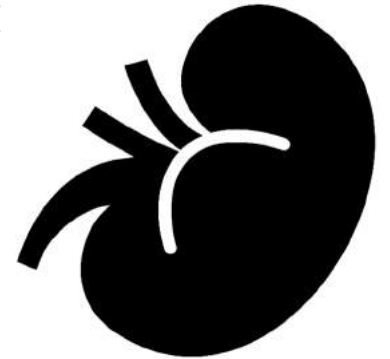
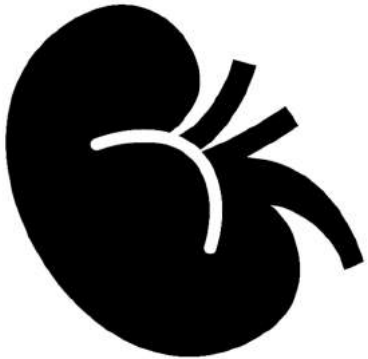


The Musculoskeletal Effects of Chronic Kidney Disease

A Focus on Conservative Management

By: Anjali Paintal, SPT

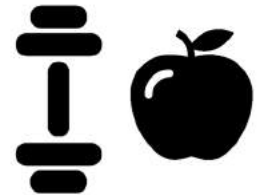


Objectives

1. *Demonstrate basic understanding of the impact of CKD on the musculoskeletal system.*



1. *Demonstrate basic understanding of the current recommendations for conservative management and prevention of CKD*





Agenda

1. Function of Kidneys
2. Eye opening facts
3. Overview of CKD
4. Effects of CKD on muscle and bone
5. Review research articles regarding MSK effects of CKD
6. Review research articles regarding exercise recommendations
7. Review article about nutritional recommendations

Please ask questions/ interject at any time!

Function of Kidneys ¹



Filters blood



Remove
waste,
toxins,
excess fluid



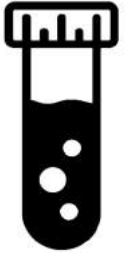
Control BP



Stimulate
production of
RBC



Keep bones
healthy



Regulate
Blood
Chemicals

Kidney disease is the **9th** leading cause of death in the US¹

More than **1 in 7** US adults are estimated to have CKD
37 million people ¹

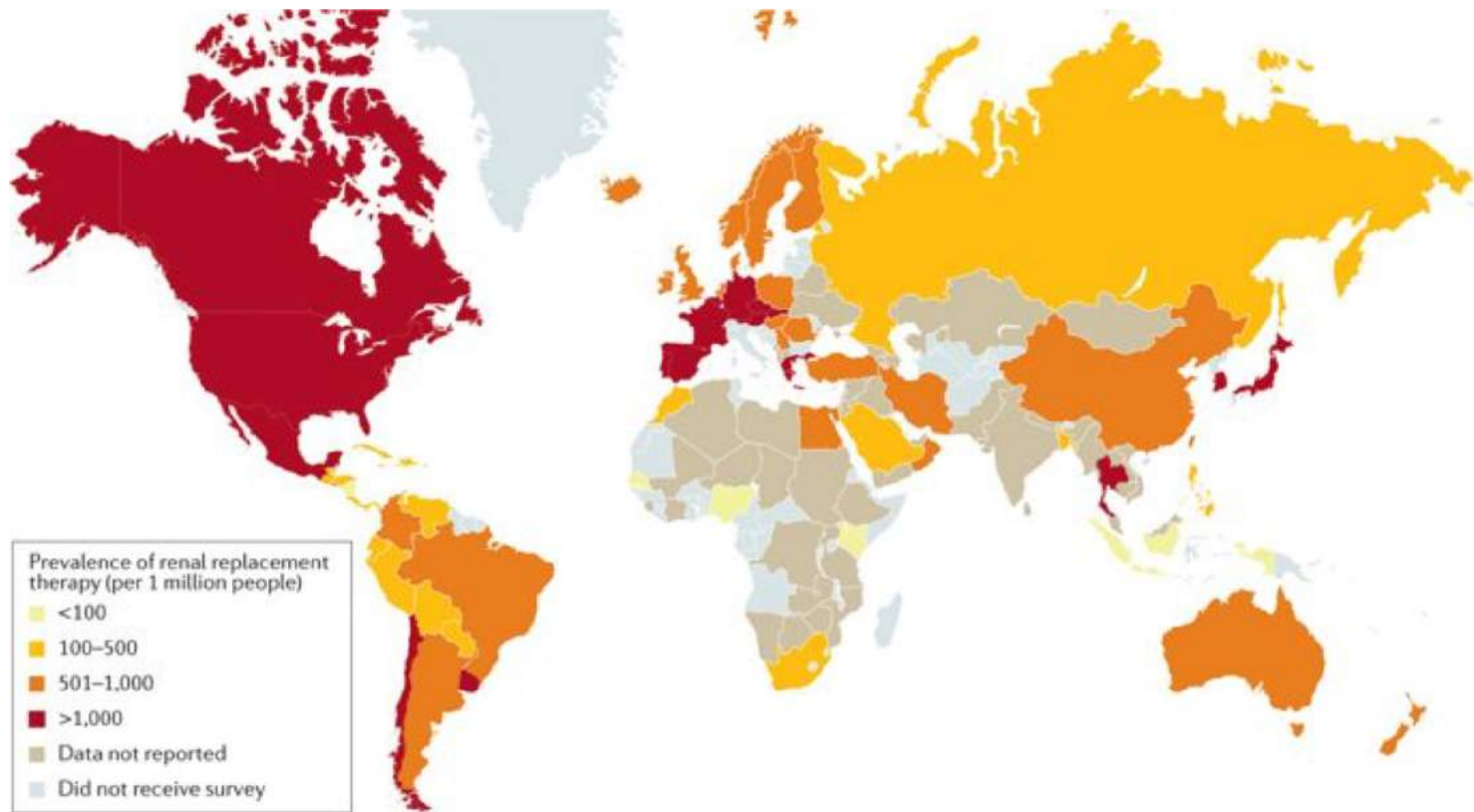
1 million North Carolinians have CKD

African Americans are 3x more likely than whites to develop end stage kidney disease¹

48% of people w/ severely reduced kidney function (and not on dialysis) are not aware they have CKD¹

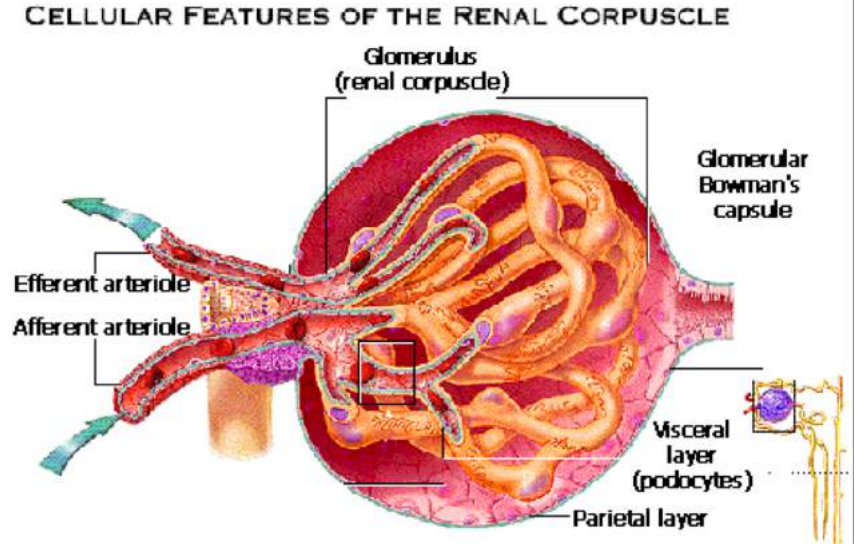
Every 24 hours, about **340** people begin dialysis treatment for kidney failure¹

Polycystic kidney disease and glomerulonephritis are main causes of ESKD for pts < 18 yrs old¹



What is CKD?²

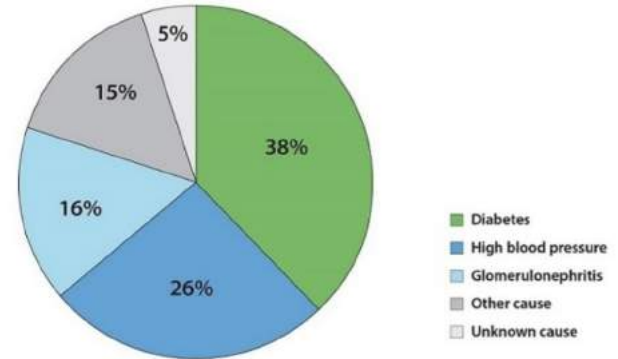
- Kidneys are damaged and unable to filter blood properly
- eGFR of less than 60ml/min/1.73m² on at least 2 occasions 90 days apart



Causes of CKD ^{3,4}

- Main risk factors
 - Diabetes
 - High blood pressure
 - Heart disease
 - Family history of kidney failure
- Other causes
 - Glomerulonephritis
 - Polycystic kidney disease
 - Malformation
 - Lupus
 - Kidney stones
 - Repeated UTI's

Reported Causes of End-stage Kidney Disease
in the United States



Stage 1	Kidney damage w/ normal kidney function	<ul style="list-style-type: none">• High BP• Swelling• UTI
Stage 2	Mild loss of kidney function	<ul style="list-style-type: none">• Similar to stage 1 symptoms, but may be more pronounced
Stage 3	3a. Mild to mod loss 3b. Mod to severe loss	<ul style="list-style-type: none">• Malnutrition• Bone pain• Unusual pain• Numbness/tingling• Decreased mental sharpness
Stage 4	Severe loss of function	<ul style="list-style-type: none">• Anemia• Decreased appetite• Bone disease• Abnormal blood levels of phosphorus, calcium, vit D
Stage 5	Kidney failure, dialysis or transplant required	<ul style="list-style-type: none">• Uremia• Fatigue• SOB• Vomiting• Abnormal thyroid levels• Swelling in hands, eyes, legs, LBP

CKD's Effect on Skeletal Muscle ⁶

Decreases Satellite Cells

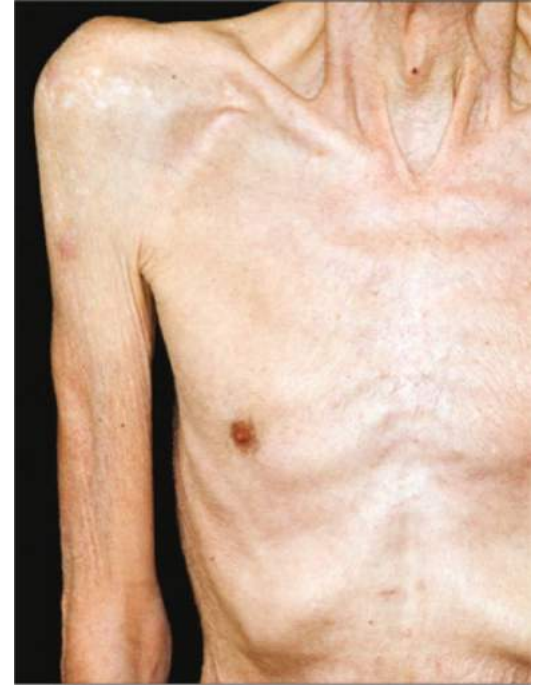
- Satellite cells (muscle progenitor cells) are regulators of muscle repair
- CKD decreased SC abundance and response to stimuli such as muscle damage (exercise)

Increases Angiotensin II

- Regulates BP, stimulates aldosterone release → sodium retention
- Decreases food intake
- Catabolic effect on muscle

Increases Resistance to Insulin like Growth Factor 1 (IGF-1)

- IGF-1 increases protein synthesis
- Works with satellite cells
- Resistance causes protein degradation



CKD's Effect on Skeletal Muscle Continued ⁶

Increases Pro-Inflammatory Cytokine Expression

- Delayed muscle regeneration/repair

Increases Myostatin

- Protein that is released by myocytes to regulate size of muscle
- An increase in myostatin → increase muscle atrophy

Increases Type II Muscle Fiber Atrophy

- Type II muscle fibers affected > Type I



CKD's Effect on Bone⁷

- Phosphate Retention
 - Causes increased calcium binding → serum hypocalcemia
- Decreased Activation of Vit D
 - Lowers GI absorption of calcium
- Hyperparathyroidism
 - Releases calcium from bone reserves
 - Increases bone turnover



Musculoskeletal manifestations in end-stage renal disease patients on hemodialysis and relation to parathyroid dysfunction

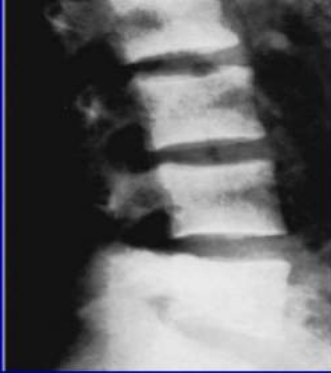
Afifi, Walid; Amany Abo Elsaoud; Elgawish, Mohammad; Ghorab, Adel.

Saudi Journal of Kidney Diseases and Transplantation; Riyadh Vol. 30, Iss. 1,
(Jan/Feb 2019): 68-82.

- **Methods**⁸
 - Cross-sectional study
 - Group A: 15 pts on hemodialysis < 1 yr, age ranged b/w 19-48
 - Group B: 38 pts on hemodialysis for >1 yr, age range b/w 20-62
- **Objective**
 - Find the frequency of MSK manifestations in dialysis patients
 - Determine the impact on the functional ability of patients
 - Detect the relation b/w parathyroid hormone level and MSK manifestations.

Results

- Most common MSK manifestations of dialysis patients:
 - Arthralgia 83%: knee 60.4%, ankle 56.6%, shoulder 20.7%, lumbar spine 17%, hip 7.5%
 - OA: knee 13.2%, ankle 13.2 %, hip 7.5%
 - Uremic polyneuropathy 43% (only in group B)
 - Carpal tunnel syndrome 24.5%
 - Thenar muscle weakness 20.7%
 - Dialysis disequilibrium syndrome 20.7%
 - Osteoporosis in 24.5%
 - Osteopenia was in 56.6% (Lumbar spine only in group B)
 - Symptoms of secondary hyperparathyroidism (SHPT)
 - Subperiosteal resorption of terminal phalanges 67.9% (group B)
 - Osteosclerosis “rugger jersey spine” 26.4% (group B)



- Fig SP 4-6 Renal osteodystrophy. Areas of increased sclerosis subjacent to the cartilaginous plates produce the characteristic "rugger jersey" spine in this patient with chronic renal failure.²



- Fig B 11-5 Hyperparathyroidism. Tuft resorption associated with subperiosteal bone resorption that predominantly involves the radial margins of the middle phalanges of the second, third, and fourth digits (arrows).

Summary



Increased joint
pain



Increased MSK
catabolic reactions



Atrophy →
decreased
functional mobility,
falls risk



Osteopenia/Osteo
porosis → more
likely to fx

Physical Activity and Change in Estimated GFR among Persons with CKD

[Cassianne Robinson-Cohen](#),^{□*†} [Alyson J. Littman](#),^{†‡} [Glen E. Duncan](#),^{†§} [Noel S. Weiss](#),[†] [Michael C. Sachs](#),^{*}
[John Ruzinski](#),^{*} [John Kundzins](#),^{*} [Denise Rock](#),^{*} [Ian H. de Boer](#),^{*†||} [T. Alp Ikizler](#),^{¶**} [Jonathan Himmelfarb](#),^{*¶} and
[Bryan R. Kestenbaum](#)^{*†||}

Methods⁹

- Longitudinal cohort study based in Seattle, Washington
- 256 participants in the Seattle Kidney Study
- Median follow up of 3.7 years
- Four Week Physical Activity Questionnaire & eGFR

Results

- Participants who walked more had slower annualized rates of eGFR decline: -6.2% per year among participants who self reported greater than or equal to 150 min per week vs -9.6% per year among participants who reported not walking at all.
- Every 60 min increase in duration of weekly physical activity = 0.5% slower decline in eGFR

T. J. Wilkinson✉, N. F. Shur, A. C. Smith

First published: 23 June 2016 | <https://doi-org.libproxy.lib.unc.edu/10.1111/sms.12714> | Cited by: 16

- **Methods** ¹⁰
 - Literature review
 - Reviewed 37 articles
- **Purpose**
 - “summarise the important role exercise may have in clinical management of kidney disease and how this form of ‘medicine’ should be best administered and ‘prescribed.’”
- **Key points:**
 - 1 hour of aerobic exercise (walking) can lower systolic and diastolic BP in pre-dialysis patients
 - Chronic inflammation is highly predictive of mortality in CKD. Reduction in inflammation response was found in pre dialysis patients who exercised an acute single bout (30min) as well as performed regular walking (6 months, 5 days a week).
 - Exercise reduces cachexia and increases muscle mass; an 8 week progressive RT program increased muscle mass in predialysis pts, similar findings in dialysis and transplant pts.

● Methods ¹¹

- Prospective cohort study
- 14,686 middle-aged adults enrolled in Atherosclerosis Risk in Communities study
- Willett Food Frequency Questionnaire
- Creatinine and eGFR measurements
- Plant based diet indices: overall plant based diet, healthy plant based diet, pro vegetarian diet, less healthy plant based diet
- Follow up visits: 1990–1992 (visit 2), 1993–1995 (visit 3), 1996–1998 (visit 4), 2011–2013 (visit 5), and 2016–2017 (visit 6).

Results

- Those in the highest quintile of healthy plant based diet
 - 14% lower risk of CKD (compared to those at lowest quintile) ($p=0.001$)
- Those in the highest quintile of pro vegetarian diet
 - 10% lower risk (compared to those at lowest quintile) ($p=0.03$)
- Higher adherence to less healthy plant diet associated w/ elevated risk.
- Higher adherence to overall plant based diet & healthy plant based diet was associated w/ slower eGFR decline.
- Higher intake of legumes was associated w/ lower risk of CKD
- Higher intake of meats or sugar sweetened beverages was associated w/ elevated risk.

Take away: Healthy plant based diets and vegetarian diet are favorable for kidney health.

Summary



Aerobic Exercise

Recommended for cardiovascular & anti-inflammatory benefits
1 hour recommended to decrease BP
>= 150 min/week



Resistance training

Recommended to prevent cachexia and atrophy
Target large muscle groups



Plant Based

A healthy plant based diet promotes kidney health

Discussion Questions

- Knowing what you know now, would you change anything in your practice regarding treatment of patients with CKD?
- Do you think we provide sufficient education in acute care regarding exercise prescription for disease management?
- What have been your experiences w/ patients w/ CKD? Have you seen trends in comorbidities present?
- Why do you think minorities are more likely to develop CKD?
- Do you have any questions?

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