Exercise In Hemodialysis Patients

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INTRODUCTION

- Kidney disease is among the highest-stress illnesses worldwide due to:
  - Chronicity
  - Long-term of treatment
  - Spend long time during dialysis as long as they live
- Physical inactivity and its negative influence on health and the quality of life is a common problem generally, especially in patients with chronic illness and also in patients with ESRD
- Patients with CKD have lower physical function and impaired physical performance, contributing to a high prevalence of frailty and mobility disability and an increased risk of mortality.
- **Physical inactivity** is associated with an imbalance of energy expenditure that can increase comorbidities, such as HTN, DM, CAD, and depressive mood, which can aggravate such issues
- Dialysis patients are particularly **susceptible to decreased** health-related quality of life **(HRQoL)** or **physical performance** compared with patients who undergo kidney transplantation.
- **Proper interventions are needed to improve** HRQoL or physical performance in dialysis patient

Physical activity levels in patients on hemodialysis and healthy sedentary controls

(*Kidney International, Vol. 57, 2000)*

- Patients on dialysis have reduced exercise tolerance compared with age-matched sedentary controls.
- 34 HD patients and 80 healthy sedentary individuals participated in the study. Physical activity was measured for seven days with a three-dimensional accelerometer and with an activity questionnaire.
- Patients on hemodialysis are less active than healthy sedentary controls, and this difference is more pronounced among older individuals. There is an association between the level of physical activity and nutritional status among patients on dialysis.

Physical activity levels in patients on hemodialysis and healthy sedentary controls

(*Kidney International, Vol. 57, 2000*)

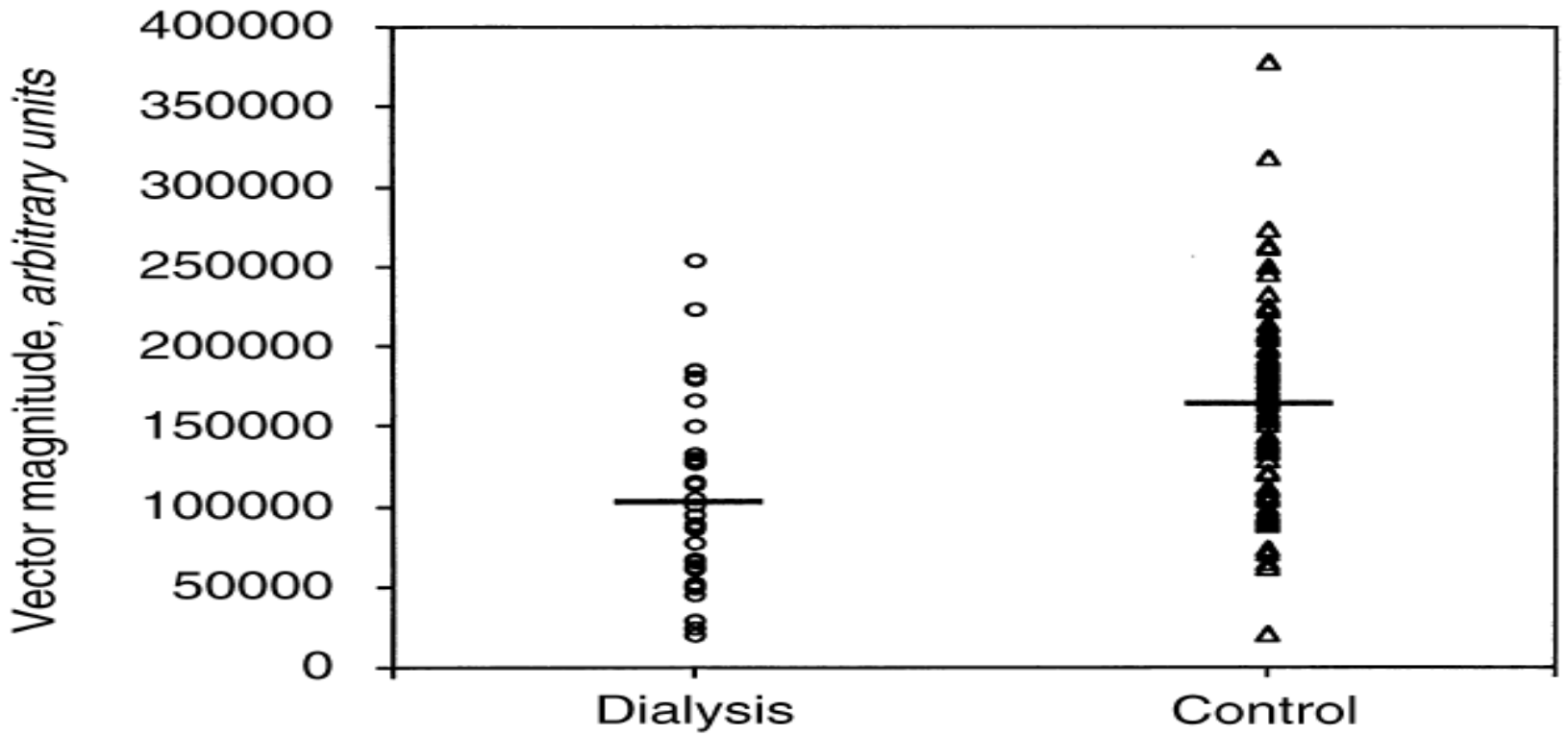


Fig. 1. Daily physical activity levels by accelerometry. Symbols are: (○) dialysis subjects ($N = 34$); (△) healthy control subjects ($N = 80$); the bars denote average values for each group.

Physical activity levels in patients on hemodialysis and healthy sedentary controls

(*Kidney International, Vol. 57 (2000)*)

- Increasing physical activity in the dialysis population could also result in improved physical functioning and rehabilitation.
- Since physical functioning has been identified as an important determinant of quality of life
- Improvements in physical functioning could translate, in turn, to an enhanced quality of life.
- Results show that activity levels are extremely low in the dialysis population, especially in view of the relatively low quality of life and high mortality in this group.
- **Intervention** geared toward **increasing physical activity** in dialysis patients, such as **intradialytic exercise programs**, have the potential to be of great benefit

CAUSES OF REDUCED PHYSICAL ACTIVITY

- As kidney disease progresses, skeletal muscle dysfunction forms a common pathway for mobility limitation, loss of functional independence, and vulnerability to disease complications
- **Muscle defect** accounts for at least a part of the **reduced physical functioning** in this group
- **Inactivity** is a common cause of muscle atrophy and could be a contributing factor to the muscle abnormalities
- **Anemia** was believed to be an important reason for the reduced functional capacity of these patients
- **Uremia** itself or hormonal abnormalities, bone disease, or nutritional status
- **Dialysis** procedure itself could contribute to low levels of physical activity

Exercise and CKD: Skeletal Muscle Dysfunction and Practical Application of Exercise to Prevent and Treat Physical Impairments in CKD

Am J Kidney Dis. 2017 June

- Kiel stein et al. investigated the association between physical activity and endogenous nitric oxide inhibitor asymmetric dimethylarginine (ADMA) as a uremic toxin even without comorbidities.
- Showed that ADMA infusion alone without CKD significantly decreased brain-derived neutrophic factors and decreased physical activity.
- These reveal that patients with CKD are inherently at risk of decreased physical activity regardless of various comorbidities.

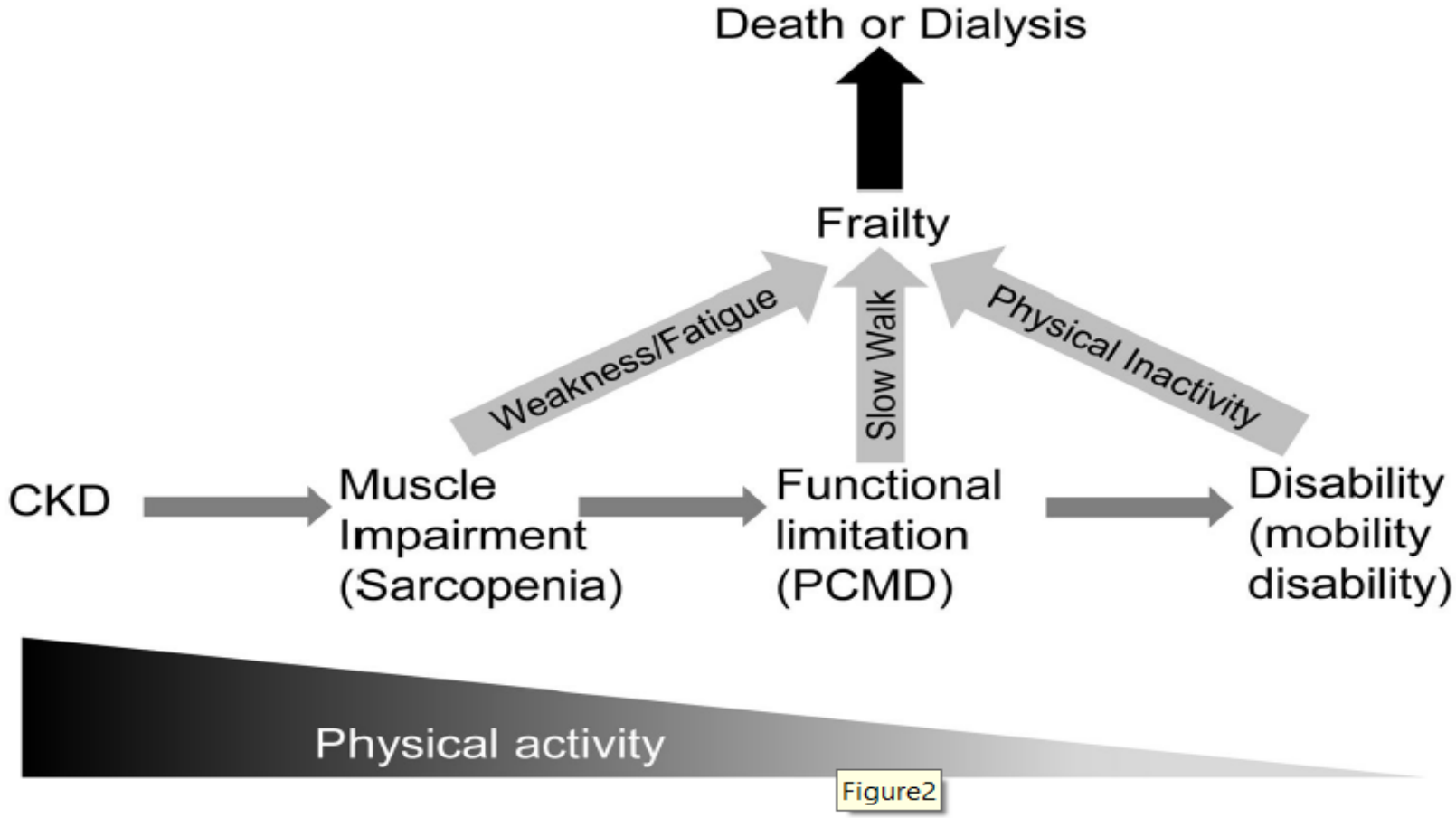


Figure 2.
CKD leads to muscle impairment promoting functional decline, mobility disability, and frailty. This figure represents CKD in the context of the Nagi disablement model. Abbreviations: PCMD – preclinical mobility disability. Source: Newman & Cauley[7].

Clinical Significance of Physical Activity in Maintenance Dialysis Patients

Blood Press Res 2017

- Present study was to evaluate the effects of physical activity on various aspects in Asian dialysis patients.
- **A retrospective cohort study**, participants were from 27 hospitals or dialysis centers in Korea (n = 1611).
- Participants were divided into 3 groups according to the degree of regular exercise:
  - **Inactive group** was defined as physical activity < 1 time per week during their leisure time for the previous 3 months.
  - **Intermediate group** was defined as participants whose activity levels were between those of the Inactive and Active groups.
  - **Active group:** Moderate activity for > 30 min/day for 5 days a week or at a high intensity for > 20 min/day for 3 days a week

Clinical Significance of Physical Activity in Maintenance Dialysis Patients

Kidney Blood Press Res 2017

- ***Results:***
- More participants in the Inactive group had a history of falls during the last 12 months.
- Number of participants with a **history of fall** during the last 12 months was:
  - 149 (20.5%) in the Inactive group
  - 88 (16.9%) in the Intermediate group
  - 48 (13.2%) in the Active group
- Most of the HRQoL scale scores were highest in the Active group.

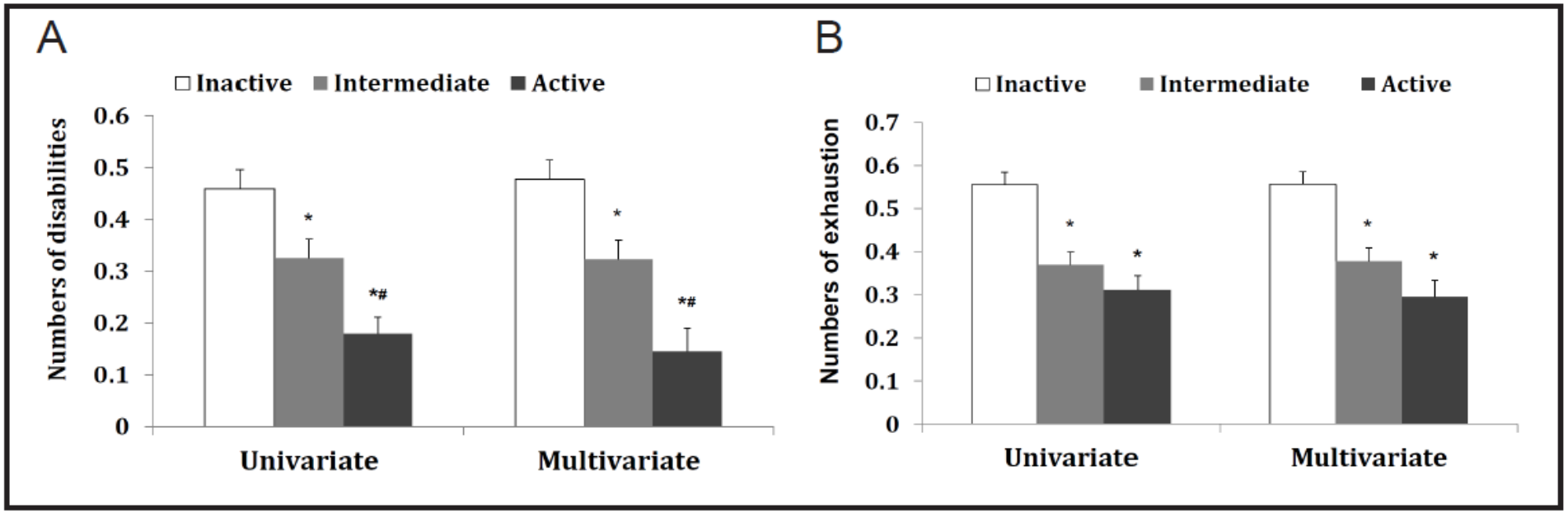


Fig. 1 Comparison of the numbers of disabilities (A) or exhaustion (B) among the groups by physical activity (data are expressed as mean and standard errors). (A) The number of disabilities (Univariate: 0.46 ± 0.04 in the Inactive group, 0.33 ± 0.04 in the Intermediate group, and 0.18 ± 0.03 in the Active group; Multiva-

- ***Results:***
- This study showed an association between physical activity and frailty or exhaustion
- Proportions of frailty, disability, and exhaustion decreased as physical activity increased.

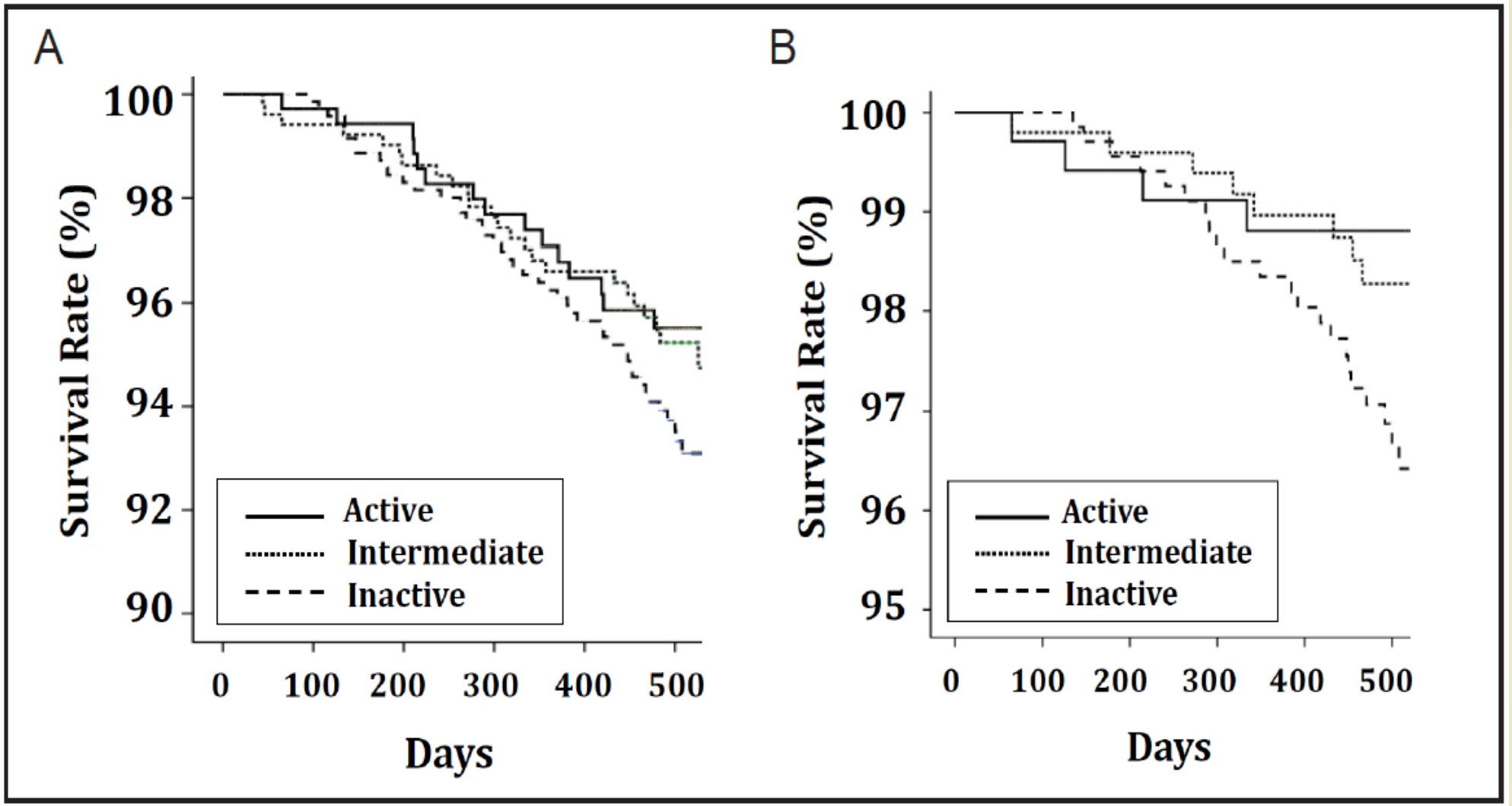


Fig. 2 Kaplan-Meier curves (A, all-cause mortality; B, cardiovascular mortality).

- The survival rate for all-cause death at 500 days was 95.5% in the Active group, 95.2% in the Intermediate group, and 93.5% in the Inactive group

Clinical Significance of Physical Activity in Maintenance Dialysis Patients

Kidney Blood Press Res 2017

- Of the total dialysis patients, 45.2% were included in the Inactive group;
- Cause of physical inactivity?
  - Most common cause of physical inactivity was **Unwillingness to exercise**
  - Fatigue
  - Lack of time to exercise
  - Pain
  - Unsure how to exercise
  - Depressive mood, lack of equipment or place to exercise
  - And unsure about the importance of exercise

Clinical Significance of Physical Activity in Maintenance Dialysis Patients

Kidney Blood Press Res 2017

- However, **proper psychological or medical supports** can be used **to move** participants **from the Inactive** group **to** the **Active or Intermediate** group.
- For example, lack of time, equipment, or place would be main a challenge of physical inactivity or exercise in dialysis patients; however, **these may be overcame by exercise during dialysis sessions**
- ***Conclusion:***
- **High physical activity was associated with favorable results** for most health-related quality of life scale scores, including frailty, disability, and exhaustion, in Korean dialysis patients.
- **Patients on dialysis should be encouraged to increase their physical activity,** which may improve their prognosis.

Physical Activity Dose for Hemodialysis Patients: Where to Begin? Results from Prospective Cohort Study Journal of Renal Nutrition, (2017) University, Sagamihara, Japan

- A total of 282 clinically stable outpatients in a hemodialysis unit from October 2002 to March 2014 were asses
- Habitual physical activity was measured using an accelerometer, that can continuously measure the intensity, duration, and frequency of activities
- The number of steps and energy expenditure of physical activity were recorded by the accelerometer.
- The instrument was worn around the waist, and it measured motion as the acceleration of the body. Patients were instructed to wear the accelerometer continuously during their waking hours for 7 days and to avoid getting it wet, such as during bathing.
- The measurements from 4 nondialysis days during the week were analyzed.
- Median follow-up was 56 months, patients divided to 2 groups according to number of steps, group of > 4,000 steps of physical activity and group of < 4,000 steps

Physical Activity Dose for Hemodialysis Patients: Where to Begin? Results from Prospective Cohort Study Journal of Renal Nutrition, 2017) University, Sagamihara, Japan

- The 7-year cumulative survival rate were 87.0% in the group of > 4,000 steps of physical activity and 60.0% in the ,< 4,000 steps
- 25% of the patients with lower physical activity died after 55 months.
- Mortality rate of patients with greater physical activity at end of the follow up was ,< 25%.
- On the basis of these findings, **hemodialysis patients spending more time on ambulatory physical activity on nondialysis day have a lower mortality risk.**
- Furthermore, our findings support **4,000 steps per nondialysis day as an initial minimum** recommendation of **physical activity level** for HD patients.
- **Walking-based physical activity is associated with decreased mortality risk** among HD patients.

Physical and psychological response to exercise training in CKD patients: A quasi-randomized controlled trial

MEDICAL SCIENCE 2021

- According to many studies, (Eghbali et al., 2009; Klaric & Klaric, 2012; Saeed et al., 2012) depression and anxiety were seen in CKD patients, it can be attributed to several factors that include:
  - Reaction to the diagnosis
  - Nature of the treatment
  - Effect of these long-term treatments, which could be compromised the quality of life, job loss, and financial burden to the patient and the family
- Depression among CKD patients complicates their illness; affects their compliance to treatment, and their ability to cope.
- The study done by Hedayati et al, (2008) showed that
  - Death is twice as likely among CKD patients with depression compared with those without depression

Physical and psychological response to exercise training in CKD patients: A quasi-randomized controlled trial

MEDICAL SCIENCE 2021

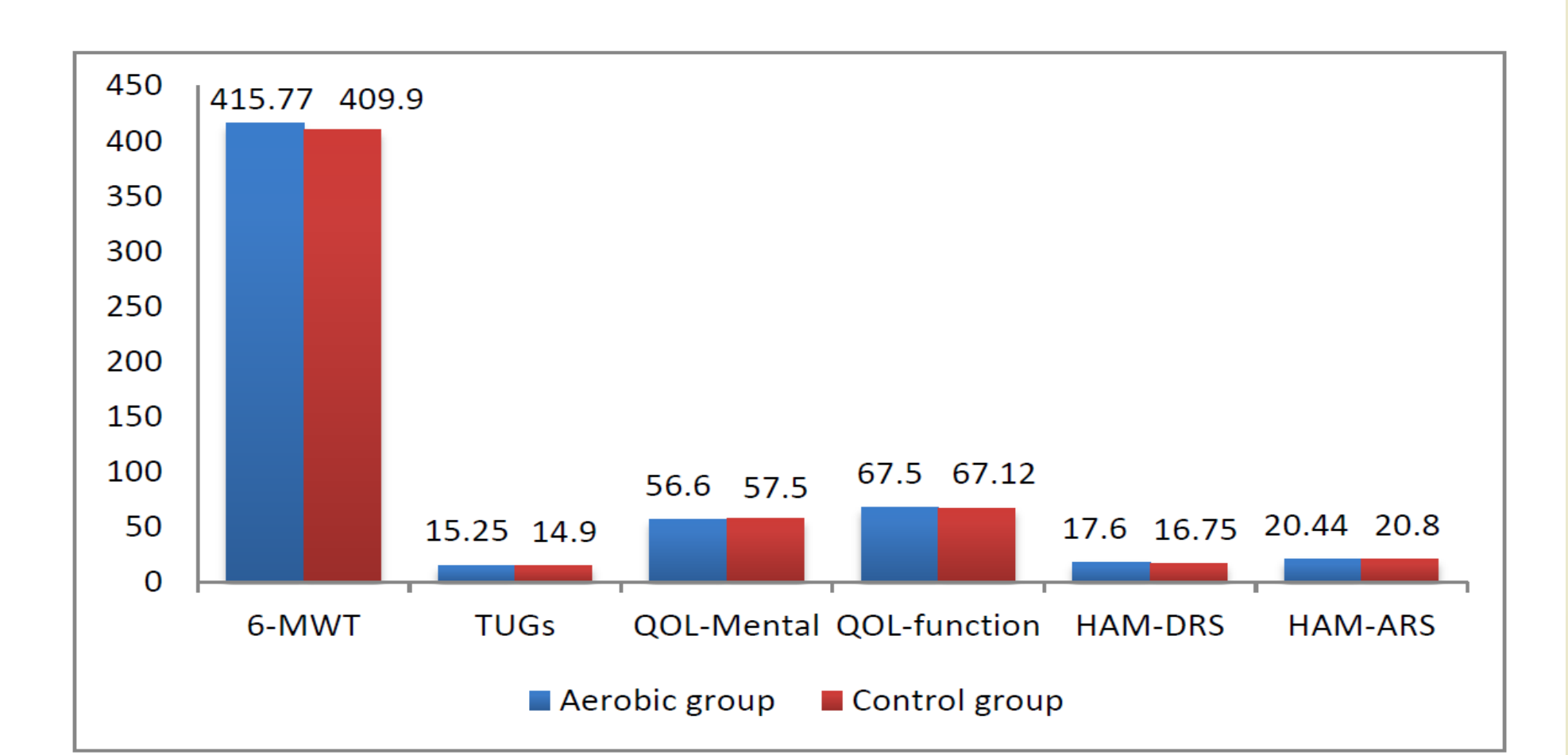
- This study was conducted between (October 2020 and December 2020), to evaluate the impact of moderate intensity aerobic exercise training on **physical capacity, psychological status,** and **quality of life** in ESRD on regular HD patient.
- 32 patients were included, allocated into two groups, aerobic group AG (n= 16) and control group CON (n=16).
- Aerobic training(by **bicycle** ergometry with an initial duration of **20 minutes**) for AG was performed in the alternate days to **HD sessions**, **three times / week** for 10 weeks; it consisted of 30 minutes of moderate-intensity exercise

Physical and psychological response to exercise training in CKD patients: A quasi-randomized controlled trial

MEDICAL SCIENCE 2021

- **RESULTS:**
  - Post-intervention, the aerobic group showed **significant improvement in** the outcome measures:
    - Six-minute walk test **(6-MWT),** p=0.024 (Increased the total distance covered during 6MWT).
    - Time up & go test **(TUG-s),** p<0.001 (Exercise program decreased the TUG-s total time)
    - Beneficial effect on mental health:
      - **QOL-mental health**, p=0.002- short-form 36-item (SF-36)
      - **QOL-role functioning/ emotional**, p=0.012- short-form 36-item (SF-36)
    - **Improvements in the psychological status** of these patients, which was measured by using the Hamilton **depression** and **anxiety** rating scale (HAM-DRS**,** p<0.001) and (HAM-ARS**,** p<0.001)
  - No significant changes were detected in the control group (6-MWT, p=0.384, TUG-s, p=0.103, QOL-mental health, p=0.416, QOL-role functioning/ emotional, p=0.305, HAM-DRS, p=0.461, and HAM-ARS, p=0.157

Clinical outcome measures between groups **pre-intervention**



Clinical outcome measures also did not show statistical significance between the two groups pre-intervention (6-MWT, p=0.609, TUG-s, p=0.533, QOL-mental health, p=0.687, QOL-role functioning/emotional, p=0.834, HAM-DRS, p=0.232, and HAM-ARS, p=0.703)

Post-intervention, the aerobic group showed significant improvement in the outcome measures

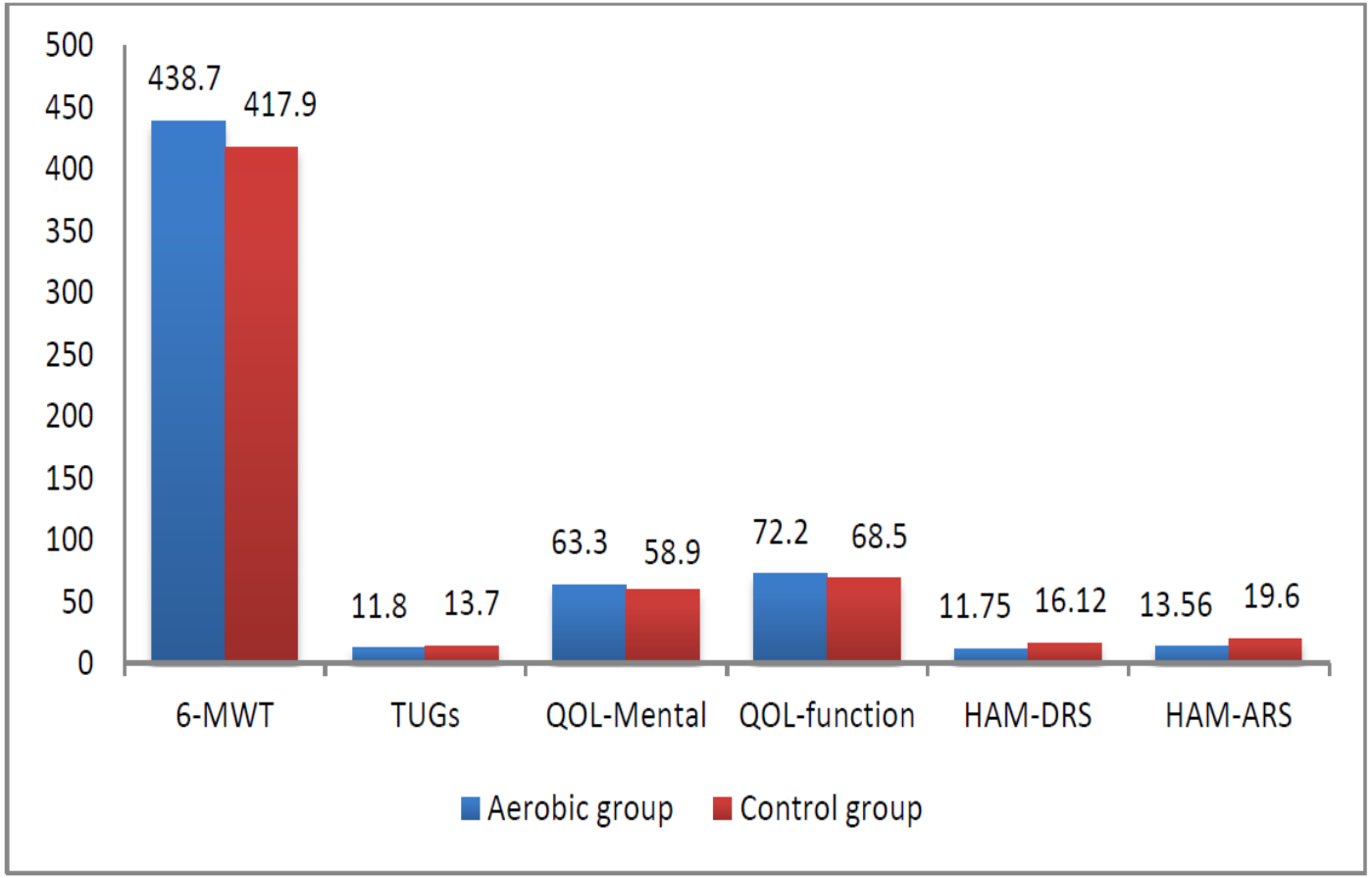


Figure 3 Post-intervention differences between groups

Physical and psychological response to exercise training in CKD patients: A quasi-randomized controlled trial

MEDICAL SCIENCE 2021

- In this study, results revealed the **aerobic exercises** had **positive effects** on:
  - Physical capacity
  - Psychological status
  - Quality of life in CKD patients

Patient-Oriented, Translational Research: Review Article

American Journal of Nephrology

Am J Nephrol 2019;50:240–254
DOI: 10.1159/000502447

Received: June 10, 2019
Accepted: July 21, 2019
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Exercise Training and Outcomes in Hemodialysis Patients: Systematic Review and Meta-Analysis

- This systematic review (20 trials (677 participants))provided valid evidence about the effect of exercise training on dialysis efficacy, BP, exercise capacity, and QoL in HD patient.
- 18 trials took place during HD, others took place at home or during predialysis, total intervention duration ranged from 8 weeks to 12 months
- Recent studies reported that exercise in patients with ESRD receiving HD can:
  - Lower blood pressure (BP)
  - Elevate aerobic capacity
  - Elevate walking capacity
  - Elevate QoL
  - Reduce morbidity and mortality by improving the dialysis adequacy

Patient-Oriented, Translational Research: Review Article

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Exercise Training and Outcomes in Hemodialysis Patients: Systematic Review and Meta-Analysis

- Aerobic exercise and combined exercise were the predominant exercise types.
- ***Conclusion:*** Aerobic exercise or combined exercise (combinations of aerobic and resistance exercises) at least for 8 weeks to 12 months, 3 times weekly, will be beneficial to physical conditions of the patients with ESRD undergoing HD.
- **National Kidney Function recommends** that exercise training should be a cornerstone for HD patients to control complications and mortality

Randomized Controlled Trial > Appl Physiol Nutr Metab. 2018 Jan;43(1):101-104.
doi: 10.1139/apnm-2017-0460. Epub 2017 Sep 29.

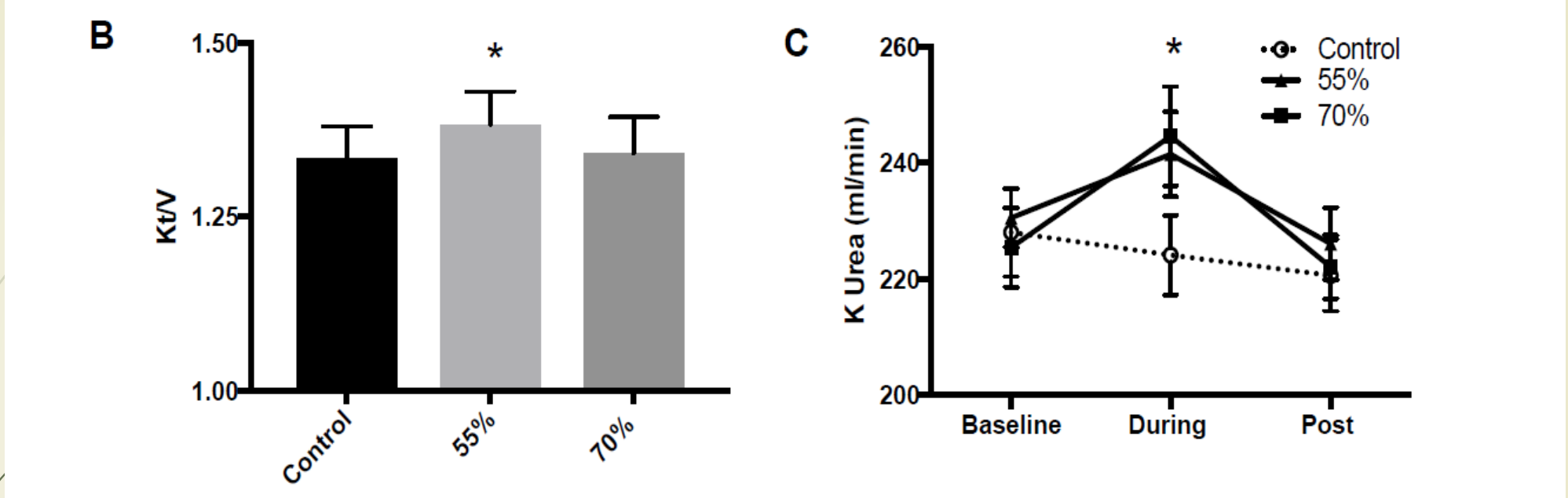
Impact of intradialytic exercise intensity on urea clearance in hemodialysis patients

- This clinical cross-over design, 22 patients who were dialyzing thrice weekly and participating in the IDE program, from two Calgary outpatient HD units from January 2015 to November 2016
- *Hemodialysis and monitoring:*
  - HD was conducted on a Fresenius 5008 machine is equipped with online Clearance Monitoring (OCM), which is an efficient method for determining solute clearance.
  - Participants were randomized to three different protocols during the mid-week HD treatment over three consecutive weeks (1/week).
  - Three protocols were
    - 1) no exercise
    - 2) 30-minutes of exercise at 55% of age-predicted maximal heart rate (HRmax)
    - 3) 30-minutes of exercise at 70% HRmax
  - On exercise days, participants started their exercise after 60 min of HD, in order to collect baseline data

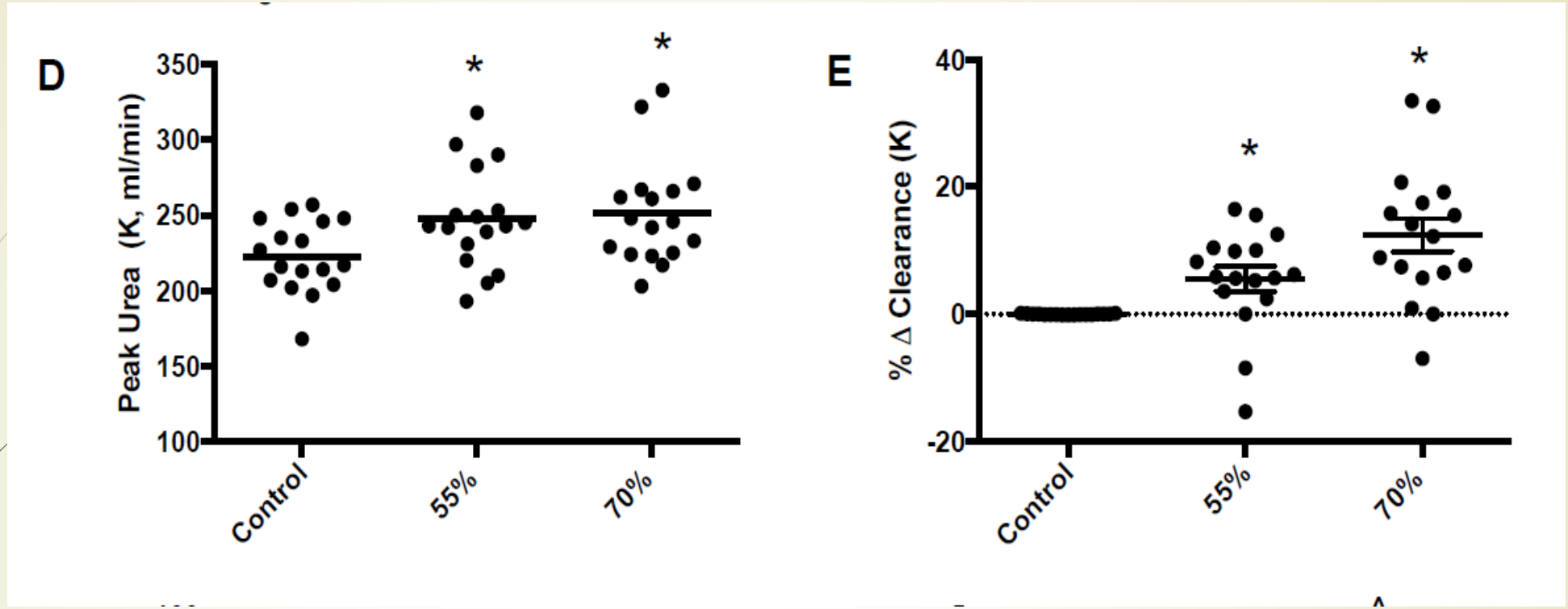
Randomized Controlled Trial > Appl Physiol Nutr Metab. 2018 Jan;43(1):101-104.
doi: 10.1139/apnm-2017-0460. Epub 2017 Sep 29.

Impact of intradialytic exercise intensity on urea clearance in hemodialysis patients

- **RESULTS**
- In total, 22 participated in the study
- No pre-exercise differences in K urea were found between treatment groups ($p>0.05$),
- Kt/V was slightly, but significantly greater during the 55% session compared to the control session **(Figure 1B, $p<0.05$)**.
- However, there was no difference in Kt/V between the 70% session and the control session **(Figure 1B, $p>0.05$)**.
- But K urea was found to be significantly greater during exercise in both IDE sessions (55% and 70%) compared to the control session
- There were no differences between K urea with exercise intensity (e.g. 55% vs. 70%) ($p>0.05$).
- Following exercise, urea clearance returned to baseline levels on all groups with no difference between treatments ($p<0.05$)



- B: Kt/V ratio value obtained from the dialysis run (~4h total) for the three experimental conditions (control, 55%, and 70% intradialytic exercise).
- C: Urea clearance (K, ml/min) values obtained at baseline, during and post exercise in control, 55% and 70% intradialytic exercise.



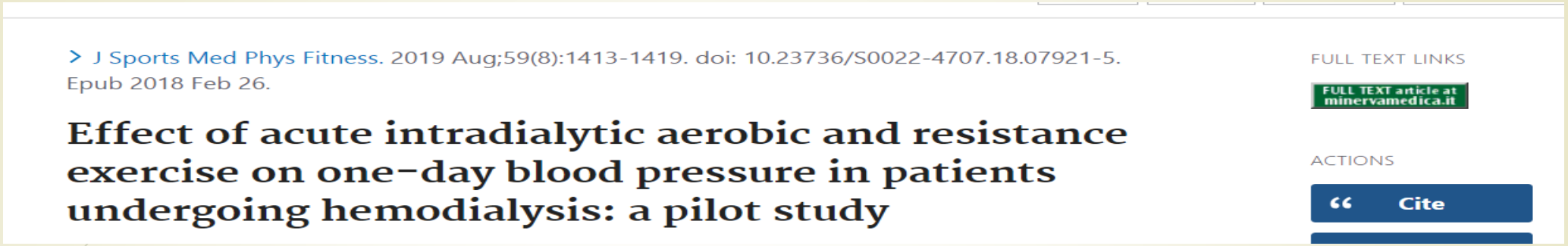
- D: Peak urea clearance (K, ml/min) in each of the three conditions of the dialysis period.
- E: Percent change in urea clearance from baseline.

- Intradialytic exercise **(IDE)** has been shown to **benefit dialysis efficacy**; however, the **effect of IDE intensity is unknown.**
- Results show that higher intensity IDE has no additional benefit on K urea

- Physical inactivity and sleep disturbance are frequently observed and relate to poor clinical outcomes in maintenance HD patients.
- To investigate the effect of intradialytic exercise on daily physical activity and sleep quality, measured by an accelerometer, in maintenance HD patients.

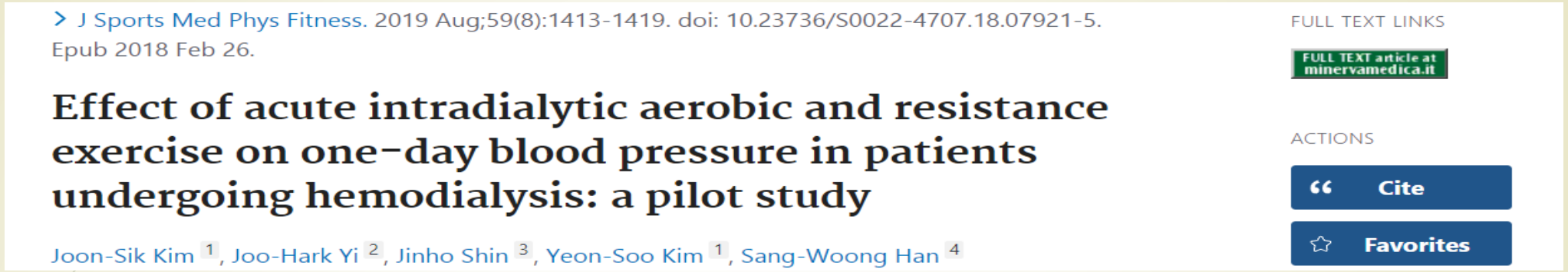
- Study randomly assigned ambulatory maintenance HD patients aged ≥ 20 years on dialysis ≥ 6 months, to 4 groups:
  - Aerobic exercise (AE, n = 11), a stationary bike was used
  - Resistance exercise (RE, n = 10), TheraBand®/theraball was used
  - Combination exercise (CE, n = 12)
  - Control group (n = 13)
- Intradialytic exercise program (3 times/week) was completed
- At baseline and 12-week follow-up, daily physical activity and sleep quality were measured with a triaxial accelerometer during a continuous 7-day wear period.

- **Results:**
- A significant increase in metabolic equivalent (MET; kcal/h/kg) in the AE (1.02 ± 0.03 vs 1.04 ± 0.04, P = 0.04) and CE (1.06 ± 0.05 vs 1.09 ± 0.08, P = 0.01) groups at 12 weeks compared with baseline.
- Comparing between-group changes in MET, there was a significant increase in METs in the CE group (0.03 ± 0.03 vs - 0.01 ± 0.04, P = 0.02) compared with the control group.
- The total number of sedentary bouts (per week) decreased significantly in the AE (200 ± 37 vs 174 ± 36, P = 0.01), RE (180 ± 31 vs 130 ± 49, P = 0.03), and CE groups (180 ± 45 vs 152 ± 46, P = 0.04) at 12 weeks compared with baseline.
- Average sleep fragmentation index, indicating poor sleep quality, decreased significantly at 12 weeks compared with baseline in the AE (51.4 ± 8.0 vs 44.5 ± 9.6, P = 0.03) and RE groups (52.3 ± 7.3 vs 40.0 ± 15.4, P = 0.01).
- **Conclusions:** Intradialytic exercise appears to be clinically beneficial in improving daily physical activity and **sleep quality** in maintenance HD patients.



- **Hypertension** and **intradialytic hypotension** are independent risk factors for mortality in hemodialysis patients.
- Hypothesized that intradialytic exercise would increase BP during dialysis and decrease BP during the postdialytic period.

- To investigate the effect of acute intradialytic exercise on BP both during dialysis and for 20 hours postdialysis
- To detect any differences in effects of aerobic exercise (AE), resistance exercise (RE), and usual care (UC-the control condition).



J Sports Med Phys Fitness. 2019 Aug;59(8):1413-1419. doi: 10.23736/S0022-4707.18.07921-5. Epub 2018 Feb 26.

Effect of acute intradialytic aerobic and resistance exercise on one-day blood pressure in patients undergoing hemodialysis: a pilot study

Joon-Sik Kim [1], Joo-Hark Yi [2], Jinho Shin [3], Yeon-Soo Kim [1], Sang-Woong Han [4]

- **Methods:** 11 patients undergoing maintenance HD performed two complete sets of AE or RE, with a 1-hour rest between the sets.
- Patients performed AE, RE and UC over three consecutive weeks at 7-day intervals.
- Intradialytic BP was measured using an oscillometric BP monitor (N.=11), and
- Ambulatory BP was measured for 20 hours after each dialysis session using an ambulatory BP monitor (N.=8).
- **Results:** Mean BP of patients in AE and RE interventions increased during exercise ($P<0.05$)
- Only RE increased BP significantly compared with UC ($P<0.05$).
- Following dialysis, daytime ambulatory BP was significantly lower after AE and RE than after UC ($P<0.05$).
- **Conclusions: Acute intradialytic exercise interventions are effective in increasing BP during dialysis and decreasing daytime ambulatory BP after dialysis.**

Absolute Contraindications of Exercise

- Absolute contraindications include:
  - Unstable coronary heart disease
  - Decompensated heart failure
  - Uncontrolled arrhythmias
  - Severe pulmonary hypertension (mean pulmonary arterial pressure >55mm Hg)
  - Severe and symptomatic aortic stenosis
  - Uncontrolled hypertension (>180/110)
  - Aortic dissection
- In HD patients, exercise can be performed in the arm or leg with dialysis access once the access has healed but this limb should not be exercised during dialysis.
- Exercise should be stopped if patients develop excessive shortness of breath, angina, severe headache or dizziness.

Practical Application

- Walking-based physical activity is associated with decreased mortality risk among HD patients.
- High physical activity was associated with favorable results for most health-related quality of life scale scores, including frailty, disability, and exhaustion
- Combined aerobic and anaerobic exercise training during dialysis was found to be effective on physical health status, intradialytic hypotension, and depression
- Low intensity aerobic activity has a favorable effect on cardiovascular risk factor
- Patients on dialysis should be **encouraged by nephrologists** to increase their physical activity, which may improve their prognosis.
- Although further investigations are needed to identify the effects and safety of intradialytic exercise and establish protocols for exercise, but Side effects of exercise are very rare
- **Intradialytic exercise may be an option to overcome physical inactivity**


Thank you for your
attention!