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Dietary Approaches to Kidney Disease

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“ Let food be thy medicine and medicine be thy food.”

HIPPOCRATES

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Kidney disease facts

- Kidney disease has **NO** symptoms early on
- CKD Prevalence: **14%** general population
- Diabetes and High Blood Pressure main causes
- Risk for dialysis compared to Caucasians
 - **3.7x ↑** African Americans
 - **1.4x ↑** Native Americans
 - **1.5x ↑** Asians
 - **1.5x ↑** Hispanics
- Each year, kidney disease **KILLS** more people than **breast** or **prostate cancer**

<https://www.niddk.nih.gov/health-information/health-statistics/kidney-disease>. Accessed 9/2018

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What is our evidence-based message?

- Sodium
- Potassium
- Calcium
- Phosphorous
- Protein
- Fats
- Fiber
- Sugar

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Sodium

SODIUM

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Guidelines

Academy of Nutrition and Dietetics	K/DOQI	KDIGO
CKD 1-5: < 2.4 g/d	CKD 1-5: < 2.4 g/d	CKD ND < 2 g/d

Academy of Nutrition and Dietetics. CKD Guideline 2010. www.andeal.org
National Kidney Foundation 2004. http://www.kidney.org/professionals/kdoqi/guidelines_updates/doqi_nut.html
KDIGO 2012. http://www.kdigo.org/clinical_practice_guidelines/pdf/CKD/KDIGO_2012_CKD_GL.pdf

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SODIUM



Restriction and CKD

Cochrane review; 8 studies (3 RCT, 5 crossover), n=258; duration 1–26 weeks

Na restriction (1-3.2 gm/d)

- **SBP ↓ 8.75 mmHg; DBP ↓ 3.7 mmHg**
- Significant ↓ **proteinuria**
- No difference in eGFR, CrCl, serum Cr

Bottom line: BP & proteinuria reduction could translate into ↓ **mortality and ESRD**, if salt reduction maintained long-term

McMahon et al. *Cochrane Database Syst Rev.* 2015

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SODIUM

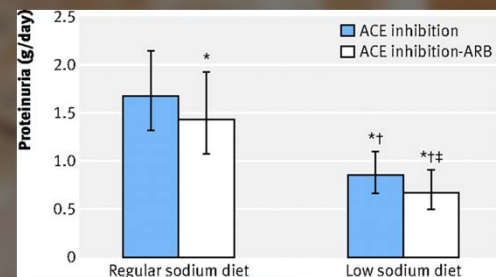


Restriction with ACEI

Multicenter, crossover; n=52 pts; 6 weeks; low Na < 2.3 gm

Proteinuria

- ACEI + Reg Na: 1.68 gm/d
- ACEI + Low Na: **0.85 gm/d**



Slagman et al. *BMJ* 2011

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Potassium

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POTASSIUM

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Guidelines

Academy of Nutrition and Dietetics	K/DOQI	USDA 2015-2020
CKD 3-5: < 2.4 g/d	CKD 1-2: > 4 g/d CKD 3-5: 2-3 g/d	Healthy Adults: 4.7 g/d

Academy of Nutrition and Dietetics. CKD Guideline 2010. www.andeal.org
 National Kidney Foundation 2004. http://www.kidney.org/professionals/kdoqi/guidelines_updates/doqi_nut.html
 USDA Dietary Guidelines 2015-2020. <https://health.gov/dietaryguidelines/2015/guidelines/appendix-7/>

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POTASSIUM

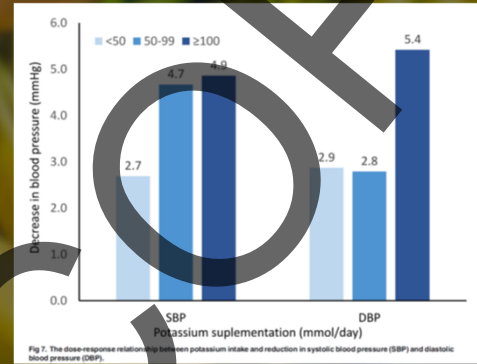


Supplementation and Blood Pressure

Meta-analysis; 23 trials, 1,213 participants; 4-52 weeks

Compared to placebo

- SBP: **-4.25 mmHg**
- DBP: **-2.53 mmHg**



Poorolajal et al. PLOS One. 2017

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POTASSIUM



Potassium intake and CKD Incidence

NHANES; $n=13,917$; cross-sectional study; mean age 45; mean GFR 88 ml/min/1.73m²

Lowest (≤ 1737 mg/d) vs Highest (>3342 mg/d) potassium intake

- **44% ↑** risk of CKD incidence

Sharma et al. Am J Neph. 2013

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Calcium

CALCIUM

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Guidelines

Academy of Nutrition and Dietetics	K/DOQI	KDIGO
CKD 3-5: Total calcium intake ≤ 2,000 mg/d	CKD 3-5: Total calcium intake ≤ 2,000 mg/d (OPINION)	No limits for dietary calcium intake

Academy of Nutrition and Dietetics. CKD Guideline 2010. www.andeanal.org
 National Kidney Foundation. http://www.kidney.org/professionals/kdoqi/guidelines_updates/doqi_nut.html
 KDIGO 2012. http://www.kdigo.org/clinical_practice_guidelines/pdf/CKD/KDIGO_2012_CKD_GL.pdf

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CALCIUM

Balance in CKD 3–4

N=12 (6 control, 6 treatment); 48 hr inpt;
800 mg vs. 2000 mg Ca²⁺ diet

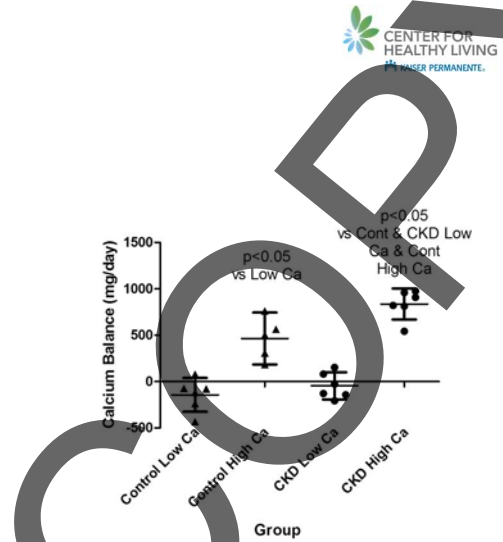
800 mg/d calcium intake

- Neg to neutral calcium balance

>2,000 mg/d calcium

- **Positive calcium balance** without ↓ in calcium absorption or ↑ in serum or urine calcium
- **Excess calcium deposition in tissue**

Spiegel et al. *Kidney Int.* 2012



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Phosphorus



PHOSPHORUS



Guidelines

Academy of Nutrition and Dietetics	K/DOQI	KDIGO
CKD 3-5: Low phosphate diet (800–1,000 mg/d)	CKD 3-4: 800–1,000 mg/d when phos. > 4.6mg/dl ESRD: 800–1,000 mg/d when phos. > 5.5mg/dl	CKD 3-5: Limit dietary phosphate intake; consider phosphate source

Academy of Nutrition and Dietetics. CKD Guideline 2010. www.andeat.org
 National Kidney Foundation. http://www.kidney.org/professionals/kdoqi/guidelines_updates/doqi_nut.html
 KDIGO 2012. http://www.kdigo.org/clinical_practice_guidelines/pdf/CKD/KDIGO_2012_CKD_GL.pdf

PHOSPHORUS



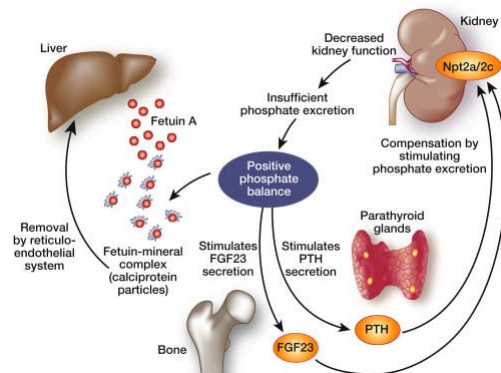
Serum Phosphorus and Mortality

Meta-analysis; 47 cohort studies; n=327,644

Each 1 mg/dl increase in serum phosphorus:

- Risk of death ↑ **18%**

Falmer et al. JAMA. 2011



PHOSPHORUS



Inorganic vs. Organic

Inorganic phosphate

- Not protein-bound
- Directly absorbed in gut
- **80-100%** absorption
- Processed foods, precooked meals, cheese, soda

Organic phosphate

- Protein-bound
- Hydrolyzed in intestine to inorganic phosphate
- **< 60%** absorption
- Animal and plant sources

Noori et al. *IJKD*. 2010

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PHOSPHORUS



Animal- vs. Plant-Based

Animal-based

- Organic phosphate in intracellular compartments
- Easily hydrolyzed and absorbed
- **40-60%** absorbed by gut

Plant-based

- Organic phosphate mostly in phytic acid or phytate storage form
- Humans lack phytase → low absorption
- **10-30%** absorbed by gut

Gonzalez-Parra et al. *Cardiovascular Pathology*. 2012
Noori et al. *IJKD*. 2010

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PHOSPHORUS



Phosphorous-Protein Ratio

Table 1. Selected Sources of Dietary Phosphorus^{6,9}

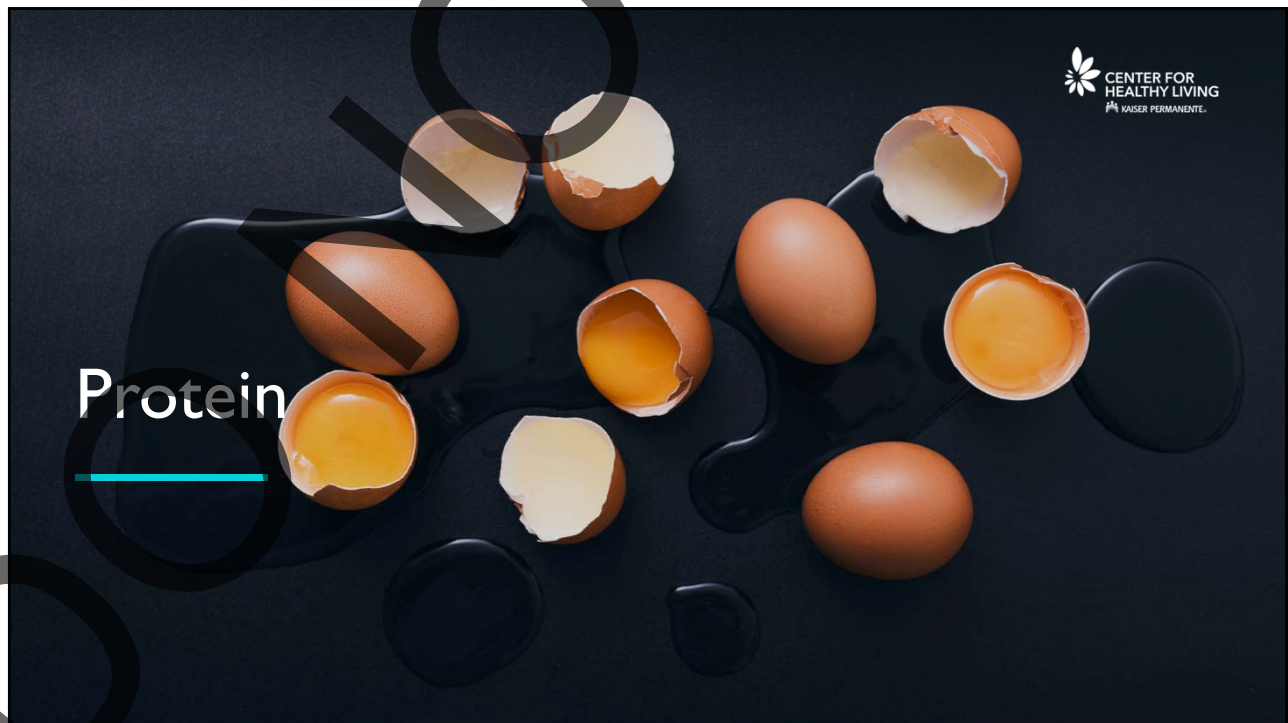
Source	Serving	Phosphorus, mg	Phosphorus-Protein Ratio, mg/g	Gastrointestinal Absorption, %
Organic				
Animal protein				
Milk, skim	8 ounces	247	29	40 to 60
Yogurt, plain nonfat	8 ounces	385	27	40 to 60
Cheese, mozzarella, part skim	1 ounce	131	20	40 to 60
Egg	1 large	86	14	40 to 60
Beef (cooked)	3 ounces*	173	7	40 to 60
Chicken	3 ounces	155	8	40 to 60
Turkey	3 ounces	173	8	40 to 60
Fish, halibut	3 ounces	242	9.3	40 to 60
Fish, salmon	3 ounces	282	13.4	40 to 60
Vegetarian protein[†]				
Bread, whole wheat	1 slice	57	Varies	10 to 30
Bread, enriched white	1 slice	25	Varies	10 to 30
Almonds	12 ounces	134	23	10 to 30
Peanuts	1 ounce	107	15	10 to 30
Lentils (cooked)	Half a cup	178	20	10 to 30
Chocolate	1.4 ounces	142 to 216	27	10 to 30
Inorganic (additives and preservatives)[‡]				
Carbonated cola drink	12 ounces	40	Not Applicable	80 to 100

*A 3-ounce serving is about the size of a deck of cards.
[†]Phytate leads to less absorptability.
[‡]Inorganic phosphorous may comprise 50% or more of daily dietary phosphorus load.

Noori et al. *JKD*. 2010

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Protein



PROTEIN



Guidelines

Academy of Nutrition
and Dietetics

0.6-0.8 g/kg/d
nondiabetic CKD

0.8-0.9 g/kg/d
diabetic nephropathy

K/DOQI

CKD 1-4:
0.6-0.75 g/kg/d

KDIGO

0.8 g/kg/d
with DM (2C),
without DM (2B)
and GFR < 30

Academy of Nutrition and Dietetics. CKD Guideline 2010. www.andeat.org
National Kidney Foundation. http://www.kidney.org/professionals/kdoqi/guidelines_updates/doqi_nut.html
KDIGO 2012. http://www.kdigo.org/clinical_practice_guidelines/pdf/CKD/KDIGO_2012_CKD_GL.pdf

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PROTEIN



Restriction

Meta-analysis LPD, nondiabetic CKD; 10 studies, 2,000 patients; CKD 3-4; avg age 48

- LPD (0.6 g/kg/d); severe LPD (0.3 g/kg/d); std (≥ 0.8 g/kg/d)
- Low-protein diet ↓ **32%** for death (RR 0.68, 95% CI 0.55-0.84; P=0.0002)
- NNT: 2 to 56 with LPD to avoid 1 renal death

Fouque. *Cochrane Database Syst Rev.* 2009

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PROTEIN



Protein Source

Multi-Ethnic Study of Atherosclerosis (MESA); Cross-sectional; n=5,042; age 45-84, no CVD, DM, macroalbuminuria

Total nondairy animal food vs. other

- **11% ↑** albumin/cr

↑ whole grains, fruits, vegetable, low-fat dairy

- **20% ↓** albumin/cr ratio

Nettleton et al. *AJCN*. 2008

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PROTEIN

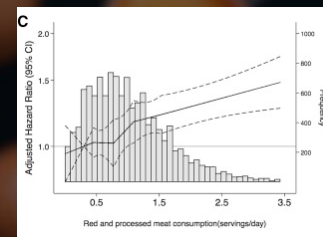


Red Meat and CKD

ARIC; n=11,952, age 44-66 yrs; eGFR > 60

Highest vs. lowest red meat intake

- **23% ↑** in CKD risk



Haring et al. *J Ren Nutr*. 2017

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PROTEIN



Red Meat and ESRD

Singapore Chinese Health Study; prospective, n=63,257; age 45-74; f/u 15.5 yrs

Highest vs. lowest total protein

- **24% ↑ risk**

Highest vs. lowest red meat intake

- **40% ↑ risk**
- Substituting 1 serving red meat with other protein: max **62.4% ↓ risk**

Intake of poultry, fish, eggs, dairy

- **No association**

Lew et al. JASN. 2017

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PROTEIN



Ketoanalogue Supplemented Vegetarian Diet

207 pts randomized; 12 months; 103 LPD (0.6 g/kg/d mixed protein); 104 KD + VLPD (0.3 g/kg/d + KA, plant-based protein)

Endpoint: RRT or > 50% ↓ GFR

- **13% KD + VLPD vs. 42% in LPD** (p < 0.001)

NNT x 1 yr to avoid reaching end point by 1 pt

- **4.4**

Garneata et al. JASN 2016

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PROTEIN



Indoxyl Sulfate, P-Cresyl Sulfate

Uremic toxins derived from bacterial fermentation of protein in colon

- ↑ **oxidative stress** in renal tubular cells and glomeruli
- Activate inflammatory pathways

Vegetarians with ↓ **levels** than omnivores

Evenepoel. Nephrol Dial Transplant. 2011
Tumur et al. Am J Nephrol. 2010

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PROTEIN



Soy Protein

Randomized, crossover trial; n=14 pts; 0.8g/kg protein: 70% animal + 30% vegetable vs. 35% animal + 35% soy + 30% vegetable

Soy protein consumption

- ↓ **urinary urea nitrogen** (-0.9 ± 0.8 vs. 0.2 ± 0.6 mg/dL, respectively, SD; $P < .001$)
- ↓ **proteinuria** (-78 ± 37 vs. 42 ± 39 mg/day, respectively, SD; $P < .001$)
- ↓ **serum phosphorous** (-0.03 ± 0.2 vs. 0.2 ± 0.3 mg/dL, respectively, SD; $P < .01$)

Azadbakht et al. J. Renal Nutr. 2009

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FATS

Saturated Fat

REGARDS study; Cross-sectional; n=19,256; age ≥ 45, 2003-2007; high ACR 25-354 ug/mg women, 17-250 ug/mg men

Saturated fat at 13% vs. < 10%

- **33%** ↑ risk for albuminuria

Lin et al. *Am J Clin Nutr.* 2010

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Fiber

FIBER

CKD Incidence

N=1630 from Tehran Lipid & Glucose study; f/u 6.1 yrs; baseline GFR > 60 ml/min/1.73m²

Highest (33.5g/d) vs. lowest (13.6g/d) fiber intake

- **53%** ↓ in CKD incidence

Each 5 g/d ↑ in fiber

- **11%** ↓ in CKD incidence

Mirmiran et al. Br J Nutr. 2018

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FIBER

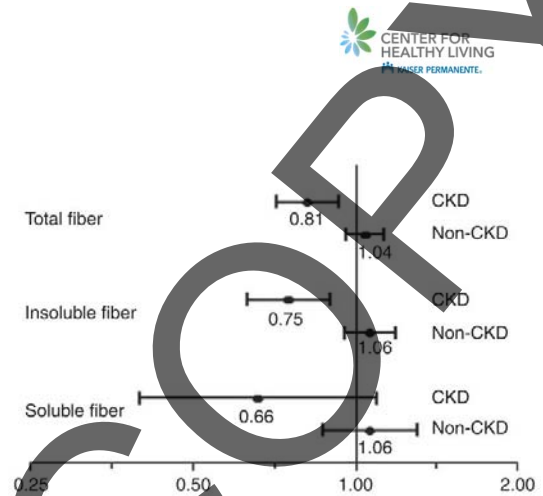
Fiber, CKD, and All-Cause Mortality

NHANES III; n=14,543; avg age 45; CKD prevalence 5.8%

Every 10 gm/d ↑ in dietary fiber

- **19%** ↓ in all-cause mortality

Raj Krishnamurthy et al. *Kidney Int.* 2016



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Sugar and Artificial Sweeteners

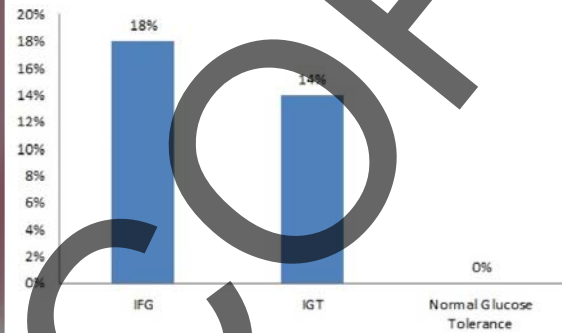
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SUGAR

CKD

- **No direct studies** with sugar and microalbuminuria
- **↑ prevalence** of microalbuminuria in prediabetics

Bahar et al. *Nephrourol Mon.* 2013

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SUGAR

Sugar Intake and CKD

*n=2,600, age \geq 50; 5 yr flu incidence CKD
eGFR < 60 ml/min 1.73 m²*

Highest (169 g/d) vs. lowest (86.2 g/d) sugar intake

- **107% ↑** risk of CKD incidence

Gopinath et al. 2011

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SUGAR



Artificial Sweetened Soda and GFR

Nurses' Health Study; women n=3,318; 1989-2000

Primary outcome: $\geq 30\%$ \downarrow GFR over 11 years

Consumption ≥ 2 servings/day

- **102%** \uparrow risk

Lin et al. CJASN. 2011

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SUGAR



Diet Soda and ESRD Risk

ARIC Study; n=15,368; median f/u 23 yrs

< 1 glass/wk vs. > 7 glasses/wk

- **83%** \uparrow risk of ESRD

Rebolz et al. 2016

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DIET

Plant-based diet

ARIC Study; n=14,686; f/u 24 yrs;

Higher adherence to:

- Plant based diet **3%** ↓ CKD incidence
- Healthy plant-based diet **14%** ↓ in CKD incidence
- Less healthy plant-based diet **11%** ↑ in CKD incidence
 - Refined grains, juices, sweets/desserts
- Results significant independent of sociodemographic factors and health behaviors
- **4%** of CKD cases avoided via ↑ adherence to plant-based diet

Hyunju et al. CJASN 2019

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The Bottom Line

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" Eat food, not too much,
mostly plants.

MICHAEL POLLAN

44 3

THE BOTTOM LINE



Higher consumption of:

- Whole grains
- Fruits & vegetables
- Legumes
- Nuts

Lower consumption of:

- Salt
- Refined grains
- Protein ≤ 0.8 g/kg/d (prefer plant-based)
- Red and processed meats
- Sugar-sweetened foods and beverages

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Thank you!



kp.org/centerforhealthyliving

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