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# Changes in physical functional performance and quality of life in hemodialysis patients in Taiwan: a preliminary study

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## Abstract

***Purpose:*** **To study the long-term changes in physical functional performance and quality of life in hemodialysis patients living in the community in Taiwan.** ***Methods:*** **This prospective study monitored 27 ambulatory hemodialysis patients for 16 months living in the community in Taiwan. Physical capacity (6-minute walk test, grip strength, pinch strength and chair-rising time), maximal cardiovascular fitness test, functional performance (Functional Independence Measure) and quality of life (WHOQOL-BREF) were evaluated.** ***Results:*** **There were 17 men and 7 women, with a mean age of 61.3 (± 9.0) years. The results showed significantly decreased pinch strength (right hand: from 6.4 kg to 4.5 kg, p=0.009; left hand: from 5.6 kg to 4.7 kg, p=0.017) and decreased quality of life (from 89.5 to 85.3 for WHOQOL-BREF total score, p=0.026), especially in the domain of physical health and subcategories of concentrating ability, satisfaction with working ability and sex life, and "eating foods whenever wanted," over the 16-month period. Maximal cardiovascular fitness and functional performance remained stationary during the 16-month period.** ***Conclusion:*** **Significantly declined pinch strength and quality of life, with maintained maximal cardiovascular fitness and functional performance, were noted in ambulatory hemodialysis patients over the 16-month period of follow-up. An intensive pinch strengthening program and overall improvement in quality of life for these patients is needed.**

**Key words:** *Cardiovascular fitness, Functional performance, Hemodialysis, Physical capacity, Quality of life*

## Introduction

In Taiwan, the national prevalence of chronic renal disease is 11.9%, contributing to one tenth of all deaths (1). Taiwan has the second greatest prevalence of treated end-stage renal disease in the world, with 15%-30% higher dialysis rates than in the United States (1, 2). It is a challenge for dialysis patients to live in the community with independence in basic activities of daily living (ADL) and instrumental ADL. Good physical functional performance is needed to maintain independence in ADL. Cardiovascular fitness and muscle strength in general dialysis patients is about 40%-50% of that for age-matched controls (3). Lower cardiovascular fitness results in general malaise, muscle weakness and atrophy, deconditioning, depression, limitation of functional performance and reduction in quality of life (QOL) (4-8).

However, there is a large range of conditions among dialysis patients. Our previous study found that ambulatory hemodialysis patients living in the community in Taiwan have only 72%-79% of physical capacity and 71% of the maximum oxygen consumption of age-matched controls (4). Functional performance and QOL were also decreased compared with age-matched controls (5). A recent study showed that an exercise program prescribed in hospital and performed at home can improve the long-term physical capacity and QOL in dialysis patients (9). Nonetheless, the long-term trends of physical capacity and QOL in dialysis patients in Taiwan are not well understood. In this study, we followed up for 16 months the previously studied ambulatory hemodialysis patients living in the community in Taiwan to examine the changes in physical functional performance, including physical capacity, maximal cardiovascular fitness, functional performance and QOL.

## Methods

From January 2003 to July 2005, a total of 27 hemodialysis patients at Shin Kong Wo Ho-Su Memorial Hospital, which is located in northern Taiwan, participated in this prospective study. All subjects agreed to 16 months of physical functional performance and QOL monitoring. The human research ethics committee of the hospital approved the investigative protocol. These subjects were able to ambulate independently for more than 6 minutes and had not had uncontrolled arrhythmia, unstable angina or active infection within the previous 3 weeks. Cognitive function was normal, based on the Mini-Mental State Examination (10) for a score greater than 23. Basic information including age, sex, body mass index (BMI), exercise conditions, marital status, smoking habit, alcohol consumption, comorbidities (e.g., hypertension, diabetes mellitus, hepatic disease, renal disease, cardiovascular disease and others) and number of medications was collected. Any pathological event during the period of observation was recorded.

Physical functional performance was evaluated by physical capacity, maximal cardiovascular fitness and functional performance testing. Physical capacity was assessed with tests including the 6-minute walk test (6MWT) (11), grip strength, pinch strength and chair-rising time (4, 5, 12) on nondialysis days. The 6MWT measures the distance covered by patients walking as fast as possible for 6 minutes on a hard, flat surface. The modified Borg scale was used to record perceived rate of exertion, with 10 as the maximum score (13). Higher score indicated more perceived exertion. Grip and pinch strength were evaluated using the Jamar hydraulic hand dynamometer and B&L pinch gauge, 3 times at 1-minute intervals, with the mean used for the analysis. Subjects performed the tests in a seated position with arm adducted and elbow flexed at 90 degrees, and the wrist between 0 and 30 degrees of extension. The pinch strength was measured by thumb to index tip pinch. Chair-rising time was the time interval required to stand and sit as rapidly as possible 5 times from a standard chair without arm support.

The Functional Independence Measure (FIM) was used to ascertain functional status and functional independence assessment (14). It consists of 18 items in the categories of self-care, sphincter control, transfer, locomotion, communication and social cognition. The ratings range from 1 to 7, with a score of 7 indicating total independence and a score of 1 indicating total assistance required. The total score ranges from 18 to 126, with higher scores indicating greater functional independence.

QOL was assessed using the World Health Organization QOL (WHOQOL-BREF) instrument. It consists of 4 domains including physical health, psychological state, social relationships and environment. We used the Chinese version of the WHOQOL-BREF (15, 16), which, compared with the English WHOQOL-BREF, has 2 additional items: "feeling respected by others" and "usually being able to get things one likes to eat." It contains 28 questions, a 5-point rating scale, and higher scores are indicative of superior QOL. It has good intra- and inter-observer test and retest reliability (16). Individual items are scored on a 5-point scale. A higher value indicates better QOL. The same well-trained examiner performed all of the above evaluations, on nondialysis days.

One to 2 weeks after the evaluations, the subjects underwent the maximal cardiovascular fitness test (Vmax 29; Sensor Medics Corporation, USA) on an electric leg cycle ergometer with 3-lead electrocardiography, $O_2$ saturation measurements and blood pressure monitoring. Tests were performed on nondialysis days by a qualified physiatrist. All participants gave adequate informed consent for the exercise test. The test started with a workload of 10 W and was increased by 10 W at each stage. Subjects were required to pedal at 50 rpm. Breath-by-breath cardiovascular exercise testing was also performed. Tests were terminated if subjects achieved maximal oxygen consumption plateau criteria or the respiratory exchange ratio was greater than 1.1. The peak oxygen consumption obtained is represented by $VO_2$ peak, which is expressed in milliliters of oxygen consumed per kilogram of body weight per minute (17). All of the above evaluations were repeated after 16 months.

Results are expressed as means ± standard deviations. The Wilcoxon signed-rank test was used for comparison of the changes in physical capacity, maximal cardiovascular fitness, functional performance and QOL. The Pearson correlation was used to assess the correlated factors of significant changes. The level of statistical significance was set at a p value $<0.05$.

## Results

Of the 27 subjects initially enrolled, 24 completed the study. Ten subjects lived in the Shi-Lin District in Taipei City, while 8 lived in other districts in Taipei City and 9 lived in Taipei County, which is near our hospital. Two subjects refused to undergo follow-up evaluation for personal reasons, and 1 subjected died during the follow-up period due to metastatic adenocarcinoma in multiple organs with septic shock. The follow-up rate was 89%. Mean length of follow-up was 16.5 months. There were 17 men and 7 women, with a mean age of 61.3 (± 9.0) years. The mean BMI

**TABLE I**
CHARACTERISTICS OF PATIENTS ON AMBULATORY HEMODIALYSIS OVER A 16-MONTH PERIOD

| Variables | Baseline | Follow-up | p Value |
|---|---|---|---|
| Age, years | 59.9 ± 9.0 | 61.3 ± 9.0 | 0.604 |
| BMI | 23.1 ± 3.0 | 23.4 ± 3.2 | 0.004* |
| ≤24 | 18 | 11 | |
| >24 | 9 | 13 | |
| Sex | | | |
| Male | 19 | 17 | 0.573 |
| Female | 8 | 7 | |
| Regular exercise | | | |
| Yes | 20 | 16 | 0.248 |
| No | 7 | 8 | |
| Employed | | | |
| Yes | 9 | 9 | |
| Domestic duties | 6 | 6 | 0.306 |
| None | 12 | 9 | |
| Religion | | | |
| Yes | 26 | 23 | 0.159 |
| None | 1 | 1 | |
| Marital status | | | |
| Single | 2 | 2 | |
| Married | 24 | 22 | 0.308 |
| Divorced/widowed | 1 | 0 | |
| Smoker | | | |
| Yes | 4 | 4 | 1 |
| None | 23 | 20 | |
| Alcohol drinking | | | |
| Yes | 3 | 3 | 1 |
| None | 24 | 21 | |
| Diabetes mellitus | | | |
| Yes | 6 | 3 | 0.473 |
| None | 21 | 21 | |
| Comorbidities | | | |
| ≤3 | 19 | 11 | 0.076 |
| >4 | 8 | 13 | |
| Medications | | | |
| ≤3 | 11 | 2 | 0.008* |
| >4 | 16 | 22 | |
| Mean dialysis duration, months | 63 (6-240) | 81 (21-252) | |

Data are number of patients or means ± SD or (range).
BMI = body mass index.
*p<0.01.

increased significantly by 16 months of follow-up (23.1 vs. 23.4, p=0.004). Sixteen patients were active and engaged in regular exercise before the baseline test (more than 1 or 2 periods of gentle exercise per week). There were 12 subjects with hypertension and 3 with diabetes mellitus. The number of medications increased significantly by 16 months of follow-up (p=0.008). The mean duration of hemodialysis was 81.4 months. There were no serious pa-

**TABLE II**
CHANGES OVER A 16-MONTH PERIOD IN HEMODIALYSIS ADEQUACY AND BIOCHEMISTRY IN PATIENTS ON AMBULATORY HEMODIALYSIS

| Variables | Baseline | Follow-up | p Value |
|---|---|---|---|
| Kt/V | 1.0 ± 0.6 | 1.4 ± 0.2 | 0.060 |
| Albumin | 4.2 ± 0.4 | 4.0 ± 0.3 | 0.004* |
| Hematocrit | 28.7 ± 6.8 | 30.2 ± 3.6 | 0.706 |
| MCV | 96.3 ± 5.4 | 95.9 ± 5.1 | 0.855 |

Values are means ± SD.
Kt/V = efficacy of hemodialysis; MCV = mean corpuscular volume.
*p<0.005.

thological events during the period of observation in the followed-up subjects (such as pneumonia, fracture, stroke, gastric ulcer or myocardial infarction). The basic characteristics of the patients are shown in Table I.

The adequacy of dialysis (Kt/V) was unchanged, and albumin decreased significantly (4.2 vs. 4.0, p=0.004).The changes in hemodialysis efficacy and biochemistries in hemodialysis patients over the 16-month period are shown in Table II.

The results of follow-up physical performance, including physical capacity and maximal cardiovascular fitness assessments, are shown in Table III. Pinch strength decreased in both hands at the 16-month follow-up compared with baseline (right: 6.4 kg vs. 4.5 kg, p=0.009; left: 5.6 kg vs. 4.2 kg, p=0.017). Grip strength, distance walked in the 6MWT, and chair-rising time did not change significantly. One subject refused to undergo the follow-up maximal cardiovascular fitness test, and 1 subject failed to complete the follow-up test due to discomfort with the nasal clip during testing. Excluding these 2 cases, the maximal cardiovascular fitness test showed no significant change in the $VO_2$ peak (12.0 mg/kg/min vs. 11.0 mg/kg/min, p=0.118).

Although the follow-up study showed improved functional independence in communication (12.6 vs. 13.5, p=0.025), there was no significant difference in the total FIM score (121.2 vs. 122.1, p=0.302) (Tab. IV).

The QOL assessment showed significantly decreased physical health domain scores (21.6 vs. 20.0, p=0.002) and total scores (89.5 vs. 85.3, p=0.026) for ambulatory hemo-

**TABLE III**
CHANGES OVER 16-MONTH PERIOD IN PHYSICAL CAPACITY AND MAXIMAL CARDIOVASCULAR FITNESS IN PATIENTS ON AMBULATORY HEMODIALYSIS

| Variables | Baseline | Follow-up | p Value |
|---|---|---|---|
| Grip strength (kg) | | | |
| Right | 22.3 ± 2.4 | 23.9 ± 2.0 | 0.235 |
| Left | 20.2 ± 2.0 | 20.2 ± 2.0 | 0.375 |
| Pinch strength (kg) | | | |
| Right | 6.4 ± 0.7 | 4.5 ± 0.7 | 0.009** |
| Left | 5.6 ± 0.7 | 4.2 ± 0.7 | 0.017* |
| Chair-rising time | 12.4 ± 0.8 | 13.6 ± 0.9 | 0.211 |
| 6MWT | | | |
| Speed (m/s) | 1.1 ± 0.0 | 1.1 ± 0.1 | 0.835 |
| Distance (m) | 377.7 ± 20.1 | 353.7 ± 29.5 | 0.376 |
| Rate of perceived exertion | 4.2 ± 0.5 | 3.4 ± 0.4 | 0.150 |
| Maximal cardiovascular fitness test | | | |
| Peak $VO_2$ (ml/kg/min) | 12.0 ± 0.6 | 11.0 ± 0.6 | 0.118 |
| Maximal power (W) | 59.0 ± 3.4 | 53.4 ± 4.0 | 0.398 |

Values are means ± SD.
6MWT = 6-minute walk test; peak $VO_2$ = peak oxygen consumption.
*p<0.05, **p<0.01.

dialysis patients at the 16-month follow-up, especially in the subcategories of satisfaction with work ability (3.4 vs. 3.1, p=0.013), concentrating ability (3.3 vs. 2.9, p=0.029), sex life (2.9 vs.2.6, p=0.023) and "eating foods whenever wanted" (4.0 vs. 3.5, p=0.043) (Tab. V).

There was no correlation between pinch strength, QOL and age, sex, duration of dialysis, diabetes, functional performance or $VO_2$ peak.

## Discussion

Our study found no significant change in grip strength, chair-rising time or 6MWT among ambulatory hemodialysis patients at the 16-month follow-up assessment. Physical capacity, including grip, chair-rising and walking, are key functional ADL (12, 18, 19). These tasks are necessary for

**TABLE IV**
CHANGES OVER A 16-MONTH PERIOD IN FUNCTIONAL INDEPENDENCE MEASUREMENTS IN PATIENTS ON AMBULATORY HEMODIALYSIS

| Variables | Baseline | Follow-up | p Value |
|---|---|---|---|
| Self-care | 42.0 ± 0.0 | 41.6 ± 0.3 | 0.174 |
| Sphincter control | 14.0 ± 0.0 | 14.0 ± 0.0 | --- |
| Locomotion | 21.0 ± 0.0 | 20.8 ± 0.1 | 0.174 |
| Mobility | 13.3 ± 0.1 | 13.2 ± 0.2 | 0.407 |
| Communication | 12.6 ± 0.3 | 13.5 ± 0.2 | 0.025* |
| Social cognition | 18.3 ± 0.5 | 19.9 ± 0.5 | 0.119 |
| Total score | 121.2 ± 0.9 | 122.1 ± 0.7 | 0.302 |

Values are means ± SD.
*p<0.05.

**TABLE V**
CHANGES OVER A 16-MONTH PERIOD IN SIGNIFICANT VARIABLES OF WHOQOL-BREF IN PATIENTS ON AMBULATORY HEMODIALYSIS

| Variables | Baseline | Follow-up | p Value |
|---|---|---|---|
| Domains | | | |
| Physical health | 21.6 ± 2.6 | 20 ± 2.8 | 0.002** |
| Need medical treatment for daily life | 2.7 ± 0.2 | 2.3 ± 0.2 | 0.052 |
| Satisfaction with working ability | 3.4 ± 0.2 | 3.1 ± 0.2 | 0.013* |
| Psychological | 18 ± 2.5 | 17.4 ± 3.1 | 0.598 |
| Ability to concentrate | 3.3 ± 0.1 | 2.9 ± 0.2 | 0.029* |
| Social relationships | 12.9 ± 2.4 | 12.5 ± 2.2 | 0.082 |
| Satisfaction with sex life | 2.9 ± 0.2 | 2.6 ± 0.2 | 0.023* |
| Environment | 30.5 ± 5.0 | 29.3 ± 4.0 | 0.169 |
| Satisfaction with convenience of medical services | 3.9 ± 0.1 | 3.6 ± 0.1 | 0.059 |
| Eating foods whenever wanted | 4.0 ± 0.2 | 3.5 ± 0.27 | 0.043* |
| Total score | 89.5 ± 2.2 | 85.3 ± 2.1 | 0.026* |

Values are means ± SD.
*p<0.05, **p<0.01.

independence to participate in social and functional activities in the community (18). Grip strength of 9 kg is necessary for maintaining most ADL (20) and is considered functional. Grip strength increases until ages in the 30s and starts to decline after the 40s by 1% annually throughout the remainder of life (21, 22). Low grip strength is associated with increasing age, hormonal change and chronic disease (21, 22). In this study, although the overall grip muscle strength among our ambulatory hemodialysis patients was lower than in the general population (22, 23), it did not change significantly and remained in a functional condition during the 16 months of follow-up.

For maintenance of function of basic and instrumental ADL, adequate hand strength is needed. Pinch requires a more precise movement than grip. It needs cutaneous, tactile afferent input to coordinate the movement and adjust the output force balance (24). Good eye-hand coordination and upper limb peripheral sensory motor function are required. Our study showed that the pinch strength in ambulatory hemodialysis patients decreased significantly from an average of 6 kg to 4.4 kg in 16 months. We found no correlation between pinch strength and age, sex, duration of dialysis or maximal oxygen consumption in our study. Activation of motor units in the central nervous system is normal among dialysis patients (25). Therefore, to determine whether the significant change in pinch strength was caused by deconditioning or impairment of peripheral sensory motor function needs further study. Because the decline of pinch strength will affect fine motor ADL, we emphasize strategies to increase pinch strength among ambulatory hemodialysis patients.

A previous study showed that peak $VO_2$ among hemodialysis patients and normal controls in Taiwan was lower than among whites after adjustment for age, sex and body weight (26). Our ambulatory hemodialysis patients had a relatively low peak $VO_2$ of about 11 to 12 ml/kg/min compared with 16 to 20 ml/kg/min among whites. Peak $VO_2$ is affected by age, sex, BMI, body composition, genetics, comorbidities, level of physical capacity, state of training, mode of exercise and race (27). Though peak $VO_2$ among our hemodialysis patients had a tendency toward declining at 16 months of follow-up, the trend did not reach statistical significant. We cannot rule out a type II error. In addition, the peak $VO_2$ with 11.0 ml/kg/min was only slightly higher than the oxygen consumption of 10.5 ml/kg/min which is the basic requirement for maintenance of ADL. Therefore, we recommend intensive cardiovascular fitness training for these patients.

We performed maximal cardiovascular fitness to measure peak oxygen consumption among our patients. This test required the use of expensive equipment by qualified specialists and carried some risk to the patients. In addition, we used 6MWT, grip strength, pinch strength and chair-rising time to measure physical capacity. Among them, 6MWT is usually used to measure submaximal functional capacity and correlates with exercise capacity among the elderly (11, 28); grip strength is a powerful predictor of disability and a good indicator of overall muscle strength (21, 22); and chair-rising time correlates well with the peak oxygen consumption among ambulatory hemodialysis patients (4). Patients with chronic diseases always perform ADL at submaximal functional activity (11). Therefore, we recommend the convenient and easy-to-perform physical measures, such as 6MWT, pinch and grip strength, and chair-rising time, for the evaluation of physical performance among dialysis patients.

Functional performance assesses the ability to carry out basic and instrumental ADL (29). Maintenance of functional performance, which means carrying out ADL in the normal course of daily life (30), is very important for patients with chronic diseases. About one fourth to one third of hemodialysis patients were unable to perform ADL without assistance (31). The total FIM score among ambulatory hemodialysis patients was lower than in age-matched controls in our previous studies (4, 5). The present study indicated that although functional performance among ambulatory hemodialysis patients was lower than that of controls, it remained stationary over the 16-month follow-up period.

QOL is defined as an individual's perception of their position in life and in a culture and value system, and the relationship of this perception to goals and expectations (32). Our study showed decreased total scores in the WHOQOL-BREF at 16 months of follow-up. Among these, the subcategory of "eating foods whenever wanted" belongs to the traditional Chinese social culture (16, 33). No correlation was noted between QOL and age, sex, peak $VO_2$ or duration of dialysis in the present study. It would be interesting to determine in the future whether this factor has the same effect on dialysis patients in different countries and cultures. The rise of consumer-oriented medical care has made QOL the embodiment of the concern for patients as people and not merely the presence of disease (34). This concept is particularly important for patients who suffer from chronic diseases, such as dialysis patients. How to maintain and improve QOL among dialysis patients is an important and ongoing issue.

## Conclusions

We aimed to study the long-term changes in physical functional performance and QOL in hemodialysis patients living in the community in Taiwan. After 16 months, pinch strength and QOL declined, while maximal cardiovascular fitness and functional performance were maintained.

Because the decline of pinch strength will affect fine motor ADL, further pinch-strengthening training for these patients is needed. Our study showed no correlation between pinch strength, QOL and age, sex, peak $VO_2$ or duration of dialysis. Therefore, it would be interesting to determine in the future whether these factors have the same effects on dialysis patients in different countries and cultures. Although maximal cardiovascular fitness remained unchanged, it was lower than in age-matched controls. We recommend intensive cardiovascular fitness training for these patients, guided by the convenient and easy-to-perform measures such as 6MWT, pinch and grip strength, and chair-rising time. A limitation of the study was the lack of a control group of age-matched healthy subjects, which would have facilitated the evaluation of the physical decline of hemodialysis patients. Further studies with age-matched larger sample sizes, different races, and variable conditions among patients with dialysis are needed to confirm these results.

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