.1**	**36.5 ± 4.9**	**0.45 (-0.03 a 0.92)**	**0.065**
WEIGHT (KG)	59.8 ± 11.3	60.1 ± 11.2	0.37 (0.03 a 0.71)	0.031	73.1 ± 15.1	73.2 ± 14.9	0.04 (-0.15 a 0.24)	0.664
BMI (KG/M²)	25.1 ± 4.4	25.3 ± 4.5	0.16 (0.01 a 0.32)	0.044	29.5 ± 5.6	29.5 ± 5.6	0.03 (-0.07 a 0.12)	0.583

Abbreviations: SBP = systolic blood pressure; DBP = diastolic blood pressure; PP = pulse pressure; HR = heart rate; BMI = body mass index; CI = confidence interval; SD = standard deviation; the paired t test was used to obtain the p value

Regarding the analysis of functional variables, the Barthel index showed an increase of 0.72 points (p = 0.005) in the patients with CKD and 0.36 points in the patients without CKD (p = 0.117). The SPPB score showed an increase of 3.6 points (p < 0.001) in the patients with CKD and 4 points (p < 0.001) in the patients without CKD. Grip strength increased by 3.48 kg/force (p < 0.001) in the patients with CKD and by 4.10 kg/force (p < 0.001) in the patients without CKD (Table 4).

Table 4(a). Bivariate analysis of chronic kidney disease and functional variables before (initial) and after (final) the physical exercise program (n= 523)

	WITH CHRONIC KIDNEY DISEASE (N = 256)				**WITHOUT CHRONIC KIDNEY DISEASE (N = 267)**			
	BEFORE MEAN ± SD	**AFTER MEAN ± SD**	**DIFFERENCE BETWEEN GROUPS (95% CI)**	**P VALUE**	**BEFORE MEAN ± SD**	**AFTER MEAN ± SD**	**DIFFERENCE BETWEEN GROUPS (95% CI)**	**P VALUE**
FUNCTIONAL VARIABLES								
DISABILITY MEASURES								
BARTHEL INDEX	96.1 ± 8.8	96.8 ± 8.0	0.72 (0.22 a 1.23)	0.005	98.4 ± 4.9	98.8 ± 4.7	0.36 (-0.09 a 0.80)	0.117
MEASURES OF PHYSICAL FUNCTION								
SPPB SCALE (COMPONENTS)								
BALANCE TEST								
PARALLEL POSITION (SEC)	1.0 ± 0.2	1.0 ± 0.1	0.03 (0.01 a 0.05)	0.004	1.0 ± 0.1	1.0 ± 0.1	0.01 (-0.01 a 0.02)	0.318
SEMITANDEM POSITION (SEC)	0.6 ± 0.5	1.0 ± 0.2	0.32 (0.27 a 0.38)	<0.001	0.8 ± 0.4	1.0 ± 0.1	0.24 (0.19 a 0.29)	<0.001
TANDEM POSITION (SEC)	0.2 ± 0.5	1.5 ± 0.8	1.28 (1.17 a 1.39)	<0.001	0.3 ± 0.6	1.8 ± 0.6	1.49 (1.40 a 1.59)	<0.001
RISING FROM A CHAIR (SEC)	2.5 ± 1.2	3.7 ± 0.9	1.23 (1.10 a 1.35)	<0.001	2.6 ± 1.2	3.9 ± 0.5	1.32 (1.18 a 1.46)	<0.001
GAIT SPEED (M/SEC)	1.1 ± 0.3	1.8 ± 0.7	0.77 (0.68 a 0.85)	<0.001	1.1 ± 0.3	2.0 ± 0.6	0.93 (0.85 a 1.01)	<0.001

Table 4(b). Bivariate analysis of chronic kidney disease and functional variables before (initial) and after (final) the physical exercise program (n= 523)

	WITH CHRONIC KIDNEY DISEASE (N = 256)				WITHOUT CHRONIC KIDNEY DISEASE (N = 267)			
	BEFORE MEAN ± SD	AFTER MEAN ± SD	DIFFERENCE BETWEEN GROUPS (95% CI)	P VALUE	BEFORE MEAN ± SD	AFTER MEAN ± SD	DIFFERENCE BETWEEN GROUPS (95% CI)	P VALUE
SPPB SCALE (TOTAL SCORE)	5.4 ± 1.7	9.0 ± 2.1	3.60 (3.38 a 3.82)	<0.001	5.7 ± 1.6	9.7 ± 1.3	4.00 (3.79 a 4.21)	<0.001
GRIP STRENGTH (KG/FORCE)	14.6 ± 6.5	18.1 ± 6.4	3.48 (3.07 a 3.89)	<0.001	15.9 ± 6.4	20.0 ± 6.2	4.10 (3.67 a 4.53)	<0.001

Abbreviations: SD = standard deviation; CI = confidence interval; SPPB = Short Physical Performance Battery; the paired t test was used to obtain the p value

The analysis of the presence of pain showed that 29.4% of the patients with CKD had no pain or mild pain before starting the physical exercise program. After the program, the percentage of patients with CKD in this group increased to 91.8% (p<0.001). A total of 70.6% of the patients reported moderate or severe pain before the intervention, a proportion that decreased to 8.2% after the program (p<0.001) (Figure 2). Among the patients without CKD, before starting the program, 24.7% showed mild pain or no pain, and this proportion increased to 93.3% after the exercise program (p<0.001). A total of 75.3% of the patients reported moderate or severe pain before the intervention, a proportion that decreased to 6.7% (p<0.001) after the exercise program (Figure 2).

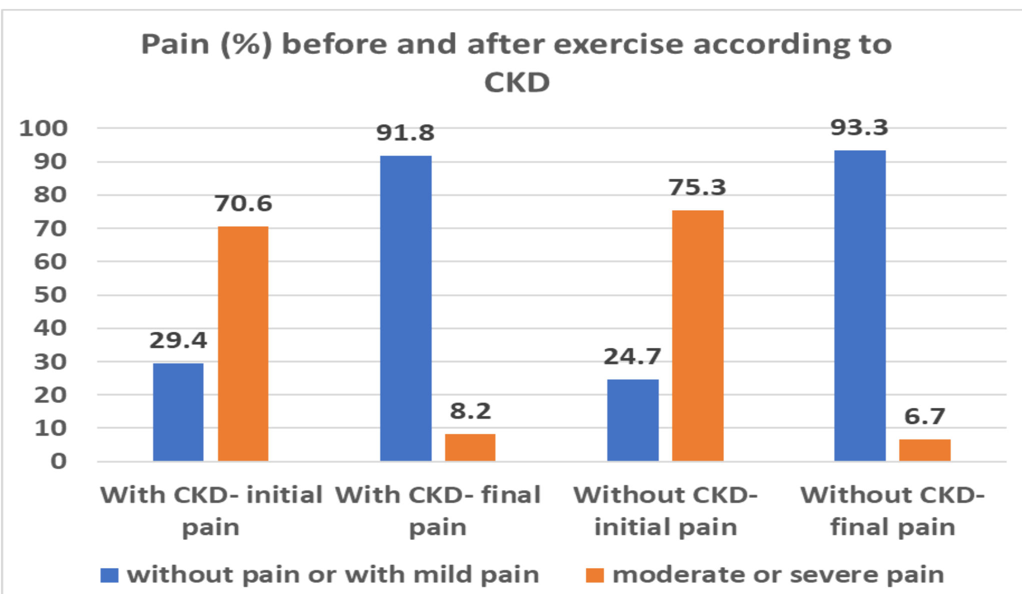

Figure 2: Analysis of chronic kidney disease and the presence of pain before (initial) and after (final) the physical exercise program (n = 523)
p <.0001 obtained by the McNemar test

In terms of SPH in the patients with CKD, 52% reported having fair or poor health before starting the physical exercise program, and 48% reported having good or excellent health. After the intervention, 8.2% reported having fair or poor health, compared to the 91.8% who reported having good or excellent health ($p<0.001$) (Figure 3). Regarding SPH in the patients without CKD, 55.1% reported having fair or poor health before starting the physical activity program, compared to the 44.9% who reported having good or excellent health. After the physical activity program, 6.7% reported having fair or poor health, compared to the 93.3% who reported having good or excellent health (Figure 3).

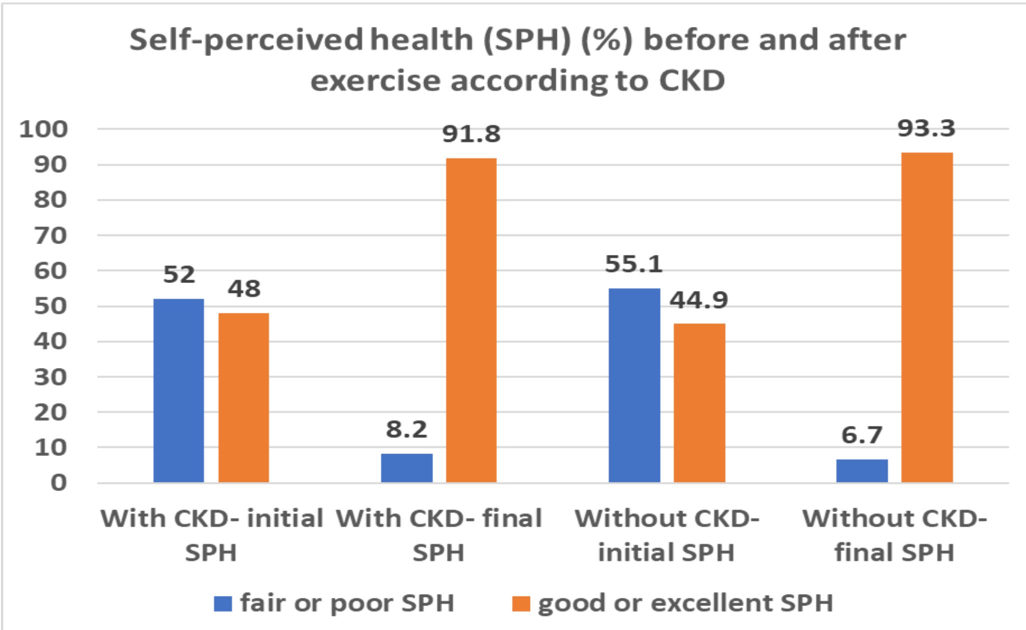

Figure 3. Analysis of chronic kidney disease and self-perceived health before (initial) and after (final) the physical exercise program (n = 523)
p < 0001 obtained using the McNemar test

4. DISCUSSION

The most significant findings of the present study of an intervention with a multicomponent physical exercise program include the improvement in the functional condition of the patients with CKD and improved scores on physical function tests for both the patients with CKD and those without CKD. Similarly, the physical exercise program was associated with significant improvement in the assessments of perceived pain and in the self-perceived global health status. It is noteworthy that the majority of the patients in our study were OA. The Barthel index values increased after the exercise program in all of the patients included in the study; however, the increase was only statistically significant in the patients with CKD. These results suggest that physical activity directly improve patients' independence in terms of their capacity to perform basic activities of daily life.[20] However, these results must be interpreted with caution, since clinically, they do not represent an important change in the degree of dependence or disability because for both groups of patients, the average scores before and after the intervention still indicate mild dependence. Other authors have demonstrated the benefit of physical exercise programs for OA patients in terms of variables that evaluate disability and dependence; however, such results have not been examined specifically in the OA population with CKD. In the literature review, no publications were found that evaluated the impact of a physical exercise program on disability and dependence in OAs with CKD in the primary care setting using the Barthel index or other standardized questionnaires(Martínez-Velilla et al., 2016; Martínez-Velilla et al., 2019).

Frailty is a highly prevalent condition among patients with CKD and is strongly associated with an increased risk of falls, hospitalization, functional impairment and death.[8] Some publications have reported that the prevalence of frailty in elderly individuals with CKD without dialysis is close to 14%, a figure that can increase drastically—by 40-70%—in patients who require dialysis and is associated with a 2.5-fold increase in mortality risk (Musso et al., 2015). The SPPB score is a useful tool for evaluating the presence of frailty; decreases of only 1 point have important clinical significance for the negative clinical outcomes mentioned above (Soler & Ruano, 2020). In the present study, improvement in the total score and each of the components of the SPPB (balance test in the parallel position, semi tandem position and tandem position; rising from a chair; and gait speed) was observed. This improvement was statistically significant in the bivariate analyses of adult patients with and without CKD (except for the parallel position item). As Table 4 shows, there were differences of 3.6 and 4 points (in adults with CKD and adults without CKD, respectively) in the total score of the SPPB, which implies that many patients were able to improve their limitations from severe or moderate to mild or minimal, that is, from presenting frailty to not presenting it.

These findings indicate that a physical exercise program improves conditions that could put the health and safety of adult patients at risk, such as the risk of falling or disability(Cantera et al.; Nogueira et al., 2019). These results have been observed in other studies, such as that of Marchesan, which included 15 patients with CKD and found that a physical exercise program significantly improved functionality variables in this population (Marchesan et al., 2016). Pain, understood as "an unpleasant sensory and emotional experience associated with actual or potential tissue damage"(Raja et al., 2019), is reported by up to 70% of patients with advanced CKD, and up to half of these patients classify their pain as moderate to severe (Metzger et al., 2021). Untreated pain negatively affects quality of life and can cause multiple complications, such as stress, depression, anxiety and a general reduction of life satisfaction (Koncicki et al., 2017).

Our results show a significant improvement in perceived pain after the exercise intervention, which has overall positive impact on quality of life. In the analysis of the results, a high percentage of patients with moderate or severe pain before the intervention indicated mild or no pain after the intervention. These results were observed for adults both with and without CKD. Very few publications have shown similar results, including a study by So Yon Rhee et al. that included 22 patients with CKD and found a reduction in perceived bodily pain after an exercise program (Rhee et al., 2019). However, only dialysis patients were included, and few participants were OAs.

SPH, as previously mentioned, is a multidimensional outcome variable that, according to studies, serves as an independent predictor of health outcomes and can anticipate the risk of mortality, functional decline, disability and the use of health services (Ocampo, 2010). The findings of our study indicate a significant improvement in SPH; a higher percentage of patients were classified as having good or excellent SPH after the physical exercise intervention. These results applied to both the adults with CKD and those without CKD. Therefore, the application of the physical exercise program applied in the target population of this study improves SPH and therefore favors positive clinical outcomes in elderly adults. These findings are consistent with other publications and meta-analyses that show better scores on multidimensional scales for the assessment of functionality, disability, dependence and quality of life through self-report questionnaires in populations with or without CKD after exercise interventions, although many of these studies were not specifically designed to evaluate adults or their samples were limited to patients with advanced CKD who were receiving renal replacement therapy(Lera López et al., 2017; Painter et al., 2000; Wilkinson et al., 2019) . Our results for the exercise program intervention show improvement trends in the clinical variables (blood pressure, HR and PP) of the analyzed patients with and without CKD; however, these findings are not significant and suggest that a longer intervention is required to achieve results, as has been reported in other publications in which exercise programs lasted for more than 12 weeks (Aoike et al., 2018; Aoike et al., 2015).

Loss of muscle mass is an important predictor of mortality in patients with CKD, particularly in advanced stages (Cheema et al., 2005). In elderly adults, it is associated with the presence of geriatric syndromes such as frailty and falls and with dependence and risk of institutionalization (Ramírez-Peris & Magaña-Vázquez, 2013). Muscle atrophy leads to generalized weakness and loss of strength; therefore, physical training is an important factor in the control and reversal of losses(Heiwe & Jacobson, 2014). Increased grip strength, measured by static dynamometry, is a reliable measure of general muscle strength. In this sense, the results of our physical exercise intervention show a significant improvement in grip strength for both the adults with CKD and those without it, which translates into a gain in muscle strength in the studied population. These findings are consistent with reports in the literature, including meta-analyses and systematic reviews, regarding adult patients with CKD in both the initial and advanced stages (Barcellos et al., 2015). It is noteworthy that the grip strength values obtained in this study are lower than those indicated as normal in the reference guide for the dynamometer that was used to perform the measurements. It will be important to determine standardized normal values for our environment to verify the data presented in this work. With respect to the anthropometric measurements of the adults in the present study, the increase in calf perimeter stands out as significant in patients with CKD. This measure has been proposed in other publications as a marker of muscle loss. Although the values for this indicator are still low, the observation of an increase in calf perimeter suggests the presence of health benefits for the patient, especially because these results are consistent with the improvement of grip strength, and therefore of muscle mass, and the positive outcomes previously described. Similarly, there was an increase in weight and BMI, which was significant only for adults with CKD. These results may be related to the gain in muscle mass and other (although controversial) benefits of physical exercise, such as improved energy balance and appetite, in older adults (Clegg & Godfrey, 2018). However, it is not possible to validate these statements since body composition studies of the study population were not performed.

In accordance with related literature, the present study found that the prevalence of CKD increases with age, although the findings are discordant in terms of the higher proportion of males with CKD in the present study than in other publications. Similarly, the presence of other chronic diseases increases the chances of having CKD, with more frequent occurrence of CKD in patients with hypertension. Among the population included in the present study, it is important to highlight that the patients with CKD had additional comorbidities. Furthermore, the majority of the patients with CKD (58.9%) had category 2 and 3 disease according to their eGFR; this predicted good results for the study since other publications have demonstrated that it is during these stages of the disease that physical exercise has the greatest improvement on patients' living conditions and reduces their risk of mortality(Zelle et al., 2017). We address some limitations of this study. First, the single-center nature of our study limits the generalizability of its results. Second, the results of this study are not applicable to adult patients with category 4 and 5 CKD given their low representation in the total sample of participants. Unfortunately, no specific scales were applied to assess the risk of falls, which are a frequent syndrome in the geriatric population. Despite these limitations, our study has notable strengths. To the best of our knowledge, this is the first Latin American study to describe the benefits of a physical exercise program, especially in terms of the outcomes of functional capacity, pain and SPH, for adult patients in primary care with and without CKD. Along the same lines, there is little worldwide literature that demonstrates the benefits for adult patients with CKD in early stages of the disease that were found in the present study, and the existing studies have a much smaller sample size and less representation of OA patients. As previously mentioned, older adults have little access to or assistance with physical exercise programs. According to the data provided by the SABE survey of the Ministry of Health and Social Protection of Colombia, only 25% of older adults between 60 and 69 years old engage in physical exercise, and this figure decreases to 7.3% in those older than 80 years.[13] The present work aims to encourage the development of larger clinical studies and to seek the nationwide implementation of supervised physical exercise programs, since they are part of the comprehensive management of chronic diseases, including CKD, in addition to being an economic intervention that is reproducible and has a great impact on individual and public health.

5. CONCLUSIONS

The purpose of this research was to demonstrate the effect of a multicomponent exercise program on adult patients with and without CKD in a primary care setting. The main effects of the multicomponent exercise program are evidenced by the improvement of functional status, pain perception and general health status. Therefore, these programs should be implemented as part of the comprehensive management of these patients.

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