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Research Article

Intradialytic Aerobic Exercise in the United Arab Emirates: A Descriptive Study

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Abstract

Aim. Intradialytic exercise (IDE) improves hyperphosphatemia management in hemodialysis (HD) patient in addition to other clinical outcomes. The aim of the study is to present the strategies needed to integrate such a protocol in an HD unit in UAE and patients' baseline characteristics. **Methods.** The largest HD unit in Sharjah emirate was chosen. All eligible patients (n = 57) in the unit were included. Patients were stable adults HD patients who served as their own controls. The intervention included an aerobic low intensity IDE of 45 minutes per HD session, tailored to each patient's fitness scale (BORG scale) for 6 months. Patients were educated on the importance of exercise. Outcome measures were barriers to exercise, serum phosphorus (P), urea reduction ratio (URR), malnutrition inflammation score, quality of life (QOL using euroqol5) collected at baseline and post intervention. **Results.** A total of 41 patients completed the study, 61% were males and 90.2%, 53.7% and 14.6% suffered from hypertension, diabetes and cardiovascular disease, respectively. Hyperphosphatemia was prevalent among 75% of the patients with a mean of 5.76 ± 1.66 mg/dl. The mean age was 48 ± 14.37 years, BMI 24.98 ± 6.09 kg/m^2, URR 71.88 ± 8.52%, and Kt/v 1.32 ± 1.09. The main barrier to exercise was identified to be fatigue on HD days by 58.5% of patients, followed by fear of getting hurt (36.6%). Finally, 80.4% of patients were mildly malnourished and QOL scale was 65.02% ± 18.54. **Conclusion.** Our study highlighted the widespread of hyperphosphatemia and malnutrition in our sample. The IDE regimen, if proven effective in future studies, could be integrated in the routine practice and may improve patients' outcomes.

Keywords: hemodialysis, exercise, quality of life, phosphorus, urea

1. Introduction

Chronic kidney disease (CKD) has been recently recognized as a global health concern [1] with a prevalence of 13.4% worldwide [2]. CKD poses an increased mortality rate compared to their age-matched healthy population [3]. In the United Arab Emirates (UAE), the estimated total number of dialysis patients in 2014 was 1870, out of which 94% are on hemodialysis (HD), with a prevalence rate of 210 per million population [4].

Hyperphosphatemia, defined as high serum phosphorus level, is highly prevalent among HD patients and a known risk factor for mortality [5]. The Kidney Disease Improving Global Outcomes (KDIGO) 2017 guidelines recommend lowering the phosphate levels toward the normal range; hyperphosphatemia management includes dialysis, limiting dietary phosphate intake, and the usage of phosphate binder, while restricting the dose of calcium-based phosphate binders [6]. It is documented that a weekly dialysis of more than 30 hours is required for a complete clearance of serum phosphate (P) without the use of P-binders [7]; yet, in the UAE, the reality remains that HD sessions in routine practice accumulate to a maximum of 12 hours per week [8]. Poor serum P control due to high P-to-protein ratio can pose the risk of malnutrition on HD patients, a phenomenon common among these patients [9]. Furthermore, sedentary lifestyle is widespread in HD patients, and stage 4 and 5 CKD cases report to have the lowest physical activity (PA) levels [10]. This is despite the fact that the literature is clear on the positive effect of PA on the management of hyperphosphatemia [11], and the negative effect of low PA on quality of life (QOL) [12] and nutritional status [13]. Broers et al. were able to demonstrate a positive correlation between the QOL-physical component and nutritional indices [13]. Thus, finding an adjunctive therapy to facilitate hyperphosphatemia management and increase PA levels becomes crucial.

Intradialytic exercise (IDE) has shown to ameliorate solute clearance by increasing blood flow and thus hyperphosphatemia management of HD [14]. Patients trained on a cycle ergometer for 20–30 minutes during the first 2 hours of HD increased their phosphate removal [11] and improved their QOL—physical component [15] and their QOL total score [16]. IDE had a positive effect on dialysis efficiency, specifically on Kt/v [17] and the urea reduction ratio (URR) [18]. In addition, IDE showed a non-significant decrease in hospitalization rate [19].

For IDE to be a routine procedure for HD patients, an HD unit needs proper exercise equipment, optimal exercise strategies tailored to the patients, trained staff and policies [20]. The fact remains that intradialytic training programs are not yet integrated in routine practice worldwide; UAE is not an exception. The feasibility analysis of an IDE program in a developing country is needed, since most of the proof of the efficacy of IDE in HD patients comes from the developed Western countries.

The aim of the current study is to present the study design and protocol of an aerobic exercise program that will be conducted on HD patients in a selected center in the UAE; another aim is to describe the baseline characteristics of the participants regarding the selected outcome parameters: adequacy of dialysis, serum phosphorus, quality of life, exercise behavior, barriers to exercise, and malnutrition inflammation score.

2. Methods

2.1. Study design

A quasi-experimental intervention with pre- and post-evaluation design was planned in Al Qassimi hospital's HD unit in Sharjah, UAE. This study was conducted according to the Helsinki Ethical Declaration of 1975 as revised in 1983 and received ethical approval from the Research Ethics Committee of the Ministry of Health and Prevention of UAE (MOHP/DXB/SUBC/NO-5/2016) and that of Zayed University (ZU15_118_F). The study was registered in the ClinicalTrials.gov (ID: NCT03131804). Patients were informed of the study protocol, its risks and benefits, confidentiality, the need for the study team to go through their medical files, and their ability to voluntarily enter and exit the study. The actual patient's name list was maintained with the primary investigator (PI), numerical identification was used instead of names to ensure confidentiality and anonymity. Moreover, the filled and signed consent forms and questionnaires were kept with the PI in a locked drawer.

2.2. Study methodology

Convenient sample technique was used; all patients in the chosen HD unit, who were eligible, that is, satisfy the pre-set inclusion criteria and consented, were included in the intervention, resulting in a convenient sampling. Inclusion criteria were stable adult HD patients, on HD for ≥ 3 months, free of acute diseases and specific cardiovascular problems (cardiac pacemaker, uncontrolled blood pressure, symptomatic ischemic heart disease, arrhythmias, deep vein thrombosis, severe dyspnea), of either gender, not practicing an exercise program at the time of the study, capable to communicate, fully aware of the study protocol, able to perform the cycle peddler and provided a consent form. Exclusion criteria were patients not meeting the inclusion criteria; in addition to any of the following: dialyzed from a femoral fistula, suffering from severe anemia (hemoglobin: < 9g/dl) [21] and/or uncontrolled diabetes.

Five research assistants (RAs) were recruited to conduct the study. They were trained by the PI on study protocol and data collection tools. A licensed physiotherapist of the selected hospital was consulted for the planning of the exercise program, choosing the proper static bicycle and for ongoing supervision of the exercise program.

2.3. Sample size

The outcome was the decrease in serum phosphate. Power analysis was conducted using the GPower 3.1 software (GPower 3.1) (Retrieved from `https://www.campbellcollaboration.org/escalc/html/EffectSizeCalculator-SMD1.php`. (accessed January 15, 2017).), based on the effect size (d = |0.56|) retrieved from [22], an RCT conducted in Iran. The sample size yielded by the power analysis (n = 34), which was inflated by 72.7% to account for drop out, leading to a total included sample of 57. We approached all eligible patients (n = 57) out of which 41 consented and were included in the analysis.

2.4. Conduct of Study

The study is designed according to three phases: baseline (T_0), intervention (T_1) and follow-up (T_2).

Phase 1: Baseline (T_0) with 2 months duration. The RAs validated the questionnaires, conducted a 2-weeks pilot study on 10 HD patients (results of which were later discarded), and completed the baseline assessment for all consented patients. Furthermore, eligible patients were educated on the importance of exercise, specifically IDE, to their health prior to the start of the study by the PI. Finally, patients were assessed using the study outcome measures and data were recorded.

Phase 2: Intervention (T_1) with 6 months duration. The RAs and the physiotherapist implemented the aerobic IDE using a static cycle peddler parallel to an ongoing monthly education on the importance of exercise and on how to integrate it in regular life. The RAs trained the patients on the exercise program and recorded the intensity (using the Borg scale) (Centers for Disease Control and Prevention) [23] and the duration of the exercise for each patient as well as the patient's complaints and reasons for dropout, if any. In addition, the blood pressure and pulse rate were taken at the beginning of the exercise and at every 15-minutes interval. Exercise were not initiated or stopped if the blood pressure was above 200/110 based on the recommendation from the literature [15]. The exercise program consists of cycling on a static bicycle "Pedal Exerciser KD" for 45 minutes during the first 2 hours of dialysis to avoid stress in the second half of the HD session; the peddler was positioned and stabilized in front of the patients, while they lied in their dialysis bed. The exercise modality is as follows: A 2-minutes warm-up cycling at the lowest resistance of the cycle ergometer [24]; thereafter, the conditioning phase consisted of cycling at patient's preferred resistance, while advising the patient to adjust the intensity to achieve moderate intensity exercise; exercise intensity was assessed using the Borg scale of perceived exertion and patients were encouraged to reach an average exertion score of 12. The study at all times was under the direct supervision of a nephrologist and physiotherapist assigned to the study by the hospital; in case of any discomfort, the intervention was stopped immediately. As a motivational tool, the patient's activity level (number of minutes exercised) was recorded on a tracking chart posted in the unit, and the patient with the highest performance was rewarded at the end of the intervention. At the end of this phase, patients were evaluated using all the study parameters.

Phase 3: Follow-up (T_2), 3 months post intervention. During this phase, there was no interaction between patients and the research team, and at the end, patients were re-evaluated on all study parameters.

2.5. Data collection

Data was collected utilizing validated questionnaires and blood tests from patient hospital charts (Table 1). All questionnaires that were originally not in Arabic (Barriers to Exercise and QOL) were translated to Arabic (local language), prior to the study by two translators whose first language was Arabic. Afterwards, each questionnaire was re-translated to English by a dietitian whose first language was English and who also knew Arabic. The questionnaires were administered by the recruited RAs at three points in time: T_0, T_1 and T_2. For quality control purposes, two questionnaires were administered at a time and reviewed prior to administering the next.

3. Outcome Measures

3.1. Objective tools

Data from the medical chart of each HD patient was collected that included demographics, biochemical markers [Serum Phosphorus (P) mg/dl, Parathyroid Hormone (PTH) pmol/L, Calcium Phosphorus Product (Ca x P) mg^2/dl^2, Hemoglobin (HGB) g/dl, Kt/v, and Urea Reduction Ratio (URR) %]. Demographics were collected only at $T_0$and the remaining information from patient file was collected at T_0 (average of 3 months prior to study), and further at T_1 (monthly throughout the study) and T_2 (average of 3 months post intervention).

3.2. Subjective tools

Four questionnaires were used in this study. All of which were administered at three phases of the study. RAs helped patients fill the questionnaires.

1. Malnutrition Inflammation Score (MIS) adapted from Kalantar-Zadeh et al. [25] had 10 components, each with four levels of severity from 0 (normal) to 3 (severely abnormal). The sum of all 10 MIS components ranged from 0 (normal) to 30 (severely abnormal); a higher score reflected severe degree of malnutrition and inflammation.
2. Exercise behavior, attitude and knowledge questionnaire were developed by the authors of this study. They included seven questions, each with multiple answers to choose from (See Appendix 1, Supplemental Material 1).
3. Barriers to physical activity questionnaire adapted from Fiaccadori et al. [26] included 24 questions that evaluated barriers to physical activity (psychological, physical, and economical barriers) in addition to the lack of time factor.
4. Quality of life was measured using QOL "EQ-5D-5L" questionnaire [27]. It assessed five health concepts: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression. Each question had five answer choices. In addition, patients marked their self-rated health on a visual scale from 0–100.

3.3. Statistical analysis

Data was analyzed using the Statistical Package for the Social Sciences (SPSS version 21). Results were considered statistically significant at $P < 0.05$ to guarantee 95% confidence interval. Descriptive data was conducted, categorical data were reported as frequencies and percentages counts; normality was checked for all continuous variables and statistical analyses were conducted accordingly (bivariate analysis). In order to keep the tables homogenous, means, SD, min. and max. were kept on. Moreover, median and interquartile range values were presented for all continuous variables.

4. Results

A total of 41 patients met the inclusion criteria and consented out of the 150 patients dialyzing in the selected HD unit (Figure 1).

4.1. Baseline sample characteristics

A descriptive analysis of baseline data (Tables 1 and 2) showed that 61% of the population was male with a mean age of 48.0 and mean BMI 24.98 kg/m^2. The majority of the patients were married (78.0%) and were Arab (Emirati and non-Emirati; 75.6%). More than half of the patients

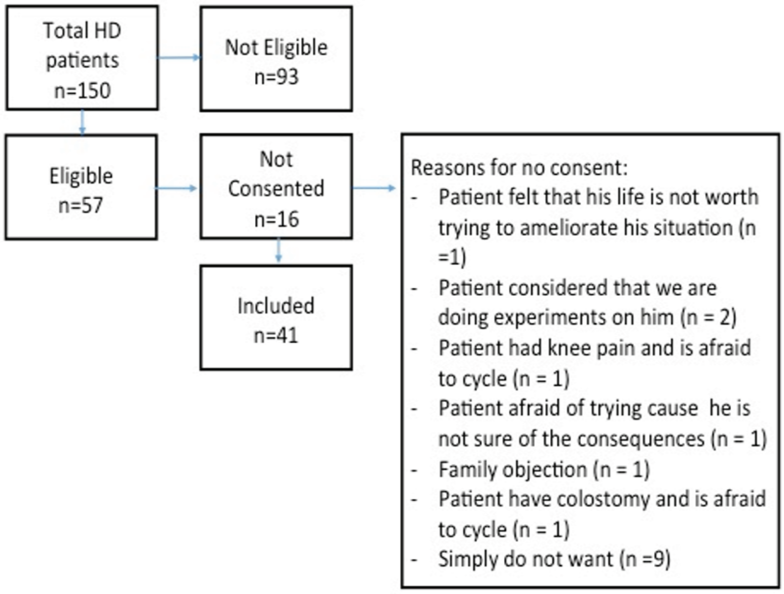

Figure 1: Flow diagram of the patients.

did not work (58.5%) and 43.9% had university degrees. Diabetes was the most common primary cause of HD initiation (56.1%), followed by hypertension (22%). The most common comorbidities included hypertension (90.2%), followed by diabetes (53.7%). Mean of recorded blood parameters were as follows: serum phosphorus (5.76 mg/dl), calcium and phosphorus byproduct (48.67 mg^2/dl^2), PTH (54.28 pmol/L), hemoglobin (10.72 g/dl), Kt/v (1.32), and URR (71.88%).

Perceived barriers to exercise among the study participants (Table 4) revealed only 1 patient (2.4%) reporting no barriers at all, followed by 14.6% of them reporting 1 barrier, 36.6% had 2–4 barriers, 36.6% had 5–9 barriers, 9.8% had 10 or more barriers. The most frequently reported barriers were fatigue on dialysis days (58.5%), fear of getting hurt (36.6%), and fatigue on non-dialysis days (34.1%).

The mean of self-rated QOL visual analogue scale was 65.02 ±18.54 (min: 25; max: 100). As for the rest of the QOL domains (Table 5), almost half of the patients did not have any problem in walking (48.8%), and most of them were independent in their routine daily self-care (90%) and activities (68.3%). Pain and discomfort were reported by 9.8% of the patients and anxiety and depression by 7.3%.

5. Discussion

The current study is the first of its kind in UAE to assess the effect of IDE on clinical, behavioral, nutritional and quality of life outcomes among HD patients. We were able to reveal patient characteristics on all study parameters.

	n (%)		n (%)
Gender, Male	25 (61)	Primary Cause of Hemodialysis	
		Diabetes	23 (56.1)
		Hypertension	9 (22)
		Nephritis	5 (12.2)
		Others	4 (9.8)
Nationality		Hemodialysis Initiation	
Emirati	8 (19.5)	<1 year	12 (29.3)
Non-Emirati – Arab	23 (56.1)	1-4 years	15 (36.6)
Non-Emirati – Other	10 (24.4)	>4 years	14 (34.1)
Social Status		Comorbidities*	
Single	8 (19.5)	Diabetes	22 (53.7)
Married	32 (78)	Hypertension	37 (90.2)
Other	1 (2.4)	Cardiovascular Disease	6 (14.6)
		Others	13 (31.7)
Work, No	24 (58.5)	Hyperphosphatemia (Serum P >4.6 mg/dl)	31 (75)[¥]
Education Level			
Illiterate	4 (9.8)		
Read and Write	4 (9.8)		
Elementary	5 (12.2)		
High School	10 (24.4)		
University	18 (43.9)		

Table 1: Baseline characteristics of patients (categorical data) (n = 41).

While existing studies in the region are limited to their descriptive and cross-sectional nature [28, 29], or to their short intervention time [30], the current study is unique in its prospective interventional design implementing the IDE program in UAE.

The study sample was similar to the general HD population in the Gulf countries and UAE in particular in many socio-demographic and clinical aspects. Our ethnic and culturally diversified sample is reflective of the nature of the UAE population [31]. Moreover, our participants were relatively young, and more than half were male. This male predominance in the HD population is a global finding [32] and is consistent with "The Dialysis Outcomes and Practice Patterns Study" (DOPPS) results reported on patients in Gulf countries in general and specifically in the UAE [4]. As for the reasons for initiation of HD, diabetes and hypertension were the most common causes in our sample; a similar finding was reported from DOPPS [4]. Finally, hypertension as a comorbidity was prevalent in more than 90% of the patients in both our sample and the representative sample of DOPPS UAE [4]. Moreover, more than half of the patients did not work and 43.9% had university degrees; the former figure is comparable to DOPPS results where

	Normal Values	Mean ± SD	Min/Max	Median	IQR
Age (years)		48.00 ± 14.37	20/74	50.00	36.50–58.00
BMI (kg/m^2)	20–25	24.98 ± 6.09	17.06/46.14	23.32	21.26–26.70
URR (%)	≥ 65	71.88 ± 8.52	50.79/89.62	71.69	66.14–77.23
Kt/v	1.2–1.4	1.32 ± 1.09	1.08/1.63	1.30	1.24–1.37
P (mg/dl)	2.5–4.5	5.76 ± 1.66	1.83/9.32	5.61	4.82–6.48
Ca x P (mg^2/dl^2)	≤ 55	48.67 ± 14.30	15.44/82.86	45.65	39.11–56.65
PTH (pmol/L)	15.90–31.81	54.28 ± 45.60	8.90 /243.2	44.50	24.40–69.30
HGB (g/dl)	13–17	10.72 ± 1.44	7.53/14.1	10.6	9.86–11.56
MIS	0	7.41 ± 3.06	3/17	7.00	5.00–9.00

Note: SD: standard deviation; Min: minimum; Max: maximum; BMI: Body Mass Index; URR: Urea Reduction Ratio; P: Phosphorus; Ca*P: Calcium Phosphorus byproduct; PTH: Parathyroid Hormone; HGB: Hemoglobin; MIS: Malnutrition–Inflammation Score; IQR: Interquartile range.

MIS Scoring System: The total MIS ranges between 0 and 30: 0: normal; 1–10: mildly malnourished; 11–20: moderately malnourished; 21–30: severely malnourished.

Behavior, attitude and knowledge of HD patients regarding exercise are detailed in Table 3. Around one-third of the participants reported at baseline that they did not exercise (31.7%), and more than half of the sample (58.6%) intended to start exercising after consulting their physician. The majority of the patients (92.5 %) perceived exercise as important. Around half of the patient knew that exercise is safe (55%) and were knowledgeable about its health benefits (43.9%).

Table 2: Baseline characteristics of patients (continuous data) (n = 41).

62% of HD population in the UAE were unemployed [4], and the latter one is comparable to Dubai Statistic Center results, where 74.1% of the unemployed citizens had university degrees [33]. All these factors allow us to generalize our findings to the general UAE HD population.

Hyperphosphatemia was highly prevalent in our sample at baseline (75%), a number that was far higher than the 38% reported in the DOPPS-UAE [29], but this can be explained by the fact that the latter results were of data collected in 2013, using a cut-off point for hyperphosphatemia as 6mg/dl. The current study followed the KDIGO 2017 guidelines using tight serum P control (> 4.6mg/dl) [6]. Data from other studies, using 5.5mg/dl cut-off point showed around 40% prevalence of hyperphosphatemia in the region [34] and worldwide [35]. Given the high clinical [36] and financial burden of hyperphosphatemia [37] and its management through phosphate binders and specifically non-calcium phosphate binders [38], finding an effective and inexpensive novel means to manage hyperphosphatemia is a necessity in modern nephrology care [39].

The majority of our sample was mildly malnourished (80.4%). This is in line with previous literature, where malnutrition was common among HD patients globally [40] and regionally [41]. In the previous literature, exercise appeared to improve protein energy wasting [42] and thus malnutrition.

		n (%)
Exercise Behavior	Frequency of Exercise per Week	
	Don't exercise	13 (31.7)
	Exercise 1–2 time per week	1 (26.8)
	Exercise 3 or more times per week	17 (41.5)
	Duration of Exercise (among patients who reported exercising once or more)	
	Less than 30 minutes each time	9 (32.1)
	30–40 minutes each time	8 (28.6)
	40 minutes and more each time	11 (29.3)
	Exercise Modality*¥ (among patients who reported exercising once or more)	
	Walking	26 (96.3)
	Jogging /Dancing/Aerobics/Others	4 (14.8)
	Weight training	2 (7.4)
Attitude to Exercise	Intent to Start Exercise	
	After consulting the doctor	24 (58.6)
	Does not know	17 (41.5)
	Attitude toward Exercise Importance on Health¥	
	Important	37 (92.5)
	Not important	3 (7.5)
Knowledge on Exercise	Knowledge about Exercise Safety¥	
	Correct knowledge	22 (55.0)
	False knowledge	18 (45.0)
	Knowledge about the Benefits of Exercise for Hemodialysis Patients*¥	
	Correct knowledge	18 (43.9)
	No knowledge	23 (56.1)
Note: *Percentages do not sum up due to multiple possible answers; ¥Valid percentages are reported.		

Table 3: Exercise behavior, attitude and knowledge questionnaire.

Despite the positive attitude of our sample about the importance of exercise, time allocated for the physical activity was limited, and walking was almost the only form of exercise performed. These practices are similar to those noted in Delgado and Johansen [43]. This is in line with the sedentarism prevalent among HD patients [10]. This might be attributed to the widespread lack of knowledge among these patients or to the fact that exercise is not routinely advocated by the nephrologist within HD patient management [44]. To date, there are no clear guidelines in the KDIGO or the Kidney Disease Outcomes Quality Initiative (KDOQI) [45] on IDE intensity, modality, and duration.

Barriers	**n (%)**
Fatigue on dialysis days	24 (58.5)
Fear of getting hurt	15 (36.6)
Fatigue on non-dialysis days	14 (34.1)
Shortness of breath	12 (29.3)
Too many medical problems	11 (26.8)
Chest pain	11 (26.8)
Feelings of helplessness	10 (24.4)
Pain on dialysis days	9 (22.0)
Ulcers on legs and feet	9 (22.0)
Sadness	9 (22.0)
Inability to travel	9 (22.0)
Pain on non-dialysis days	8 (19.5)
Lack of time on dialysis days	8 (19.5)
Can't afford to exercise	8 (19.5)
Lack of safe place for exercise	6 (14.6)
Physician concern	5 (12.2)
No exercise partner	5 (12.2)
I don't want to	5 (12.2)
Family concern	5 (12.2)
Lack of time on non-dialysis days	4 (9.8)
Lack of time because of too many medical appointments	4 (9.8)
No place to exercise	3 (7.3)
Feeling too old	2 (4.9)
Not wanting to be seen doing exercise	1 (2.4)

Table 4: Perceived barriers to physical activity.

	No problem n (%)	Slight problem n (%)	Moderate problem n (%)	Severe problem n (%)	Unable / very severe n (%)
Self-care	37 (90.2)	1 (2.4)	1 (2.4)	1 (2.4)	1 (2.4)[a]
Daily Activities	28 (68.3)	2 (4.9)	6 (14.6)	2 (4.9)	3 (7.3)[a]
Anxiety/Depression	24 (58.4)	6 (14.6)	5 (12.2)	3 (7.3)	3 (7.3)[a]
Mobility	20 (48.8)	9 (22)	4 (9.8)	5 (12.2)	3 (7.3)[b]
Pain/Discomfort	17 (41.5)	10 (24.4)	4 (9.8)	6 (14.6)	4 (9.8)[b]
Note: [a]= unable; [b]= very severe					

Table 5: EuroQOL 5D-5 L questionnaire.

Most of our patients reported the existence of at least one barrier, 73% had more than two barriers and the most common barrier was "fatigue on dialysis days"; this was in line with other studies [26, 43]. The second most prevalent barrier in our sample was "fear of getting hurt", and very few stated, "I do not want to" for exercise; these findings were unique for our patients and different from the literature [26, 43]. Barriers related to physical limitations and fears surrounding exercise ranked higher than logistics-related barriers in our sample.

The QOL visual analogue scale (VAS) was 65.02 ± 18.54, which was slightly higher than VAS results reported from other countries [46]. Also, the percentage of patients reporting no problem across the five dimensions of EQ-5D-5L was higher than the score reported in another countries [46]. Those differences might be attributed to cultural variances. In fact, while conducting the EuroQOL-5D questionnaire, the research team faced a limitation that was most prevalent in the VAS question, which raised the question of its cultural appropriateness and its suitability to assess the quality of life in this population. Patients showed strong religious beliefs and interpreted sickness as “fate” and the “will of God”. When asked to rate their health, many of our patients used the word “Thank God” which was difficult to score. This answer was translated to a high score on the scale. Such impact of religious beliefs influencing the QOL assessment among the chronically ill has been previously reported among other cultures as well [42]. Further validation of the instrument in religious-oriented cultures is recommended.

6. Conclusion

Our baseline findings revealed the hyperphosphatemics and malnourished patients and the barriers impeding them from integrating exercise in their lifestyle. Our results may shed light on this overlooked population and enlighten other researchers and stakeholders about the current situation of hemodialysis patients in the UAE. Furthermore, it will highlight the strategies needed to tailor-made exercise program for HD patients in the UAE.

7. Conflict of Interest

None declared

8. Acknowledgment

The project was under the supervision of Dr Harith Muthana, consultant nephrologist at Al Qassimi Hospital. Dr Muthana assigned a nephrologist for the daily supervision of the research. The physiotherapy department at Al Qassimi Hospital assigned a physiotherapist to help in the exercise program implementation. The College of Natural and Health Sciences department at Zayed University in Dubai and Sharjah campuses provided students who helped us in data collection. Special thanks to the staff and patients in participating in the dialysis unit for facilitating the process.

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