The Role of Plant Based Diets in Chronic Kidney Disease

Merideth Miller, RD, CSP, LD

Objectives

- What is a plant-based diet?
- Why follow a plant-based diet
- Plant based diets and CKD
- Nutrients of concern

What is a Plant-Based Diet?

- No true definition
  - Vegetarian
    - Various forms
  - Vegan
  - Provegetarian
    - Preference for plant-based foods but no exclusion of animal products
  - “Diet that emphasizes the consumption of plant foods (fruit, vegetables, nuts, seeds, oils, whole grains, legumes and beans) and may or may not include small amounts of meat, fish, seafood, eggs and dairy.”
    - Mediterranean
    - DASH
- Western Diet

Western Diet

- High in processed foods
  - Boxed, bagged/shelf stable or longevity
- High in saturated fat
- Low in fruits and vegetables
- Low in fiber
- Sugary drinks
- Fast food

Western Diet

72.1% of US diet is dairy, cereals, refined sugars, refined vegetable oils and alcohol

Can impact gene expression

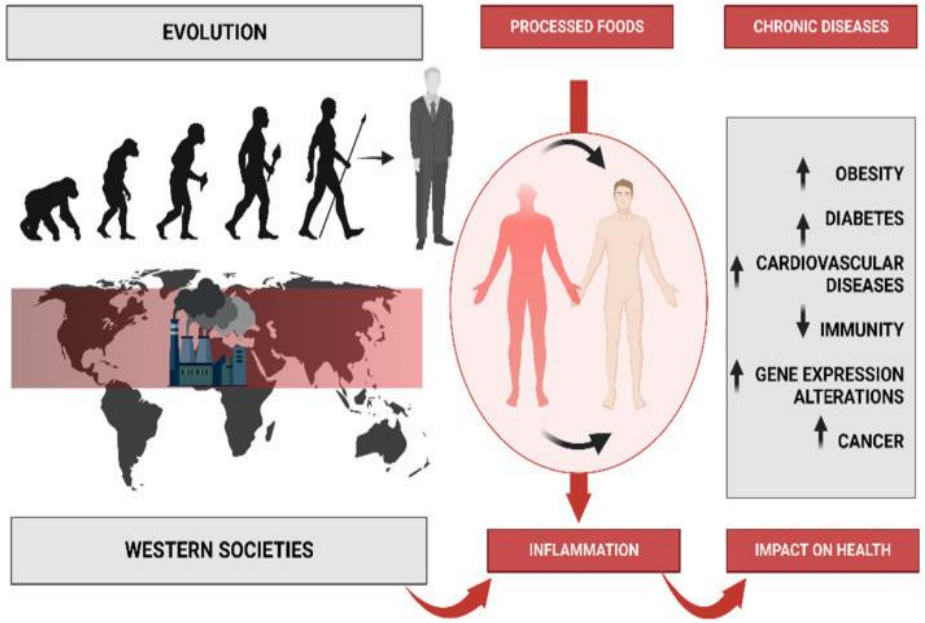
- Alters nutrient availability, hormone levels, cell pathways, methylation and more

Mice: alters co-expression of 445 gene pairs

- Associated with metabolism and fat deposition in humans
- Changes behavior

Decrease in antioxidants

Gut Dysbiosis



Inflammatory

- Increased CRP, IL-6, and TNF-α
- Lead to chronic disease

Associated with faster CKD progression and proteinutia

Mediterranean Diet

- Whole foods
- High in fiber
  - Fruits, vegetables
  - Whole grains
- Low fat dairy
- Olive oil
- Fish
- Plant-based proteins
  - Nuts and seeds
  - Legumes and beans
- Cardiovascular Disease

DASH Diet

- Whole foods
  - Low fat/fat-free dairy products
  - Fish and poultry
  - Beans, nuts, and legumes
- Limit high sugar beverages and foods
- Limit saturated fats
  - Fatty meats
  - Full fat dairy
  - Coconut and palm oils
- Choose foods high in K+, Mg, Ca, fiber and protein
- Low sodium
- Most notable for blood pressure control

Why Choose a Plant-Based Diet

- Reduce risk of chronic diseases
  - Obesity
  - Diabetes
  - Cardiovascular disease
  - High blood pressure/hypertension
  - Certain forms of cancer
  - Gut dysbiosis

Obesity

- Plant-based diets have been shown to be helpful for weight loss
  - Increased amounts of fiber/satiety
  - Healthier protein choices
  - Decrease in processed foods/fast foods
- Whole foods = better diet quality
- European Prospective Investigation into Cancer and Nutrition (EPIC- Oxford)
  - Looked at changes in weight and BMI over 5 years
  - Meat eating, fish eating, vegetarian, and vegan
  - Weight gain lowest when decreased animal products
  - Highest BMI: meat eaters; lowest BMI: vegans

Diabetes

Decrease in obesity

- Insulin resistance
- Insulin sensitivity

Higher fiber

- Improved blood glucose control
- Slower digestion/satiety

Lower sugar laden foods and beverages

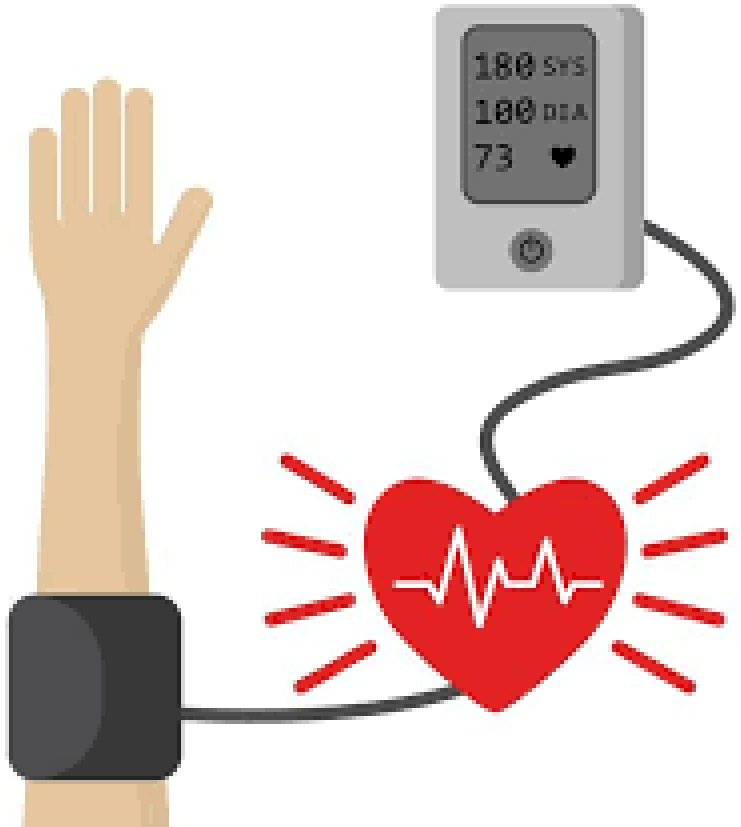
Healthier fats for heart disease

Low sodium for blood pressure

Heart Disease

- High fiber
  - Aids in lowering LDL cholesterol
- Omega 3 fatty acids/PUFAs
  - Increasing HDL cholesterol
- Obesity/diabetes
- High blood pressure
- Decrease in inflammation
- Adventist Health Study (AHS-2)
  - 34,000 CA Seventh-day Adventists
  - Vegetarian diet decreased all-cause mortality and increased life expectancy
- EPIC-Oxford
  - No difference in all-cause mortality in vegetarian vs. non-vegetarian
- BROAD trial- prospective study
  - Whole food plant-based diet vs. control
  - Whole food group: BMI decrease of 4.4 $kg/m^{2/}$4.2 kg/m^2; 12.1 lbs/11.5 lbs
  - Decrease in cholesterol statistically significant throughout

High Blood Pressure Hypertension

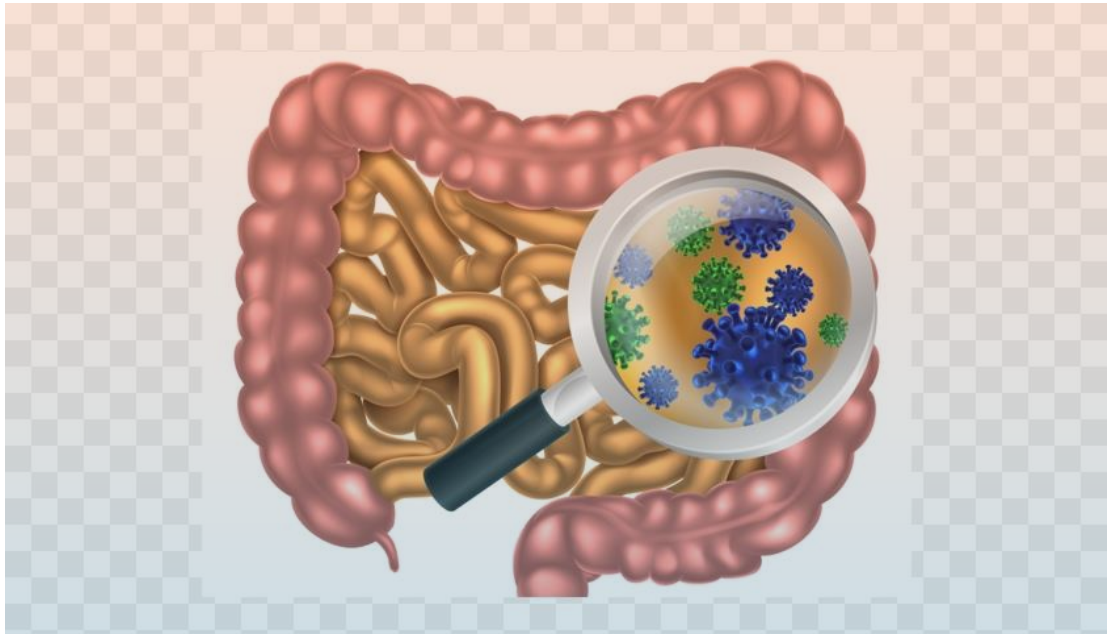


- EPIC-Oxford
  - Vegans = lowest BP and hypertension
  - Meat-eaters = highest BP and hypertension
  - Adjustment for BMI- decreased this finding
- AHS-2
  - Vegans and vegetarian = lower BPs than meat eating
  - Adjustment for BMI- decreased this finding
- Coronary Artery Risk Development in Young Adults (CARDIA)
  - Dose dependent relationship between plant intake and decreased high BP
- Nurses' Healthy Study I and II and Health Professionals Follow-up Study
  - Association between eating meat/seafood and hypertension
- DASH/DASH-sodium
  - Lowered BP (6-11 mm Hg)
  - Decreased sodium in addition = lower BP

Cancer

- High fiber
  - Strongly linked to decreased risk of bowel cancer
- Antioxidants, phytochemicals, and anti-inflammatory
  - Cancer fighting components
- Prostate, breast cancer (soy)
- Improved nutrient balance when going through treatment
- Studies are inconsistent

Gut Dysbiosis



- Gut microbiome
  - Bacteria in the digestive tract
    - Abundance: how many of a specific microorganism in gut
    - Diversity: the variety of different microorganisms in gut
  - 3 trillion microbes
  - Diet effects the abundance and diversity
  - Linked to the whole body
- Antioxidant, anti-inflammatory, anti-obesity, and antiproliferative
- Change in microbiome within 3-5 days of changing diet
- Pagliai et al- no statistical difference in SCFA production in Mediterranean vs. vegetarian diets
- Plant based diets
  - High in fiber and other carbs that produce SCFAs (fruit, veg and legumes)
  - CKD- high fiber intake associated with decreased risk of inflammation and mortality
  - CKD 5D- low fiber = increased inflammation, and higher risk of CVD

Gut Dysbiosis

- SCFAs
  - Butyrate
    - Provides energy to colonocytes
    - Healing intestinal barrier by repairing tight junctions
    - Lowers lipopolysaccharide (LPS) and prevents it from crossing intestinal wall
  - Acetate, propionate, and butyrate
    - Protective against T2DM, IBS, and immunological diseases
    - Neuron function and growth to maintain blood brain barrier
    - Increases metabolism- prevent and treat obesity
- TMAO (Trimethylamine N-oxide)
  - Animal product intake (choline and L-carnitine)
  - Gut microbiome converts to trimethylamine
  - High levels linked to cardiovascular disease and atherosclerotic build up

Plant Based Diets (PBD) and CKD

- A meta-analysis of 6 studies (Dang et al.)
  - Increased plant protein intake and ketoanalogs- associated with decreased decline in eGFR over a year in plant-based diet vs. animal protein diet
  - PBD significantly associated with 26% lower rate of CKD
  - Incidence rate and progression of CKD, showed a dose-dependent relationship
  - Unhealthy vs. healthy PBD
    - Unhealthy – 11% higher risk of CKD
    - Healthy- 14% lower risk of CKD
  - 28% decrease in absolute risk of CKD incidence in general population when on PBD
  - Dietary Acid Load (DAL)
    - Healthy PBD: reduced DAL, increase in dietary fiber, and improved micronutrient intake = 11% decreased risk/5g fiber increase
    - Rich in calcium, magnesium, potassium and vitamin C

Plant- based Diet =Renoprotective

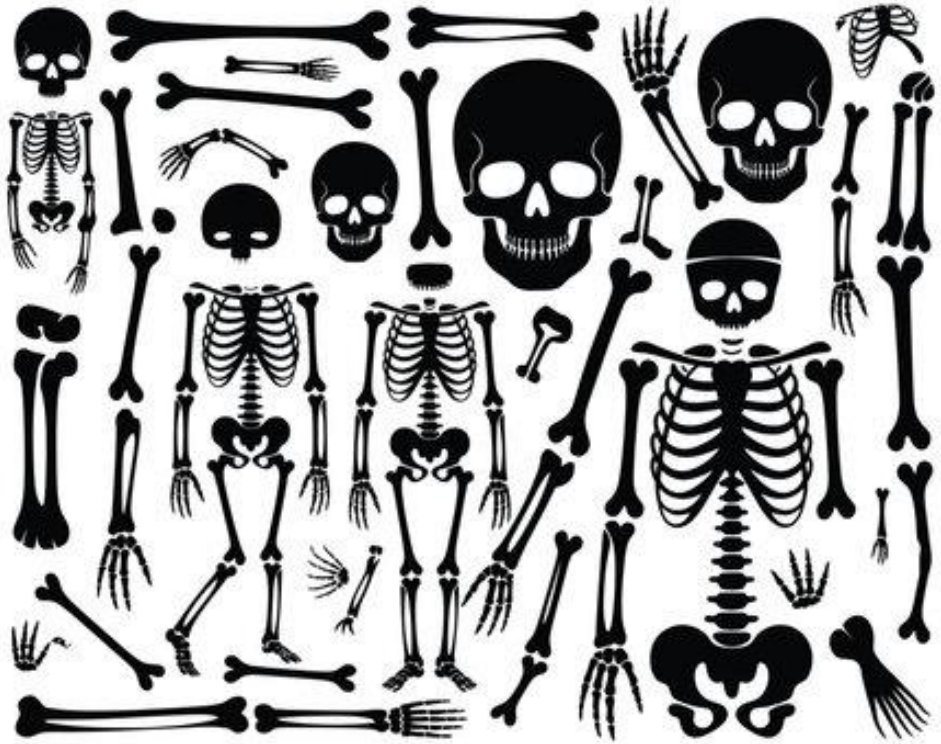
- Acid-base balance
  - PBD decreases DAL
  - PBD = organic anions (malate and citrate)
    - Converted to bicarbonate
    - Increases serum bicarb = decreases excess acid in body
    - Helpful with CKD and metabolic acidosis
  - Metabolic acidosis can speed up CKD progression
    - Endothelin and aldosterone
- Higher in certain amino acids: glutamic acid, proline, phenylalanine, cysteine, and serine vs. animal protein
- Threonine and histidine from PBD associated with better BP
- PUFA, n-6 fatty acids and fiber- positively associated with eGFR and inversely associated with CKD risk
- Plant based- lower production of uremic toxins decreasing progression

Plant Based Diets (PBD) and CKD

- Tovar et al. (2002)
  - Significant decrease in eGFR decline and progression to renal replacement therapy
  - Plant-based, very low protein diet
- PBD helps with
  - Antioxidant
  - Electrolyte balance
  - Glycemic control – decreases microalbuminuria and proteinuria
- KDIGO: balanced diet; plant based over animal protein and processed foods

Phosphorus

- Bone health CKD-MBD
- Standard education
  - Whole grains, brown rice, beans, legumes, nuts
  - 800-1000 mg/day
- Bioavailability is different in animal vs plant foods
  - Organic phos in animal foods = 40-60%
  - Organic phos in plant foods = 20-40%
  - Inorganic phos in additives = 90-100%



Protein

- Standard education
  - Adults CKD 3-5 (no dialysis) to slow progression
    - Low protein diet
      - 0.55-0.6g pro/kg/day
    - Very low protein diet
      - 0.28-0.43g pro/kg/day with ketoanalogs
    - 50% from animal origin/high biologic value
  - Peds
    - Do not typically limit protein due to growth
    - High biologic value
- Heo et al.
  - 4% risk reduction for developing CKD for every 0.1g/kg/day plant protein
- Can meet very low protein goals on plant-based diet

Potassium

- Standard education: limit intake based on labs
  - Typically limit dairy products, fruits and vegetables
  - Juices and sauces- limited fiber
  - Potassium salts/supplements
- Generally, do not account for K+ in meats – higher bioavailability
- Higher fiber and alkali content
  - May decrease absorption and increase potassium removal via stool
- 5 studies showed no incidence of hyperkalemia with increased plant food intake in patients on HD
  - Wu et al (2001); Saglimbene et al (2019); Gonzalez Ortiz et al (2021); Nerbass et al (2022); Picard et al (2022)
- 2/7 studies showed no incidence of hyperkalemia with increased plant-based intake in CKD patients
  - Goraya et al (2012; 2013; 2014); Tyson et al (2016); Turban et al (2021); Moorthi et al (2014); Barsotti et al (1996)
- Picard et al (2023)
  - Stage 5 CKD and dialysis
  - Plant foods do not always lead to hyperkalemia
- For each gram of fiber = excretion of 25 mg K+
- 3.5g psyllium fiber, increase of 32% in removal of K+ in stool

Overall Review of PBD and CKD Joshi et al (2020)

Causes of Kidney Disease	
Hypertension	Well-established effect of rapid lowering in BP
Type 2 DM	Combined effect of weight loss and improved insulin sensitivity
Obesity	Lower energy density and higher fiber content facilitates weight loss
Treatment of Kidney Disease	
Progression of disease	Tend to be lower in protein and tend to avoid protein excess, which may avoid hyperfiltration and temper the rate of GFR loss; treatment of complications may affect disease progression as well
Complications of Kidney Disease	
Metabolic acidosis	Natural alkali
Hyperphosphatemia	Lower bioavailability of phos
Hypertension	Improved sodium: potassium, weight loss
Cardiovascular disease	May reduce risk for CVD risk factors
Uremic toxins	Appear to generate fewer uremic toxins, which may be due to changes in the microbiome and fiber content

Nutrients of Concern

- **Protein**
  - inadequate protein intake can lead to malnutrition
  - Peds- need protein for linear growth
  - Increased mortality and morbidity
- **Vitamin D and calcium**
  - Limiting dairy intake
  - Plant sources of calcium
    - Broccoli, tofu, green leafy vegetables
    - Oxalates- limits absorption
- **Iron**
  - Non- heme iron in PBD- may need increased amounts
  - Anemia
- **Vitamin B12**
  - Common deficiency in vegetarian and vegan diets
  - Anemia
- **Zinc**
  - Animal proteins are significant source
  - Nuts, seeds, legumes, tofu, fortified cereals
  - Seen to be low in dialysis patients

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