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Original Article

Impact of a physical activity program for psychophysical well-being in the dialysed and transplanted patient: a pilot study

Impatto di un programma di attività fisica sul benessere psicofisico nel paziente dializzato e trapiantato: uno studio pilota

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Key words: chronic kidney disease, nordic walking, quality of life, cardiovascular health.

ABSTRACT

Background: chronic lidney disease (CKD) is a worldwide health problem. This study evaluated the effects of Nordic Walking on health and quality of life in patients with CKD.
Materials and Methods: single-centre, non-pharmacological, single-arm pilot study in 15 patients undergoing haemodialysis, peritoneal dialysis, or kidney transplantation. The intervention consisted of 22 Nordic Walking sessions over two and a half months. Pre- and post-intervention assessments included blood pressure, oxygen saturation, bioimpedance analysis, and quality of life. Statistical analysis was performed using Wilcoxon's T-test, with significance $p<0.05$.
Results: improvements were observed in blood pressure (137.5±19.6 mmHg at T0 *vs* 130.8±16.3 mmHg at T1, p=0.03), SpO_2 (98.5±0.6% *vs* 99.1±0.3%, p=0.02) and HDL cholesterol (48.8±11.1 mg/dL *vs* 54.9±19.6 mg/dL, p=0.05). Lean mass increased (73.7±8.9% to 76.1±9.8%, p=0.04) while fat mass decreased (26.3± .9% to 23.9±9.8%, p=0.04). Quality of life scores improved significantly (76.6±14.4 at T0 *vs* 87.8±6.9 at T1, p=0.01).
Conclusions: nordic walking improved cardiovascular health and quality of life in people with CKD. More research is needed to confirm these findings.

Background: la malattia renale cronica (CKD) è un problema di salute globale. Questo studio ha valutato l'impatto del Nordic Walking sulla salute e qualità di vita nei pazienti con CKD.
Materiali e Metodi: studio pilota, non farmacologico, a braccio singolo, monocentrico con 15 pazienti sottoposti a emodialisi, dialisi peritoneale o trapianto di rene. L'intervento ha coinvolto 22 sessioni di Nordic Walking in due mesi e mezzo. Le valutazioni pre e post-intervento includevano pressione arteriosa, saturazione di ossigeno, analisi bioimpedenziometrica e qualità di vita. L'analisi statistica è stata eseguita con test T di Wilcoxon, con significatività $p<0,05$.
Risultati: sono stati osservati miglioramenti nella pressione arteriosa (137,5±19,6 mmHg a T0 *vs* 130,8±16,3 mmHg a T1, p=0,03), SpO_2 (98,5±0,6% *vs* 99,1±0,3%, p=0,02) e colesterolo HDL (48,8±11,1 mg/dL *vs* 54,9±19,6 mg/dL, p=0,05). La massa magra è aumentata (73,7±8,9% a 76,1±9,8%, p=0,04), mentre la massa grassa è diminuita (26,3±8,9% a 23,9±9,8%, p=0,04). I punteggi della qualità di vita sono migliorati significativamente (76,6±14,4 a T0 *vs* 87,8±6,9 a T1, p=0,01).
Conclusioni: il Nordic Walking ha migliorato la salute cardiovascolare e la qualità di vita nei pazienti con CKD. Servono ulteriori ricerche per confermare questi risultati.

Background

Chronic Kidney Disease (CKD) is a complex condition characterized by irreversible and progressive kidney damage, leading to impaired renal function;[1] it is recognized as a global public health priority due to its high prevalence and associated complications.[2] The primary causes of CKD include hypertension and diabetes mellitus, with other contributing factors such as cardiovascular diseases, glomerulopathies, genetic conditions like polycystic kidney disease, recurrent kidney or urinary tract infections, excessive use of nephrotoxic drugs, and systemic diseases, including autoimmune disorders, rheumatic diseases, and vasculitis.[3] CKD carries a significant risk of progression to End-Stage Kidney Disease (ESKD), which requires Renal Replacement Therapy (RRT).[4] Globally, between 4.9 and 7 million people are estimated to need RRT, and in 2017, approximately 843.6 million individuals were affected by CKD.[5] Medical treatments for CKD, including pharmacotherapy, dialysis, and surgery, are essential but insufficient to address the broader clinical and functional impacts of the disease.[6]

Physical activity has emerged as an important component of kidney rehabilitation, with evidence showing that even modest increases in exercise levels can enhance cardiovascular responsiveness, exercise tolerance, and overall quality of life in patients with CKD.[7] Exercise has also been shown to specifically target key risk factors in CKD, such as chronic inflammation, cardiovascular disease, diabetes, and hypertension, helping to reduce and control blood pressure in both pre-dialysis and dialysis patients.[8] Regular and continuous physical activity can improve the disease state and consequently the quality of life.[9]

Despite the known benefits, CKD patients often remain physically inactive. While the National Kidney Foundation's guidelines encourage patients to increase their physical activity, observational and epidemiological studies indicate that patients with CKD participate in physical activity for only about 9 days per month, and 45% of those with ESKD report no exercise at all.[10] This sedentary lifestyle typically begins in the early stages of CKD and contributes to a decline in physical performance, which parallels the decrease in glomerular filtration rate.[11] Physical inactivity in CKD patients is associated with higher morbidity and mortality rates, placing an increased burden on healthcare systems.[12] As a modifiable lifestyle factor, physical inactivity plays a critical role in the progression of chronic diseases, particularly in CKD patients, where decreased fitness and increased frailty are strongly linked to poor prognosis and diminished quality of life.

The objective of this pilot study is to integrate a structured physical activity program into the therapeutic regimen of adult patients undergoing renal replacement therapy (both peritoneal and hemodialysis) and kidney transplant recipients. The study aims to enhance physical performance and evaluate the impact of regular physical activity on clinical outcomes, such as blood pressure, oxygen saturation, laboratory parameters, body composition, and quality of life.

Materials and Methods

Design and population

This was a pilot, non-pharmacological, single-arm, monocentric, non-profit interventional study.

The study included patients undergoing hemodialysis, peritoneal dialysis, or kidney transplant (from deceased or living donors) at the SC Nephrology and Dialysis Unit, aged between 18 and 75 years. Patients with active neoplasms, cardiovascular instability, or musculoskeletal problems that could impair physical activity were excluded.

Intervention procedure

The group of staff responsible for following the patients selected for the study consisted of 6 nurses, the nurse coordinator, and a nephrologist from the Hemodialysis Department of the university hospital. They participated in a training course at the Nordic Walking Passion (NWP) association in Alessandria, which allowed them to obtain the certification of "Nordic Walking Instructor."

The study project planned one-hour sessions, held twice a week (the first two sessions being mainly theoretical and demonstrative), in the garden of the Teresio Borsalino Multifunctional Rehabilitation Center in Alessandria, lasting approximately two and a half months, for a total of 22 sessions, including theoretical ones between March and September 2023.

Instruments

Data on age, gender, diagnosis, and the onset date of the nephrological condition were collected. Written informed consent was required from patients for participation in the study, obtained using specific forms after a comprehensive description and sharing of the study protocol.

Blood tests, Immediate Recovery Index (IRI) tests, and bioimpedance analysis were conducted on enrolled patients, as well as quality of life assessments before (T0) and after the intervention (T1).

The instruments and scales used were as follows.

IRI: this test involved stepping up and down a 50 cm step for 3, 4, or 5 minutes at a rate of 30 cycles per minute (90, 120, or 150 steps, respectively) or pedaling on an ergometer. In our study, the procedure involving pedaling on an ergometer was activated, as specified below. Before starting the test, a resting Electrocardiogram (ECG) was performed. If the results were normal, the patient was asked to pedal on an ergometer, which was available at the bedside stations in the CAL Dialysis Unit of the Hospital-University of Alessandria. During the test, heart rate and blood pressure were measured, which were useful parameters for assessing cardiovascular efficiency. Based on their characteristics (age and weight), the patient had to pedal at a specific watt load and a pedaling frequency per minute defined by the sports physician, for a duration of 180 seconds. At the end of the test, an ECG was recorded with the heart rate measured between 60" and 90" after exercise. This determined the so-called IRI: the lower the heart rate value measured, the better the judgment of cardiovascular efficiency. The IRI test was performed before starting the 22-session Nordic Walking program and at the end of the program.

Body composition was assessed before (T0) and after (T1) the Nordic Walking sessions through bioimpedance analysis using the "Human in Touch" device. This tool provided valid support in hydration status analysis by measuring Total Body Water (TBW) and estimating, through the most accredited formulas, body composition in its reference parameters: Lean Mass (FFM) and Fat Mass (FAT).

Blood parameters were measured through routine laboratory tests already scheduled for the patients, specifically monitoring cholesterol, glycated hemoglobin, and albumin on a monthly basis.

Quality of Life (QoL) was measured using the EQ-5D-3L scale,[13] which evaluates health status in terms of five health dimensions. It is considered a "generic" questionnaire because these dimensions are not specific to any patient group or health condition. The EQ-5D-3L could also be referred to as a patient-reported outcome measure since patients could complete the questionnaire themselves to provide information on their current health status.

Data collection

The study data were collected through paper CRFs, evaluation scales, and laboratory test reports, and later entered into the online electronic platform "Electronic Data Capture" (REDCap), currently in use at the promoting center and adapted to the specificities of the study. The electronic tool complied with current clinical trial and privacy regulations (GCP E6(R2)–IHC, European Regulation 2016/679 – GDPR), was validated (GCP E6(R2)–IHC), all changes were electronically recorded and tracked, access was password-protected, and it was hosted on the hospital's server with automatic backup.

Statistical analysis

Statistical analysis was performed to evaluate changes in the patient's physiological and body composition parameters before (T0) and after (T1) implementation of the physical activity program. All data were expressed as mean and Standard Deviation (SD). The paired samples t-test was used to compare the values of each parameter between T0 and T1 in cases where the data followed a normal distribution. The Wilcoxon signed-rank test was used for data that did not meet the normality criterion. A p-value of less than 0.05 was considered statistically significant. Analyses were performed using appropriate statistical software (e.g. SPSS or R). All parameters analysed were tested for normality to ensure the adequacy of the analysis performed.

Results

The enrolled sample consisted of 15 patients, the majority of whom were men (11 men and 4 women). The average age of the participants was 63.5±7.2 years, ranging from 54 to 74 years.

The statistical analysis revealed significant improvements in several physiological and body composition parameters following the physical activity program. For instance, systolic blood pressure showed a significant reduction from a mean of 137.5±19.6 mmHg at T0 to 130.8±16.3 mmHg at T1 (p=0.03). Similarly, SpO_2 increased significantly from 98.5±0.6% at T0 to 99.1±0.3% at T1 (p=0.02), and HDL cholesterol improved from 48.8±11.1 mg/dL to 54.9±19.6 mg/dL (p=0.05). In terms of body composition, the Fat-Free Mass to Fat Mass Ratio (FFM/FAT) increased significantly from 30.3±14.2 to 36.9±14.5 (p=0.03), and Skeletal Muscle Mass (SM) showed an increase from 391.2±43.6 to 402.7±50.3 (p=0.05). Other parameters, such as weight and Extracellular Mass (ECM), did not show statistically significant changes (Table 1).

Bioimpedance analysis

Lean body mass showed a significant increase, rising from 73.7±8.9% at baseline to 76.1±9.8% after completion of the physical activity program (p=0.04). Conversely, fat mass exhibited a significant reduction, decreasing from 26.3±8.9% to 23.9±9.8% (p=0.04). The FFM/FAT ratio demonstrated a notable improvement, increasing from 30.3±14.2 to 36.9±14.5 (p=0.03). Additionally, SM significantly increased from 391.2±43.6 to 402.7±50.3 (p=0.05), reflecting positive changes in muscle composition and overall body composition (Table 2).

Discussion

The findings of this study shows that a structured physical activity program, such as Nordic Walking, can significantly improve both physiological parameters and body composition in patients undergoing dialysis or with kidney transplants. These results are consistent with existing literature that highlights the benefits of physical exercise in improving cardiovascular health, muscle mass, and overall body composition in patients with CKD.[14]

The significant reduction in systolic and diastolic blood pressure observed in our study aligns with previous research indicating that regular physical activity contributes to improved blood pressure control in CKD patients. Similar findings were reported by Heiwe

Table 1. Physiological and body composition parameters.

Parameter	Mean T0±SD	Mean T1±SD	p-value
Systolic blood pressure (mmHg)	137.5±19.6	130.8±16.3	0.03*
Diastolic blood pressure (mmHg)	80.8±8.8	71.7±8.4	0.05*
SpO2 (%)	98.5±0.6	99.1±0.3	0.02*
HDL Cholesterol (mg/dL)	48.8±11.1	54.9±19.6	0.05*
Glycated Hemoglobin (HbA1c %)	5.6±0.57	5.47±0.62	0.08
Albumin (g/dL)	3.5±0.36	3.54±0.95	0.04*
EQ-5D (Quality of Life)	76.6±14.4	87.8±6.9	0.01**

SD, standard deviation.

Table 2. Bioimpedance parameters.

Parameter	Mean T0±SD	Mean T1±SD	p-value
Weight (kg)	80.3±18.6	80.1±17.8	0.34
Fat-Free Mass (%)	73.7±8.9	76.1±9.8	0.04*
Fat Mass (%)	26.3±8.9	23.9±9.8	0.04*
FFM/FAT ratio	30.3±14.2	36.9±14.5	0.03*
Body Cell Mass (BCM)	341.5±43.2	350.7±50.1	0.07
Extracellular Mass (ECM)	377.1±60.1	392.3±49.8	0.12
Skeletal Muscle Mass (SM)	391.2±43.6	402.7±50.3	0.05*

SD, standard deviation; FFM/FAT, fat-free mass to fat mass ratio.

and Jacobson (2014),[15] who demonstrated that aerobic exercise significantly reduced both systolic and diastolic blood pressure in dialysis patients. This improvement in cardiovascular parameters, particularly the increase in SpO_2 levels, is consistent with the enhanced oxygen uptake and cardiovascular efficiency commonly reported in exercise interventions for this population.[14]

Body composition changes were also notable in our study. Lean body mass increased significantly, while fat mass decreased significantly. These findings mirror those of previous studies, which reported similar improvements in body composition following resistance exercise training in elderly CKD patients.[16] The increase in the FFM/FAT ratio and skeletal muscle mass observed in our study further underscores the positive impact of physical exercise on muscle preservation and fat reduction, which are critical in maintaining functional capacity in CKD patients.[17]

The increase in HDL cholesterol levels in our study is another important finding, suggesting improved lipid metabolism as a result of physical activity. This aligns with studies by Painter *et al.* (2000), who reported that aerobic exercise improved lipid profiles, specifically increasing HDL levels in dialysis patients.[18] Although there was a trend toward improvement in Glycated Hemoglobin (HbA1c) levels, it did not reach statistical significance, possibly due to the relatively short intervention duration. However, long-term studies have shown that regular exercise can lead to better glycemic control in CKD patients.[15]

Lastly, the significant improvement in the EQ-5D quality of life scores indicates that physical activity not only benefits physiological and metabolic outcomes but also positively impacts patients' perceptions of their health and well-being. This is consistent with previous research, which highlighted the substantial improvement in quality of life and physical function in dialysis patients who engage in structured exercise programs.[19]

Limits

This study has several limitations that should be acknowledged. First, the sample size was small, with only 15 participants, limiting the generalizability of the findings. As this was a pilot study, the small cohort reduces the statistical power to detect smaller but potentially clinically significant changes. A larger sample size would provide more robust conclusions and allow for subgroup analyses (e.g., hemodialysis *vs* peritoneal dialysis patients).

Second, the duration of the intervention was relatively short, lasting only two and a half months. Longer follow-up periods may be necessary to fully assess the sustained effects of physical activity on body composition, cardiovascular health, and quality of life in patients with CKD. The short timeframe may also explain the lack of significant improvement in some parameters, such as HbA1c, where longer interventions are typically required to see substantial changes.

Additionally, this study was conducted at a single center, which may introduce site-specific biases related to patient care protocols, exercise supervision, and resources. A multicenter design would be preferable for increasing external validity and minimizing institutional variability.

Moreover, while the study controlled for several baseline characteristics, it did not account for potential confounders such as dietary intake, medication changes, or levels of physical activity outside the study program, all of which could have influenced the results. Future studies should incorporate more comprehensive monitoring of these factors to better isolate the effects of the exercise intervention.

Conclusions

Our study supports the growing body of evidence that physical activity is a vital therapeutic intervention for improving cardiovascular health, body composition, and quality of life in patients with CKD. These improvements are essential for maintaining physical function and reducing the risk of cardiovascular complications in this high-risk population. Further studies with larger sample sizes and longer follow-up periods are needed to confirm these findings and explore the long-term benefits of physical activity in this population.

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Informed consent: the study included patients aged <75 years with nephropathy, patients on haemodialysis, patients on peritoneal dialysis and transplant patients; they also signed an informed consent form.

Availability of data and materials: data will be available upon request from the authors.

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