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Fulfilling of exercise training program scheduled: a secondary analysis of influencing factors in a clinical study on chronic kidney patient

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Abstract: Chronic Kidney Patients (CKP) present a negative clinical status, with structural and functional changes in the musculoskeletal system and mental health partly due to a sedentary lifestyle. An effective physical stimulus for CKP is as important as to be able to follow it in the long-term. This study aimed to analyze the association between some of the most influencing exercise adherence factors in CKP performing an exercise prescription programme. 67 subjects (23.9% women) participated in 14-week exercise programme in 3 dialysis centers in Madrid (Spain). Social-economic, educational, demographics, physical fitness, psychological and quality of life-related factors, were analyzed by a binary logistic regression model. Exercise adherence was established according to the number of training sessions attended per total sessions scheduled (cut-off point >75%). According to our binary logistic regression model performed with CKP, actual side effects symptoms/problems (OR:0.925: 95% CI [0.871, 0.983]) and depression status (OR:0.882: 95% CI [0.788, 0.987]), showed significant negative associations (B= -0.078; B= -0.126, respectively) and State-Trait Anxiety level (OR: 1.122: 95% CI [1.007, 1.250]) and emotional well-being dimension (OR:1.046: 95% CI [1.001, 1.094]), showed significant positive associations (B=0.115; B=0.045, respectively). These were the most influencing factors related to the fulfilling >75% sessions of the exercise training program scheduled, explaining 33.20% in our model. From the total of variables analyzed in our model, psychological issues such as anxiety and depression, besides the health-related quality of life factors such as actual side effects (symptoms/problems) and emotional well-being were the most influencing factors related to the exercise prescription adherence in CKP.

Keywords: patient compliance; chronic disease; exercise therapy; exercise; adherence.

1. Introduction

Physical inactivity has been identified as the fourth risk factor of all death causes (WHO, 2009). In the world, 27.5% of adults and 81% of adolescents do not meet physical activity guidelines (Bull et al., 2020). Sedentary behavior produces negative metabolic effects and is considered an independent health risk factor (Eanes, 2018; Rynders, Blanc, DeJong, Bessesen, & Bergouignan, 2018). Chronic Kidney Disease (CKD) is a serious health condition with a 15% prevalence among the world population (Shah, Ramsbotham, Seib, Muir, & Bonner, 2021). Furthermore, it is predicted that more than two million people will undergo dialysis treatments by 2030 (Szczech & Lazar, 2004). This chronic disease increases the risks of cardiovascular and premature mortality and decreases health-related quality of life (HRQL) in Chronic Kidney Patients (CKP) (Shah et al., 2021). CKP have limited physical fitness, muscular abnormalities, and weakness together with daily symptoms such as fatigue, myoclonus and cramps, besides of many other conditions such as anaemia, cardiac dysfunction, depression, etc. attributed to the CKD (Valenzuela et al., 2018). In addition, CKP spend long-term sedentary periods during dialysis treatments showing a faster loss of physical conditions in a short-term time period (Blake & O'Meara, 2004). A well-planned exercise program during dialysis sessions could improve their health and quality of life (Pellizzaro, Thome, & Veronese, 2013; Rebollo Rubio, Morales Asencio, & Eugenia Pons Raventos, 2017; Yurdalan, Kondu, & Malkoc, 2007), as physical activity levels (PAL) attenuate, but do not eliminate, the risk associated with sedentary or sitting long periods of time (Ekelund et al., 2018; Ekelund et al., 2016).

Recent health promotion strategies consider health care settings as a good resource to promote Physical Activity on Prescription (PAP) (Eanes, 2018; Persson, Brorsson, Ekvall Hansson, Troein, & Strandberg, 2013; Sanchez, Bully, Martinez, & Grandes, 2015; WHO, 2015, 2018). However, there is uncertainty about using and awareness by health care professionals and the effectiveness of the health care settings (Persson et al., 2013). Health professionals assume that patients uniformly will follow their prescriptions (Blackstock, ZuWallack, Nici, & Lareau, 2016). Nevertheless, specifically in CKP unwillingness and inability to follow the pharmacological and non-pharmacological guidelines have been identified and could decrease the compliance and effectiveness of the treatment (De las Cuevas Carlos & Wenceslao, 2014). Adherence in healthcare treatments is defined by the World Health Organization (WHO), as “The extent to which a person’s behavior-taking medication, following a diet, and/or executing lifestyle changes, corresponds with agreed recommendations from a health-care provider”

To apply a successful treatment should be considered as important as to know if the patient is able to follow-up it (Barley & Lawson, 2016; McPhate, Simek, & Haines, 2013; Picorelli, Pereira, Pereira, Felicio, & Sherrington, 2014). Estimated data suggests that around 40% of patients do not adhere to pharmacological treatments, with the prevalence rate rising up to 70% on lifestyle treatments (Stonerock & Blumenthal, 2016). Studies of exercise training programs report dropout rates of 20-50% in the first 3-6 months (Viken et al., 2019). A meta-analysis by (Rao et al., 2019) showed that the dropout rate of patients on exercise and pharmacological treatments were rather similar, with a 17.9% and 12% mean dropout rate, respectively (Ruiz, Lavie, & Ortega, 2019). And another meta-analysis showed that training periods longer than 20 weeks improve adherence to PAP training programs (Rowley, Mann, Steele, Horton, & Jimenez, 2018).

Furthermore, there is no consensus about what determines human behavior and much less is known about active behavior change in patients, being well known the complexity of health-related human behavior changes (Barley & Lawson, 2016). Although some studies identified differences on individual characteristics (Martin & Sinden, 2001; Picorelli et al., 2014; Rhodes, Warburton, & Murray, 2009), other ones have shown that the extent and nature of the adherence problems are similar across diseases, regimens, and age groups (Dunbar-Jacob et al., 2000; Martin & Sinden, 2001).

Prediction models are designed to support health care staff to estimate the likely or risk that a specific event will occur in a future period of time (prognostic models). These predictions can be used for planning lifestyle or therapeutic decisions based on the influencing factors for performing a designed treatment within a planned period of time. However, the estimated probability is rarely based on a single factor. For that reason, health-care staff should naturally integrate several influencing factors to make a prediction, being the prediction model inherently multivariable (Collins, Reitsma, Altman, & Moons). In this way, all types of clinical prediction studies and methodological issues are considered important in prediction research. However, most clinical prediction studies do not follow current methodological recommendations, limiting their reliability and applicability (Bouwmeester et al., 2012), as well as the prediction models used for CKP (Collins, Omar O Fau - Shanyinde, Shanyinde M Fau - Yu, & Yu, 2013).

According to the potential predictors to exercise adherence, several factors had been shown in research studies using multivariable prediction models such as demographic, clinical, behavioral, and psychosocial factors. However, some of them have been significantly associated with exercise adherence by univariate analyses, but not in the subsequent multivariate analysis (Murray et al., 2019). Besides of use of several statistical analyses to examine all these potential predictors of exercise adherence (Cadmus-Bertram et al., 2014) or being unable to use all desired data are considered limitations in exercise adherence multivariable prediction models research (Tuakli-Wosornu, Selzer, Losina, & Katz, 2016). In this sense, to enhance exercise adherence should be considered several predicting factors such as the used in the WHO 5 dimensions adherence model (Calonge-Pascual, Casajús-Mallén, & González-Gross, 2022) (Figure 1), under a socio-ecologic approach (Burke, Utley, Belchamber, & McDowall, 2020).

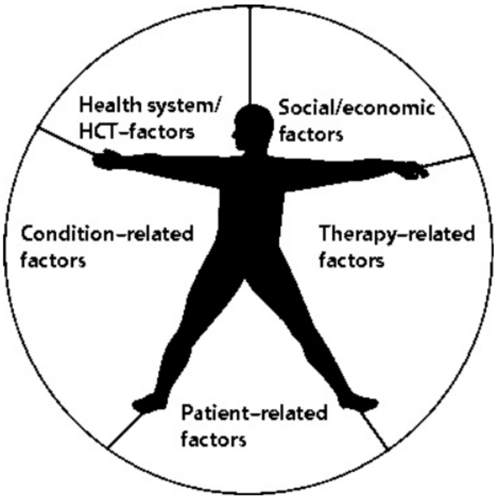

Figure 1. The five dimensions affecting adherence in the general population, as outlined by the World Health Organization. Reproduced with permission of the publisher from WHO. Adherence to long-term therapies: Evidence for action. Chapter V. pag 27. ISBN 92 4 154599 2 (NLM classification: W 85) (2003). Available from: apps.who.int/iris/bitstream/10665/42682/1/9241545992.pdf. HCT: health care team.

In this study, the aim was to analyze the association of multi-dimensional factors related to exercise training adherence in CKP, considering "adherence" according to the number of training sessions attended from the total sessions planned.

Finally, we hypothesize that exercise adherence is significantly associated with mental health, forecasting that high levels of anxiety and depression (Dziubek et al., 2016; Frih et al., 2017) will offer a negative association and a well health-related quality of life predictor factors will have a positive association (Akman et al., 2007) in CKP.

2. Materials and Methods

Subjects —This is a secondary study analysis on 67 CKP patients (23.9% women), aged 55-86 years, who voluntary participated in an exercise intervention study performed from March to June 2015 (Vázquez Rigueira et al., 2019). Subjects were patients of three dialysis centers of the *"Íñigo Álvarez de Toledo"* Kidney Foundation (FRIAT) in the Region of Madrid (Spain) participated in the study.

The study was performed according to the principles established in the 1964 Declaration of Helsinki and approved by the Ethical Committees of the University Hospital Foundation of Alcorcon (Madrid, Spain).

Informed consent was obtained from all individual participants included in the study. The Project was registered in the ClinicalTrials.gov (P141115303).

Design—The intervention study design was developed in 2 periods of 14 weeks. The first one with a non-exercise intervention period (T1-T2) and the next one with a concurrent exercise program (defined as simultaneously incorporating both resistance and endurance exercise within a periodized training regime) (T2-T3). In the general study data were registered at T1, T2 and T3. For this study, only data from T2 and T3 were considered. Subjects with the following co-morbidities were excluded from participation: unstable angina, brain-vascular disease or a high risk for recurrence, cardiac ejection fraction <45%, myocardial infarction 6 weeks before to the start of the exercise training program, uncontrolled hypertension, peripheral vascular disease, musculoskeletal or respiratory alterations, osteoporosis, active liver disease, blood hemoglobin concentration <10 g/dL, or problematic vascular access (immature arterial venous fistulas, high risk for extravasations).

Methodology—The 14-week exercise training intervention has been described previously (Valenzuela et al., 2018; Vázquez Rigueira et al., 2019). Sessions were supervised by an experimented and qualified exercise trainer. Each session was performed individually with a first warm up, with exercises of joint mobility (neck, shoulders, elbows, hips, knees and ankles) and different kinds of breathing exercises. Targeting cardiovascular and musculoskeletal fitness exercises in the main part of the session. Training load was progressively adapted to patients (Vázquez Rigueira et al., 2019).

No motivation strategies and adverse events occurred during the intervention.

The exercise program designed complied with the Consensus on Exercise Reporting Template (CERT) (Slade, Dionne, Underwood, & Buchbinder, 2016). Attendance or non-attendance to the daily session was registered daily by the trainer on a specific sheet.

Several questionnaires were filled in for the primary study, measuring demographic, socioeconomic and educational data extracted from the general EXERNET questionnaire (Red Espanola de Investigacion En Ejercicio Fisico y Salud et al., 2016). Socioeconomic status was measured by salary per month (<600€/month; 600-900€/month; >900€/€/month). Educational level, by a dichotomy cut-off point (more or less/equal secondary level study); and demographic factors based on age. The Kidney Disease and Quality of Life™ (KDQOL™-36) (Arizona, 2000) questionnaire was used to assess: symptom burden; physical functioning; actual side effects (Symptoms/problems and effects of kidney disease) and emotional well-being, using the KDQOL™-36 Scoring Program (v 1.0).The psychological issues as depression, were measured by the Beck Depression Inventory survey (WHO, 2003), establishing this disease as one of the most related to this kind of patients and their associated symptoms (Rebollo Rubio et al., 2017). The State-Trait Anxiety Inventory survey (Spielberger, 1997) was used to assess additional psychological issues. In this case, the total of 20 items were considered, (WHO, 2003), according to this equation: A/E= 30 + (3, 4, 6, 7, 9, 12, 13, 14, 17, 18 questions) - (1, 2, 5, 8, 10, 11, 15, 16, 19, 20 questions). If more than three questions were not answered, the total result was not considered for the patient. Furthermore, the Oviedo sleep quality questionnaire (Bobes et al., 1998; García-Portilla et al., 2009) was used to assess sleep status, establishing for this study a personal cut-off point when the patient had consumed at least 4days/week any pharmacological sleep inducers in the last month.

Furthermore, the physical performance battery, as previously described (Valenzuela et al., 2018) was used to establish physical fitness. A Z-score was calculated including mean data of the 6-min walk test (6MWT) (Rikli & Jones, 2001), 10-repetition sit-to-stand (STS-10rep) (Csuka & McCarty, 1985; Ritchie, Trost, Brown, & Armit, 2005), 30 and 60 seconds sit-to-stand (STS-30sec) (Rikli & Jones, 2001) (STS-60sec) (Csuka & McCarty, 1985; Ritchie et al., 2005), and right and left handgrip strength tests (Oja & Tuxworth, 1995).

Finally, adherence to the clinical exercise training program was analyzed considering the attendance to scheduled exercise training program. It was calculated by dividing the number of training sessions attended by the number of training sessions scheduled (sessions attended/sessions scheduled). According to the previous data of the Systematic Review of Pavey et al., completing >75% of exercise program of available sessions is categorized as adequate adherence (Pavey et al., 2012). In a similar sense, Van der Deijl et al., in 2014, established the mean proportion of persons completing an effective PA program was 71.3% (Van der Deijl, Etman, Kamphuis, & Van Lenthe, 2014). Furthermore, dropout rates no lower than 20% within the first 3-6 months for exercise programs, as was previously mentioned, have been reported (Viken et al., 2019). Because of this, we established a cut-off point of 75% for the exercise sessions attendance-dependent variable in our study.

Statistical Analysis—Binary Logistic Regression (LR) was employed, assuming normal distribution by the Central Limit Theorem (n>50). If the correlation between two retained variables exceeded 0.60, only one variable was selected for future regression models to avoid multicollinearity. Upon the detection of a correlation greater than .60, it is wise to calculate the values of Tolerance (TOL) and the Variance Inflation Factor (VIF). Values below .10 for tolerance and above 10 for VIF indicate collinearity between the independent variables (Menard, 1995). However, other researchers consider values below .20 for TOL and above 5 in VIF problematic (D'Ancona, 2002). In our case, all independent variables were in a range of (0.32-0.54) for TOL and (1.86-3.13) for VIF.
Finally, homoscedasticity was measured by Levene's test ($p > 0.5$). The final model was created by aggregating all variables and selecting the better ones by the authors. Nagelkerke R Square was used as predictive value of the model. Dependent variable was considered by the percentage of exercise sessions attendance ≤75% or >75% of the total classes scheduled.
After the stepwise, binary logistic regression model and analyzing the results, researchers performed additional statistical tests to rescue and select several independent variables that had no collinearity but that the model had left out in some of the previous steps due to the automatic functioning of the statistical program. In this way, the final model had a higher degree of significance and higher number of independent variables, in order to associate them to the compliance of this exercise program.
All statistical analyses were performed using the Statistical Package for Social Science software (SPSS, version 21.0; SPSS, Chicago, IL, USA) and the JASP Team (2022). JASP (Version 0.16.3) [Computer software]. Values of $p < 0.05$ were considered statistically significant (OR; 95%CI).

3. Results

Descriptive values of the sample regarding all considered factors and attendance to exercise sessions are shown in Table 1.

Table 1. Descriptive analysis of the sample according to exercise training adherence.

			≤75% Adherence		>75% Adherence	
Category	Sub-category	Survey	n	% or Mean±SD (Min-Max.)	n	% or Mean±SD (Min-Max.)
Low socioeconomic status	<600€/ month	EXERNET survey	2	8.70%	3	9.10%
	600-900€/ month		7	30.40%	8	24.20%
	>900€/ month		14	60.90%	21	63.60%
Educational level	<secondary educational level	EXERNET survey	12	52.20%	20	60.60%
	≥secondary educational level		11	47.80%	13	39.40%
Demographics factors	Male Sex	EXERNET survey	20	87.00%	24	72.70%

Category	Sub-category	Survey	≤75% Adherence n	≤75% Adherence % or Mean±SD (Min-Max.)	>75% Adherence n	>75% Adherence % or Mean±SD (Min-Max.)
	Female Sex	EXERNET survey	3	13.00%	9	27.30%
	Age		23	72.34 ± 8.91 (56.00- 86.00)	33	70.96 ± 9.46 (56.00- 86.00)
Symptom burden	Symptom burden	KDQOL™-36	23	64.40 ± 26.67 (12.50- 100.00)	33	41.72 ± 23.04 (00.00- 87.50)
Activity limitation	Physical functioning	KDQOL™-36	23	34.78 ± 41.10 (00.00- 100.00)	33	46.96 ± 43.19 (00.00- 100.00)
Sleep status	<4 days sleep helps intake/week	Oviedo sleep quality survey	12	52.20%	25	75.80%
	≥4 days sleep helps intake/week		11	47.80%	8	24.20%

			≤75% Adherence		>75% Adherence	
Category	Sub-category	Survey	n	% or Mean±SD (Min-Max.)	n	% or Mean±SD (Min-Max.)
Actual side effects	Symptoms/problems	KDQOL™-36	22	84.46 ± 11.90 (60.42- 100.00)	33	78.66 ± 17.36 (41.67- 100.00)
	Effects of kidney disease	KDQOL™-36	22	69.46 ± 22.57 (15.63- 100.00)	32	66.11 ± 21.03 (31.25- 100.00)
Physical Fitness status	Fitness skills (Zscore)	Physical fitness tests	21	- 0.55 ± 0.51 (-01.75-01.24)	30	- 0.16 ± 0.78 (-01.51- 01.63)
Psychological issues	Anxiety	State-Trait Anxiety Inventory survey	23	17.13 ± 11.15 (05.00- 55.00)	33	17.27 ± 9.99 (01.00- 43.00)
Psychological issues	Depression	Beck Depression Inventory survey	21	16.14 ± 11.15 (02.00- 36.00)	32	12.21 ± 09.52 (00.00- 45.00)
Beliefs and perceptions	Emotional well-being	KDQOL™-36	23	62.17 ± 26.96 (00.00- 100.00)	33	71.51 ± 19.38 (40.00- 100.00)

SD = standard deviation.

Table 2. Statistical descriptions of independent variables introduced in the binary logistic regression model.

	B	O.R	p	95% C.I. Lower	95% C.I. Upper
Actual side effects Symptoms/problems	-0.078	0.925	0.012*	0.871	0.983
Psychological issues: Depression levels	-0.126	0.882	0.028*	0.788	0.987
Emotional well-being status	0.045	1.046	0.048*	1.001	1.094
Psychological issues: anxiety levels	0.115	1.122	0.036*	1.007	1.250

*O.R: Odds Ratios for binary logistic regression. * Statistically significant p < 0.05*

All the variables mentioned in table 1 were integrated in the binary LR model. However, only the following were significantly associated and finally integrated in the binary LR model (Table 2).

The depression levels showed a significant negative association (B= -0.126) to exercise training program attendance in our model (OR: 0.882: 95%CI [0.788, 0.987]). For each point increase, the CKP could achieve 12% non-adherence. Actual side effects, measured by symptoms and problems of KCP, were definitely introduced in the binary LR model (OR: 0.925: 95%CI [0.871, 0.983]), indicating a significant negative association to exercise adherence (B= -0.078). For each point of increase in this variable, the patient had a 7.5% probability to not complete more than 75% of the exercise training program. Regarding Anxiety levels (OR: 1.122: 95%CI [1.007, 1.250]) showed a significant positive association (B= 0.115). For each one-unit increase in this variable, an increase of 12.2% of adherence to the exercise program was observed. Emotional, well-being status, showed significant association (OR: 1.046: 95%CI [1.001, 1.094]) with a positive relationship to exercise training sessions attended (B= 0.045). For each unit of increase in this variable, there was an 4.6% probability to complete more than 75% of scheduled sessions.

Nevertheless, the self-efficacy variable based on the average of Z-score fitness status was not significantly associated with the rest of variables in the binary LR model.

The final binary LR model explains a 33.20% (ϱ= 0.33) with the four independent variables integrated, according to the following equation regarding attended exercise sessions in the sample analyzed: Exercise adherence (≤/> 75% sessions attended/sessions scheduled) = 3.501 - 0.126 x Psychological issues: Depression levels - 0.078 x Actual side effects (symptoms/problems) + 0.115 x Psychological issues: Anxiety levels + 0.045 x Emotional well-being status.

4. Discussion

According to our binary logistic regression model performed with CKP, the most influencing factors related to the fulfilling >75% sessions of the exercise training program scheduled were related to psychological issues such as anxiety and depression levels as well as the health-related quality of life factors such as actual side effects (symptoms/problems) and emotional well-being status.

According to the WHO 5-dimension model, these therapy and patient-related factors could be established as determinant factors to predict adherence, according to the attended dialysis exercise. In this sense, exercise adherence is fully associated with mental health status under a multi-dimensional approach (Kardas, Lewek, & Matyjaszczyk, 2013) as we hypothesized at the start of this study. However, according to the scientific literature, the relationship among them is not clear (Martin-Borras et al., 2018) depending of the statistical analyses used in the multivariable prediction models (Cadmus-Bertram et al., 2014; Murray et al., 2019). Furthermore, patient adherence to PAP is considered as a multi-dimensional phenomenon such as proposed by WHO in 2003 (Kardas et al., 2013). However, many studies analyze PA adherence not considering all specific subcategories of the WHO's adherence model (Horne & Tierney, 2012; Picorelli et al., 2014; WHO, 2003). The Systematic Review published in 2019 about exercise referral schemes only deals with psychosocial adherence factors (Eynon, Foad, Downey, Bowmer, & Mills, 2019). In our previous review done in 2020, following the WHO 5-dimension model, a lack of considering about health system/healthcare-team factors and therapy-related factors was concluded (Calonge-Pascual, Casajús-Mallén, & González-Gross, 2022). In any case, studies have not yet overcome the most relevant PA barriers to PA adherence (Martin-Borras et al., 2018). And a strict follow-up to improve adherence to non-pharmacological treatments, such as in exercise prescriptions, should be done (Lorenz et al., 2015).

Changes from sedentary into active behavior in the human being seem not to be easy, being recently more and higher the interest of PA promotion by health institutions (McEwan et al., 2016; WHO, 2015, 2018).

When analyzed individually, social/economic factors such as low socioeconomic status, educational level, and demographics factors) are significantly associated to the exercise adherence level. Interestingly, when they are analyzed together with the rest of factors in our model, this significance disappears. This lack of an integral multidimensional analysis could be leading to wrong conclusions. However, in many studies, mainly social/economic factors are only considered (Batra, Coxe, Page, Melchior, & Palmer, 2016; Garmendia et al., 2013; Morgan et al., 2016; WHO, 2003). In this way, as was proposed by the WHO in 2003, a multidimensional model should be used for a better comprehension of adherence in the clinical setting. Because adherence in a pharmacological and non-pharmacological treatment is defined as a multifactorial phenomenon determined by the interplay of five "dimensions" (Figure 1).

Each dimension, including a set of factors which have been related to long-term adherence therapies of pharmacological and non-pharmacological treatments such as exercise prescriptions for chronic diseases (Venegas, Carrasco, & Casas-Cordero, 2018; WHO, 2003).

In our analysis, depression levels, offered a negative significant association in the LR model, showing that higher level of depression in CKP would offer a significant negative association to the attendance of more than 75% of the exercise training program. Data agree with other studies (Dziubek et al., 2016; Frih et al., 2017). Furthermore, evidence from scientific literature suggests that moderate to vigorous PA, plays a main role in the prevention and management of depression disease (Mendoza-Vasconez et al.).

Actual side effects (extracted from the symptoms/problems dimension of KDQOL™-36) were significantly associated with the rest of independent variables of our model. This means that CKP with higher levels in this variable (better KDQOL status), reduced their adherence levels to exercise training. To the best of our knowledge, there are no references in this sense in the scientific literature. We could hypothesize that the intelligent non-adherence that has been described in pharmacological treatments (WHO, 2003), could occur also when CKP feel better, refusing the non-pharmacological exercise treatment. In contrast, other studies have shown that higher general levels of quality of life are related to higher adherence levels to dialysis treatments (Akman et al., 2007; Dobbels, Decorte, Roskams, & Van Damme-Lombaerts, 2010; Simons et al., 2008). Psychological issues based on state-anxiety levels, as described above, had a positive association in our model to predict exercise adherence. Better levels of state anxiety offer an increased likelihood to attend more than 75% of scheduled exercise training, helping to reduce the anxiety levels when the exercise training program is followed and correctly executed (Dziubek et al., 2016).

Emotional well-being status, assessed by KDQOL™-36, showed significant associated values to exercise adherence in our model. Well-being is a subjective feeling of enthusiasm, vigor, energy, and alertness (Fitzpatrick, Appel, Bray, Brooks, & Stevens, 2018). Exercise in routine dialysis provides the key to enhance the emotional well-being status of older patients (Kutner, 2008), being associated to exercise adherence levels in CKP patients (Toyama, Sugiyama, Oka, Sumida, & Ogawa, 2010; Wong, Velasquez, Powe, & Tuot, 2018). Our study suggests that psychological components before the start of a non-pharmacological treatment may help determine who will adhere to exercise treatments and could, therefore, contribute to prevent and tailor chronic disease treatments (Fitzpatrick et al., 2018).

A high fitness level provides benefits in health status and is being nowadays widely accepted (Booth, Roberts, Thyfault, Ruegsegger, & Toedebusch, 2017; Pedersen & Saltin, 2015). An optimal exercise stimulus during dialysis treatments could improve the negative musculoskeletal conditions of CKP (Austin, Qu, & Shewchuk, 2012). Introducing exercise prescriptions in all dialysis centers could be an important measure in this sense (Barcellos, Santos, Umpierre, Bohlke, & Hallal, 2015). This exercise training program of 14 weeks, was able to improve physical fitness levels (Valenzuela et al., 2018). In this study, we tried to measure physical fitness status, based on a Z-score fitness index, before starting the exercise training program (T2) could be associated to enhanced exercise training adherence. However, no significant association was appreciated independently of the variables chosen in the LR model.

The high anxiety status of CKP is well known (Rebollo Rubio et al., 2017). The State-Trait Anxiety Inventory survey was used to measure the psychological issues category. A significant association in our LR model was observed which could indicate that high levels of state anxiety are a barrier to attend exercise training programs in CKP. The improvements in anxiety and depression levels by exercise prescriptions could be considered an effective non-invasive treatment, which should be as effective as other treatments or at least contribute to CKP (Cwiek et al., 2017). Adherence to exercise training prescriptions during the dialysis treatment would improve health and quality of life in CKP (Austin et al., 2012; Dziubek et al., 2016; Frih et al., 2017).

5. Practical Applications.

Adherence factors have been mostly perceived as an issue of the patient, and not of the health care providers or the health care System. There is evidence that Health care System factors have an important impact on adherence of their patients (Kardas et al., 2013). In this study, we were not able to analyze the health system/healthcare team-related factors in our modelling, as no related data were included in the primary study, similar to it has been observed in the scientific literature (Calonge-Pascual et al., 2022). However, health system/healthcare team and therapy-related dimensions should be considered in future studies, which assesses exercise prescription adherence, independently of context. Furthermore, scientific literature has shown that the quality of published articles of multivariable prediction models in medicine is poor. In this sense, it is difficult for researchers and health care providers to consider, objectively, the barriers and facilitators of a prediction model (Collins et al.). The WHO 5 dimension adherence model could be used to predict adherence to non-pharmacological treatments, as exercise prescription among others (Calonge-Pascual et al., 2022). Besides of being a cost-effective strategy to improve patient exercise adherence in a non-pharmacological treatment at health care settings, and according to a socio-ecological approach (Burke et al., 2020), this model could be improved following all dimensions and factors of the WHO 5-dimension adherence model.

As analyzing adherence to exercise was not the main objective of the primary study, this imposes some limitations to our secondary analysis study. The main limitation was not having been able to analyze all factors proposed by the WHO 5-dimension model related to adherence in long-term pharmacological and non-pharmacological therapies. Another limitation could be the design of the study. Due to the pluripathology of these patients, we performed a within-subjects design, and participants served as their own control. This design could not be optimal for this secondary analysis of data. Furthermore, we did not carry out the analysis based on gender due to our reduced CKP sample for this study.

Much more efforts would be necessary to find the relationship between facilitators and barriers to exercise adherence in CKP to increase the compliance in order to offer an efficient and individualized exercise prescription in dialysis centers.

6. Conclusions

Above 75% hemodialysis exercise training adherence of chronic kidney patients, was 33.20% explained in our model, considering anxiety and depression psychological status and quality of life-related factors such as actual side effects (symptoms/problems) and emotional well-being, which could be used to determine independent and combined associations to develop good hemodialysis exercise training adherence in CKP.

When analyzed individually, socio/economic factors are significantly associated to exercise adherence level. Interestingly, when they are analyzed together with the rest of dimensions, this significance disappears. Only considering socio/economic factors in an isolated way and not an integral multidimensional analysis could be leading to wrong conclusions.

The WHO 5-dimension adherence model could be used to plan exercise programs aiming at higher adherence rates or to analyze the influence of adherence to non-pharmacological treatments.

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