

The Role of Diet in CVD, CKD, and Heart Failure

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Outline

1

There is commonality between the positive impact of diet on CVD, CKD, and heart failure risk reduction

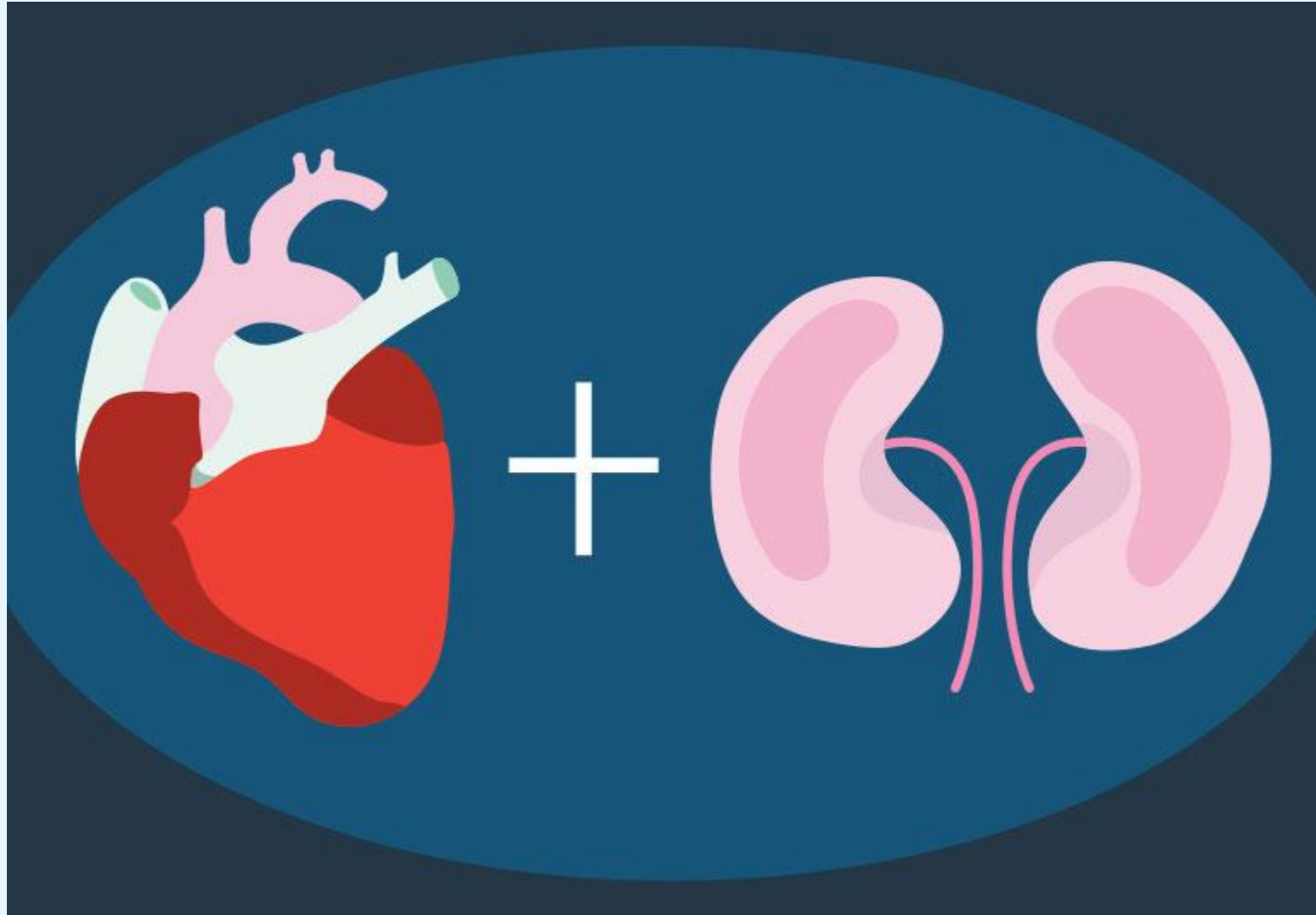
2

Should we be recommending a plant-based diet for CVD, **CKD**, and heart failure?

3

Is potassium a key feature in the plant-based diet and should we strengthen our recommendations even for patients with **CKD**?

Healthy Heart = Healthy Kidneys



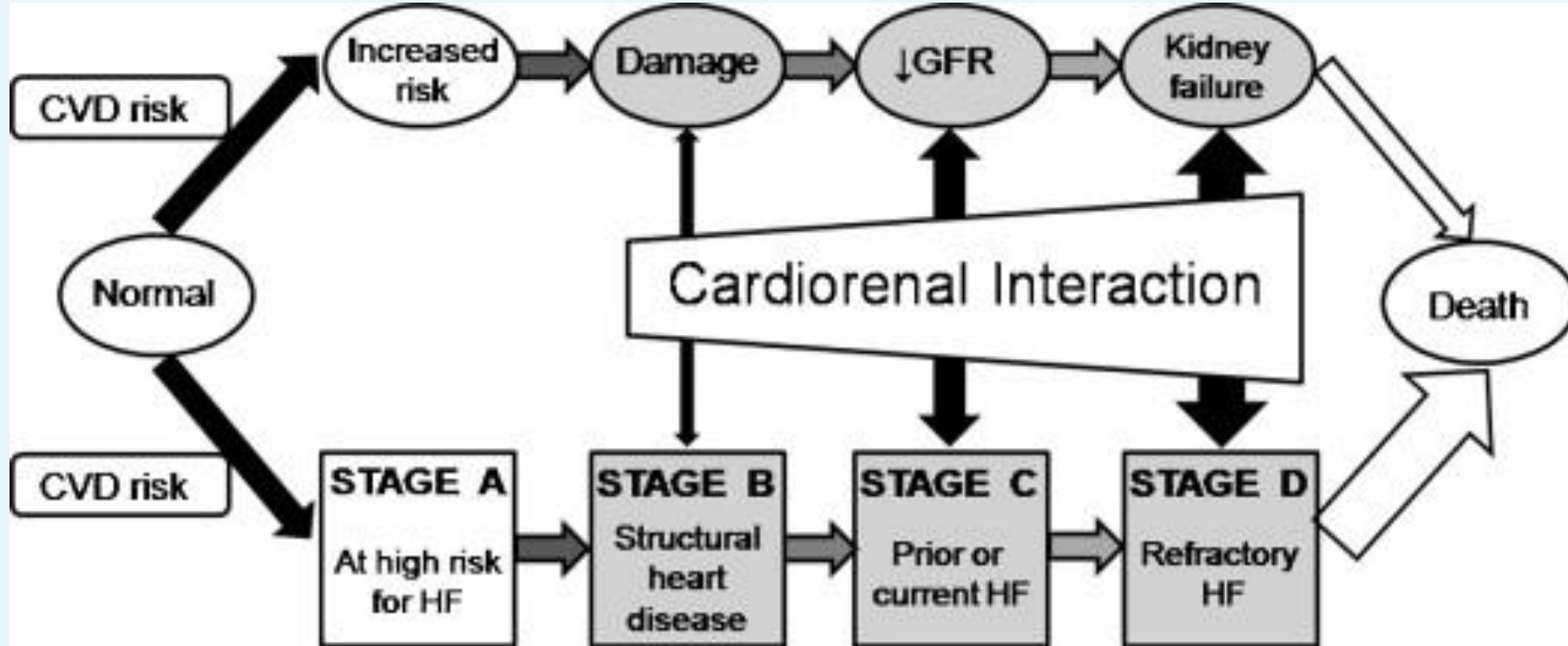
Intersectionality Between CVD,CKD, Heart Failure



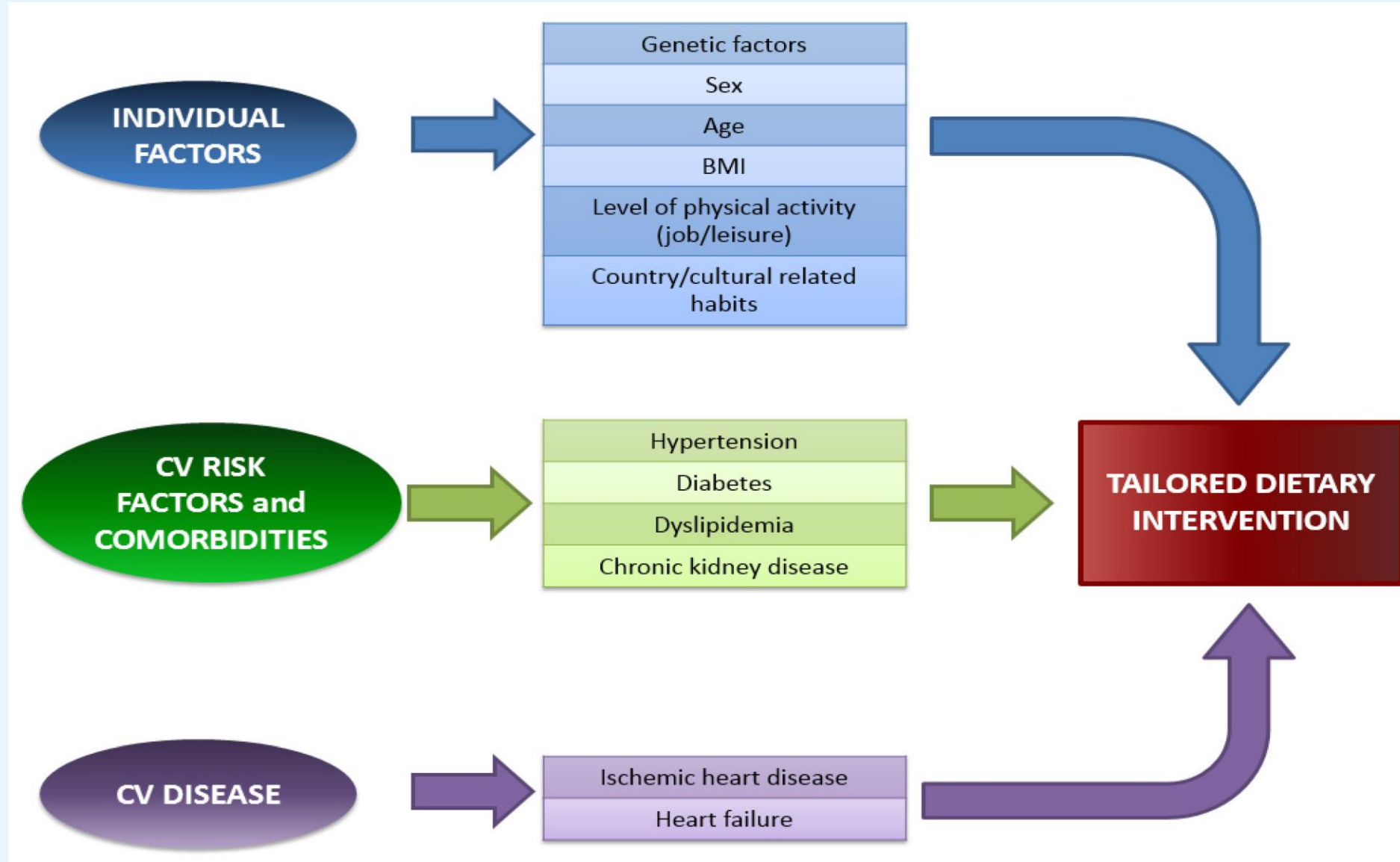
1 in 3

Approximately 1 in 3 adults with diabetes (and 1 in 5 adults with high blood pressure) may have chronic kidney disease.

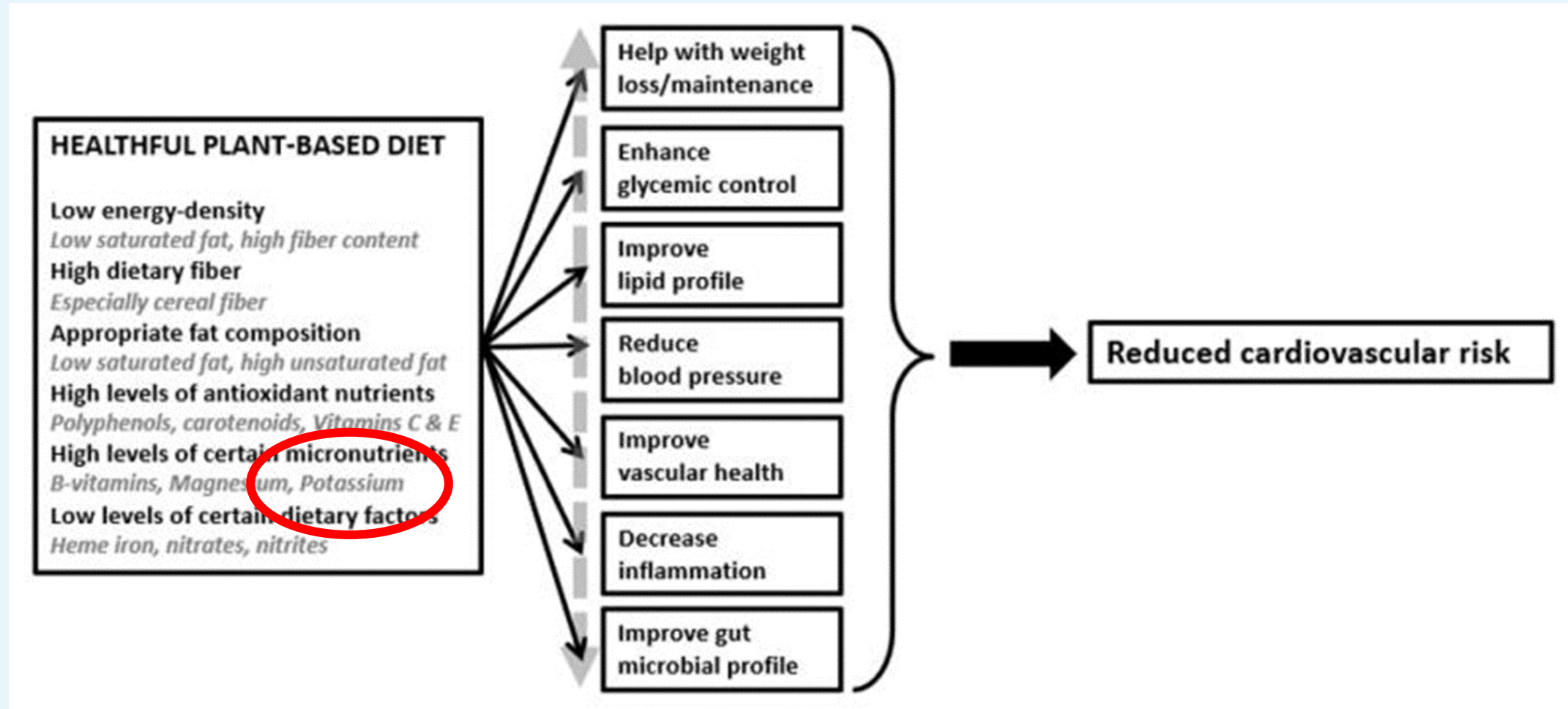
As CVD Risk Increases, There is an Increase in CKD



CVD, CKD, and Heart Failure Common Risk Factors



Plant-Based Diet Reduces CVD Risk



Diet Terminology

PLANT-BASED VS. VEGAN VS. VEGETARIAN

	Plant-Based	Vegan	Vegetarian
Meat & Poultry 🐕 🐔	---	✗	✗
Seafood 🐟 🍤	---	✗	✗
Dairy 🥛	---	✗	✓
Eggs 🥚	---	✗	✓
Oil 🛢️	✓	✓	✓
Fruits & Veggies 🍏 🥬	✓	✓	✓
Grains 🌾	✓	✓	✓
Legumes 🥜	✓	✓	✓

✗ - No --- - Avoid ✓ - Yes



@ MeatlessMonday
MeatlessMonday

'Universal' Benefits of A Plant-Based Diet

Health Benefits of A Plant-Based Diet



- Lower BMI, body fat
- Lower overall mortality
- Lower mortality from ischemic heart disease
- Reduced medication requirements
- Sustainable weight management
- Reduced incidence of hypertension, hyperlipidemia, and hyperglycemia
- Reduced risk of certain cancers (especially colorectal cancer)
- Reduced obesity inflammatory markers
- Reversal of advanced coronary artery disease
- Reversal of type 2 diabetes



A plant-based diet supports living longer not just living longer



Question

Epidemiologic studies in patients with **CKD** have shown that **high** K⁺ intake is associated with cardiorenal benefits?

- a) True
- b) False



Question

Epidemiologic studies in patients with CKD have shown that **high** K⁺ intake is associated with cardiorenal benefits?

a) True

b) False



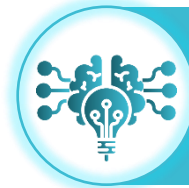
Health benefits of K⁺

Boosts the nervous system



Prevents muscle cramps

Maintains optimal fluid balance



Maintains electrical conductivity in brain

Improves bone health and muscle tissue growth



Stabilizes blood sugar levels and blood pressure

Keeps brain functioning normal and prevents strokes



Maintains optimal muscle and nerve function

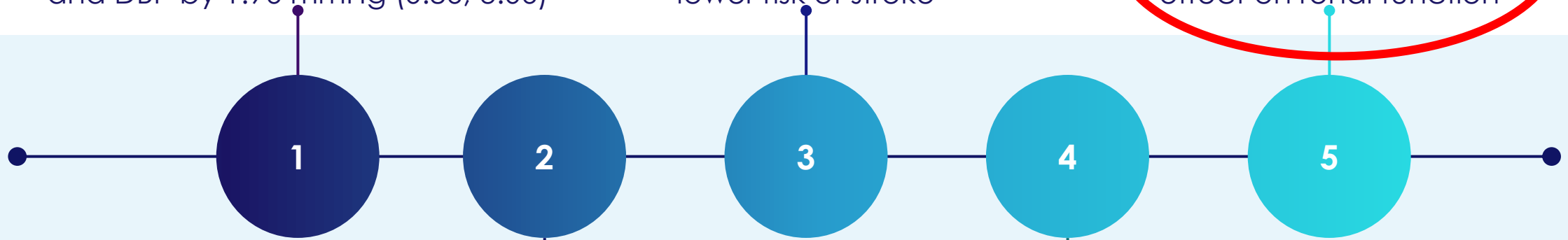
Increased K⁺ intake and beneficial CVD outcomes in the general population

Meta-analysis included adults with hypertension and no CKD from 22 RCTs (N=1606) and 11 cohort studies (N=127,038)

Overall, increased K⁺ intake reduced SBP by 3.49 mmHg (95% CI: 1.82, 5.15) and DBP by 1.96 mmHg (0.86, 3.06)

Higher K⁺ intake was associated with a 24% lower risk of stroke

Increased K⁺ intake had no significant adverse effect on renal function



SBP was reduced by 7.16 mmHg (1.91, 12.41) with higher K⁺ intake (90–120 mmol/day), without any dose response

Associations between K⁺ intake and incident CVD or CHD were not statistically significant

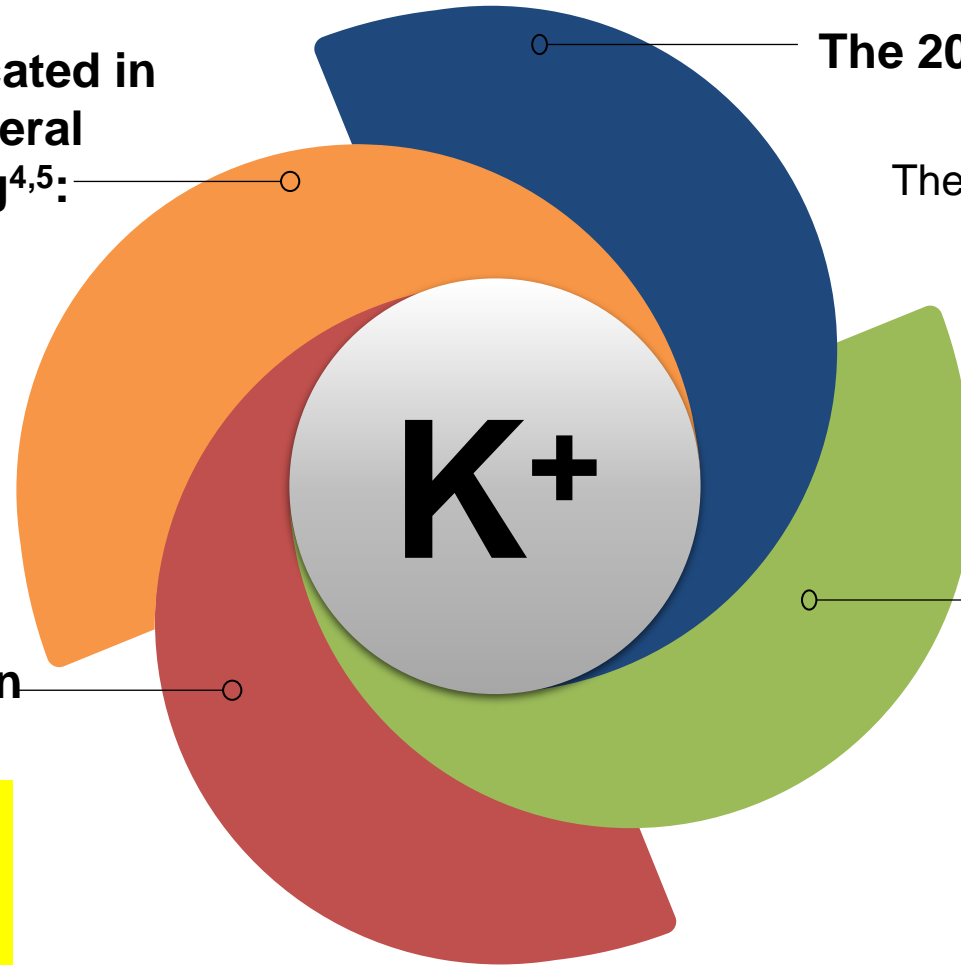
K⁺ listed as “nutrient of concern”

Inadequate dietary K⁺ is implicated in the pathophysiology of several chronic diseases including^{4,5}:

- Hypertension
- CVD
- Osteoporosis
- Nephrolithiasis

NHANES estimated the mean K⁺ intake in US as³:

- 2,290 mg/day for women
- 3,026 mg/day for men



The 2015–2020 Dietary Guidelines for Americans¹:

The guideline list K⁺ as a nutrient of public health concern

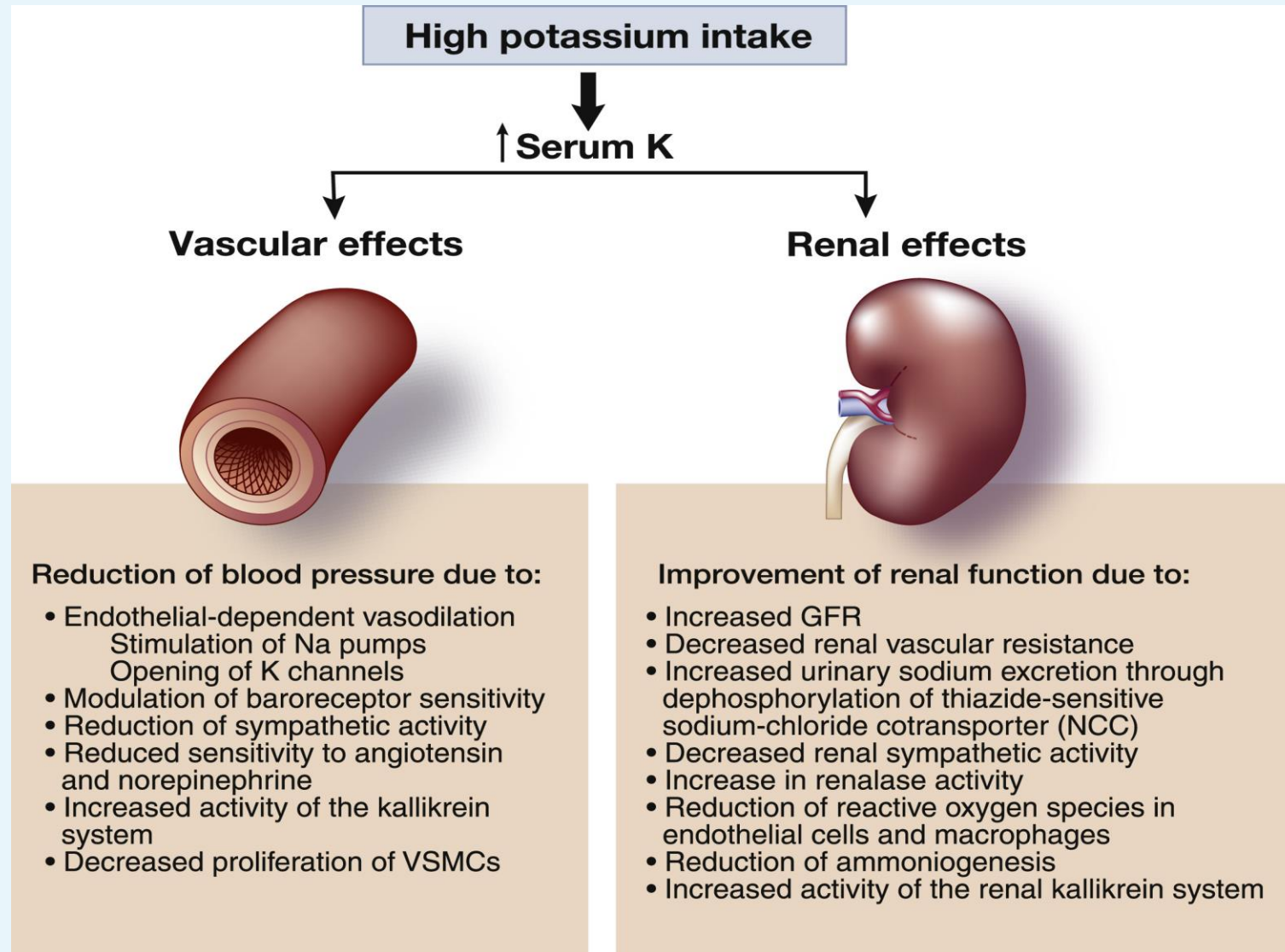
The Food and Nutrition Board of the Institute of Medicine²:

Recommended K⁺ intake levels of 4,700 mg/day

CVD, cardiovascular disease; NHANES, National Health and Nutrition Examination Survey

1. U.S. Department of Health and Human Services and U.S. Department of Agriculture. 2015 – 2020 Dietary Guidelines for Americans. 8th Edition. December 2015. Available at <https://health.gov/our-work/food-and-nutrition/2015-2020-dietary-guidelines/> (Accessed March 2020); 2. Food and Nutrition Board. Institute of Medicine. The National Academies Press; Washington, DC, USA, 2005; 3. U.S Department of Agriculture, Agriculture Research Service 2010. What we eat in America, NHANES 2007–2008. Available at: <http://www.ars.usda.gov/ba/bhnrc/fsrg> (Accessed March 2020); 4. Linus Pauling institute, Oregon State University. Potassium. Available at: <https://lpi.oregonstate.edu/mic/minerals/potassium> (Accessed March 2020); 5. Institute of Medicine. Dietary reference intakes for water, potassium, sodium, chloride, and sulfate. Washington, DC, USA: The National Academies Press; 2005

High Dietary K⁺ Reduces Blood Pressure and Improves Kidney Function





American Journal of Kidney Diseases
Volume 77, Issue 2, February 2021, Pages 235-244

Adherence to Healthy Dietary Patterns and Risk of CKD Progression and All-Cause Mortality: Findings From the CRIC (Chronic Renal Insufficiency Cohort) Study

Emily A. Hu, Josef Coresh, Cheryl A.M. Anderson, Lawrence J. Appel, Morgan E. Grams, Deidra C. Crews, Katherine T. Mills, Jiang He, Julia Scialla, Mahboob Rahman, Sankar D. Navaneethan, James P. Lash, Ana C. Ricardo, Harold I. Feldman, Matthew R. Weir, Haochang Shou, and Casey M. Rebholz, on behalf of the CRIC Study Investigators



What is the association between plant-based diets, incident CKD and kidney function decline?

Methods and Cohort



Middle-aged adults enrolled in ARIC study
N=14,686



Dietary assessment using the Willet food frequency questionnaire



Diets characterized using 4 plant-based diet indices



Positively scored



Negatively scored



Not scored



Plant-based diet indices

Animal foods were negatively scored

Overall plant-based diet



Healthy plant-based diet



Pro-vegetarian diet



Less healthy plant-based diet



Outcomes



Incident CKD

Adjusted HR of Q5 vs Q1

0.94
(0.84-1.03)

0.86
(0.78-0.96)

0.90
(0.82-0.99)

1.11
(1.01-1.21)



eGFR decline

Annual change of Q5 vs Q1

-1.54 vs -1.68
p<0.001

-1.55 vs -1.62
p=0.01

-1.54 vs -1.60
p=0.15

-1.56 vs -1.57
p=0.24

Conclusion

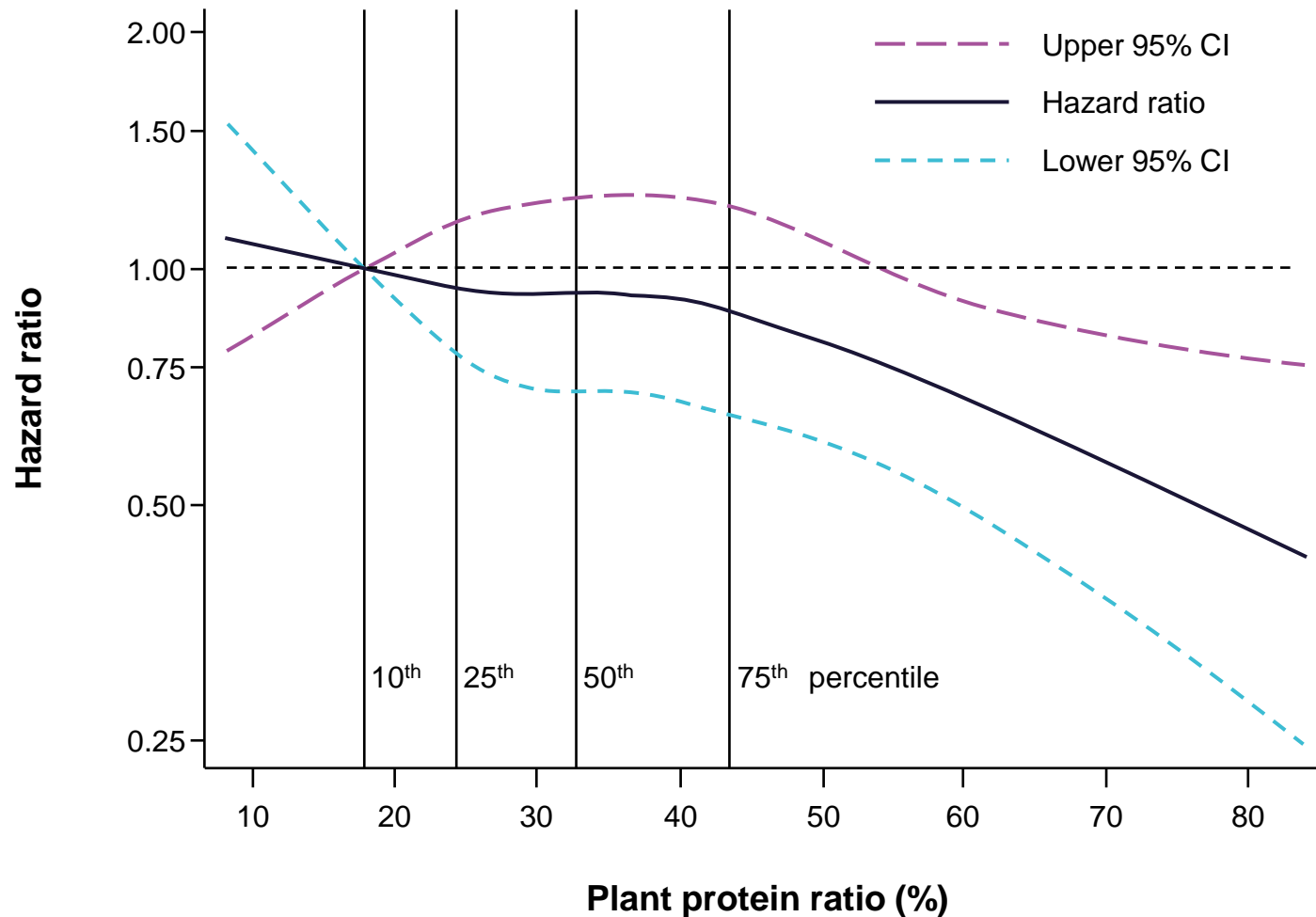
Higher adherence to healthy plant-based diets and a vegetarian diet was associated with favorable kidney disease outcomes.

Hyunju Kim, Laura Caulfield, Vanessa Garcia-Larsen, Lyn Steffen, Morgan Grams, Josef Coresh, Casey Rebholz. **Plant-Based Diets and Incident Chronic Kidney Disease and Kidney Function.** CJASN doi: 10.2215/CJN.12391018. Beatrice Concepcion, MD

Consumption of a plant-based diet (containing K⁺) is associated with lower mortality in CKD

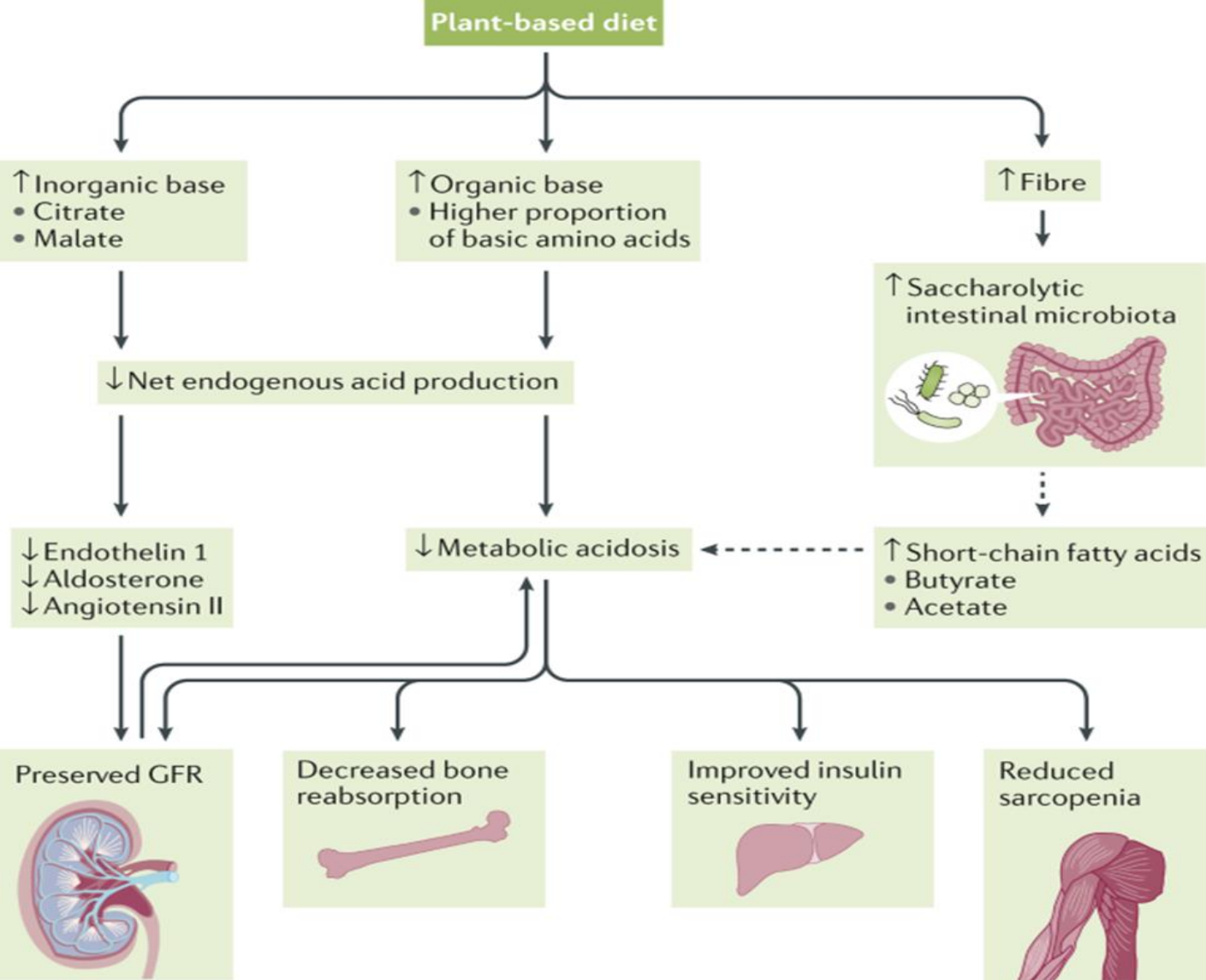


NHANES III participants (N=14,866)



Each 33% increase in the plant protein ratio had a statistically significant lower risk of all-cause mortality among patients with eGFR <60 mL/min/1.73 m²

Plant-Based Diets Preserve Kidney Function and Improve Insulin Sensitivity Through Reductions in Metabolic Acidosis



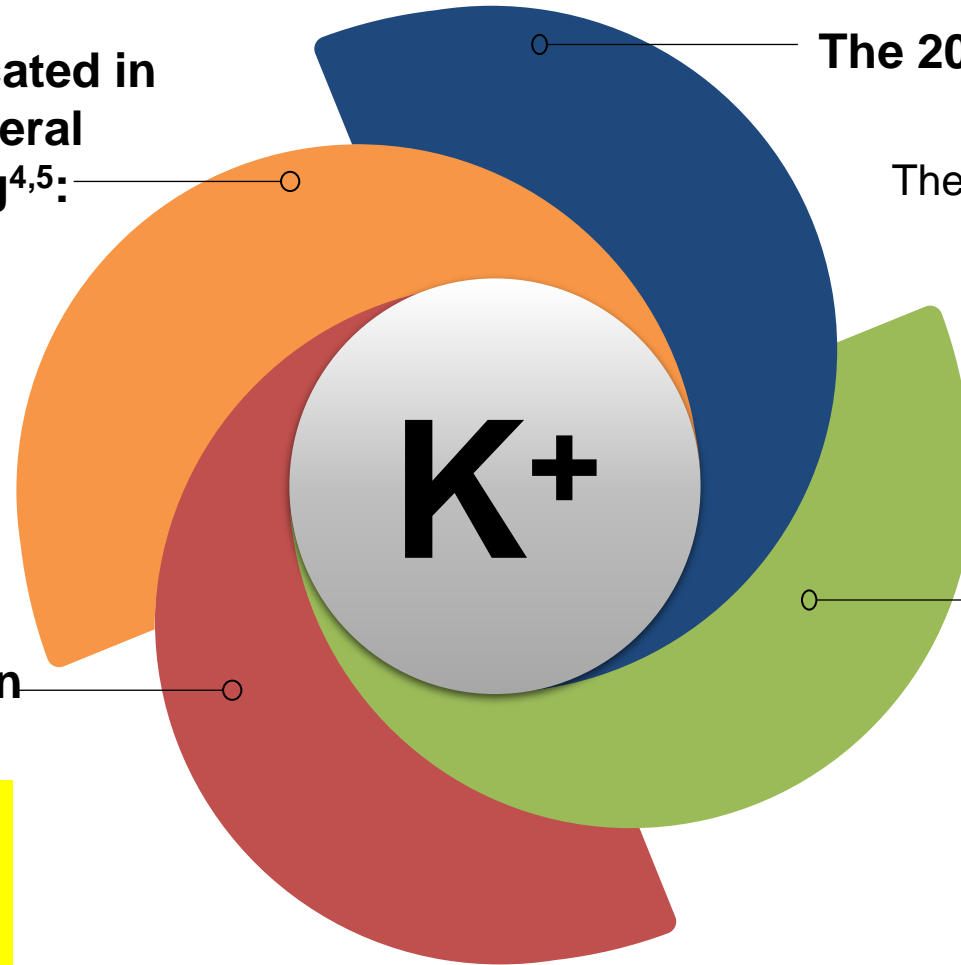
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Dietary K⁺ intake recommendations in CKD

	Guidance	g/day	mmol/day
DRI-AI >19 years	Males	3.4	88
	Females	2.6	68
	CKD G1–G2	<4.0	>104
	CKD G3a–G4	2.0–4.0	52–104
	CKD/hemodialysis	2.0–4.0	52–104
	Hemodialysis	2.7–3.0	70–78
	Peritoneal dialysis	3.0–4.0	78–104
	HK	<3.0	<78



CDK, chronic kidney disease; DRI-AI, Dietary Reference Intake – Adequate Intake; HK, hyperkalemia; KDOQI, Kidney Disease Outcomes Quality Initiative
 Adapted from Clase CM, et al. *Kidney Int* 2020;97:42–61



Dietary K⁺ restriction in CKD/ESRD patients

Low K⁺ diet:



1 Is difficult to adhere¹

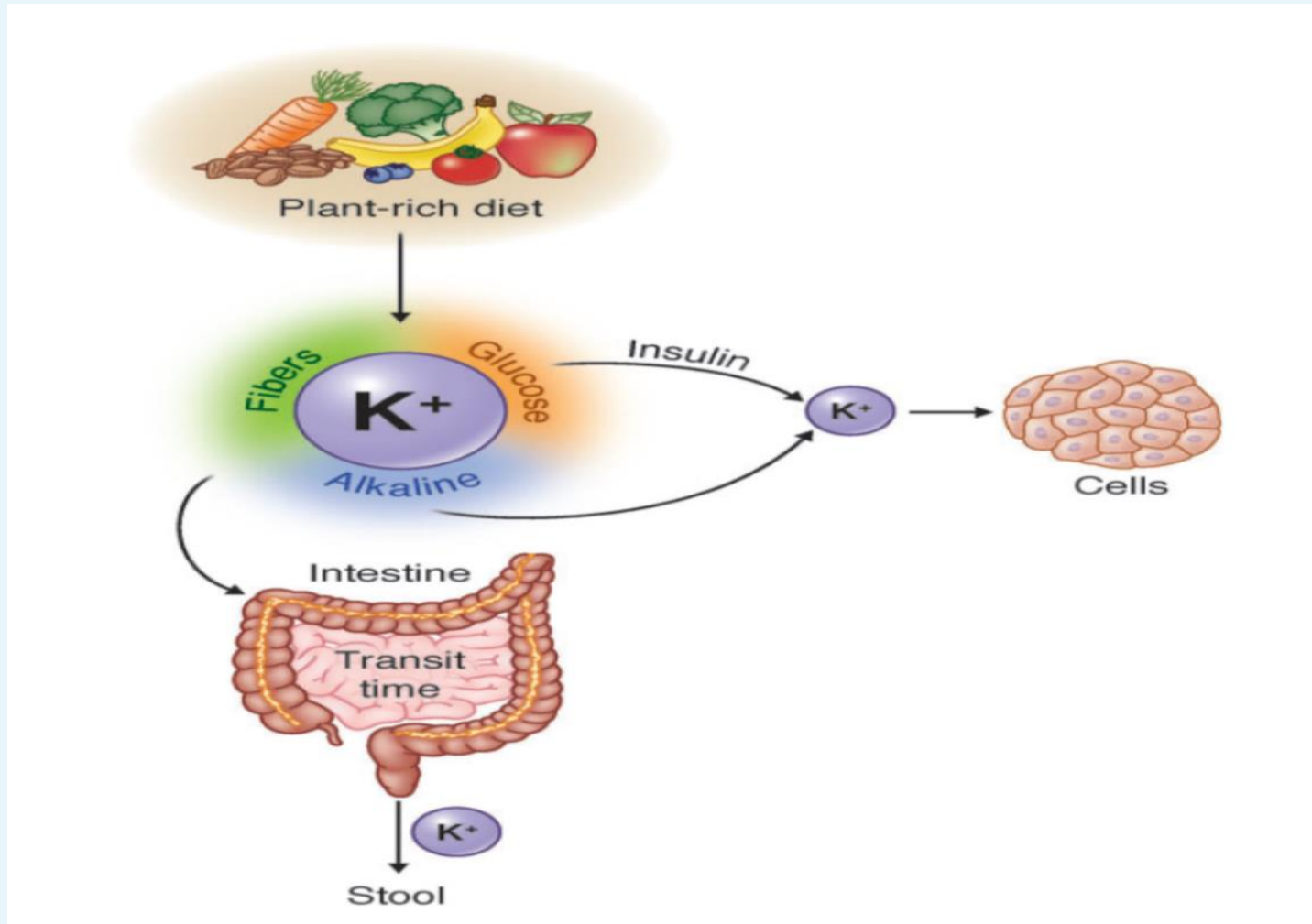
2 Is associated with malnutrition: low protein and low fibre^{2,3}

3 Malnutrition in ESKD is common and strongly associated with mortality and morbidity²

4 Malnutrition and K⁺ restriction are associated with reduction in QoL in dialysis patient cohort⁴

ESKD, end-stage kidney disease; QoL, quality of life
1. Chaaban A, et al. *Ren Fail* 2013;35:185–188; 2. St-Jules DE, et al. *J Ren Nutr* 2016;26:282–287; 3. Palmer SC, et al. *BMJ Open* 2015;5:e006897; 4. Khoueiry G, et al. *J Ren Nutr* 2011;21:438–447

Theoretical Model of How Plant-Rich Diets Reduce Hyperkalemia





The kidney has an amazing capacity to handle dietary K^+



Mismatch between the modern diet introduced over the last 10,000 years and the nutritional requirements encoded into the human genome, which developed over the several million years from the Stone Age¹



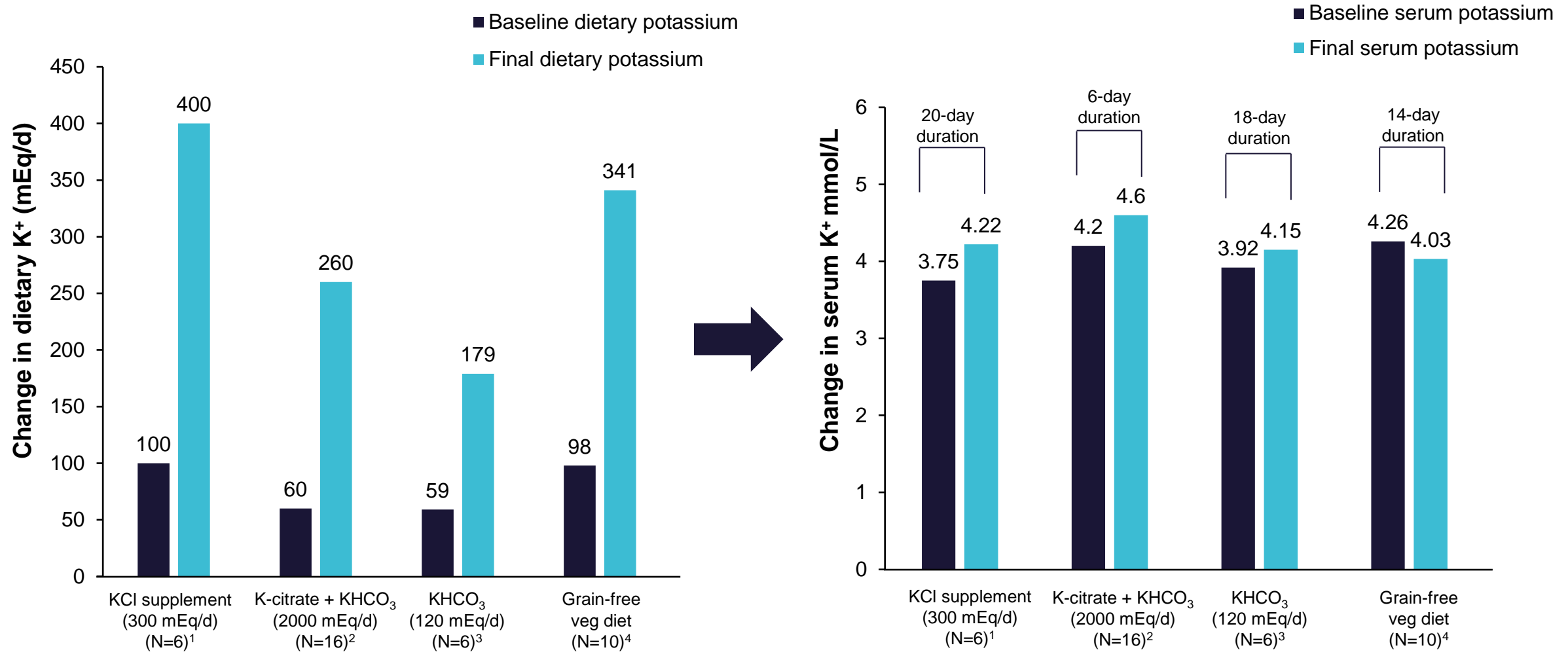
K^+ intake of prehistoric man was estimated to be 15,000 mg/day²
Current K^+ intake is estimated to be approximately 2,700 mg/day

Diet has shifted from:

HIGH K^+ and LOW Na^+
to
LOW K^+ and HIGH Na^+



Effect of prolonged K⁺ intake in healthy humans

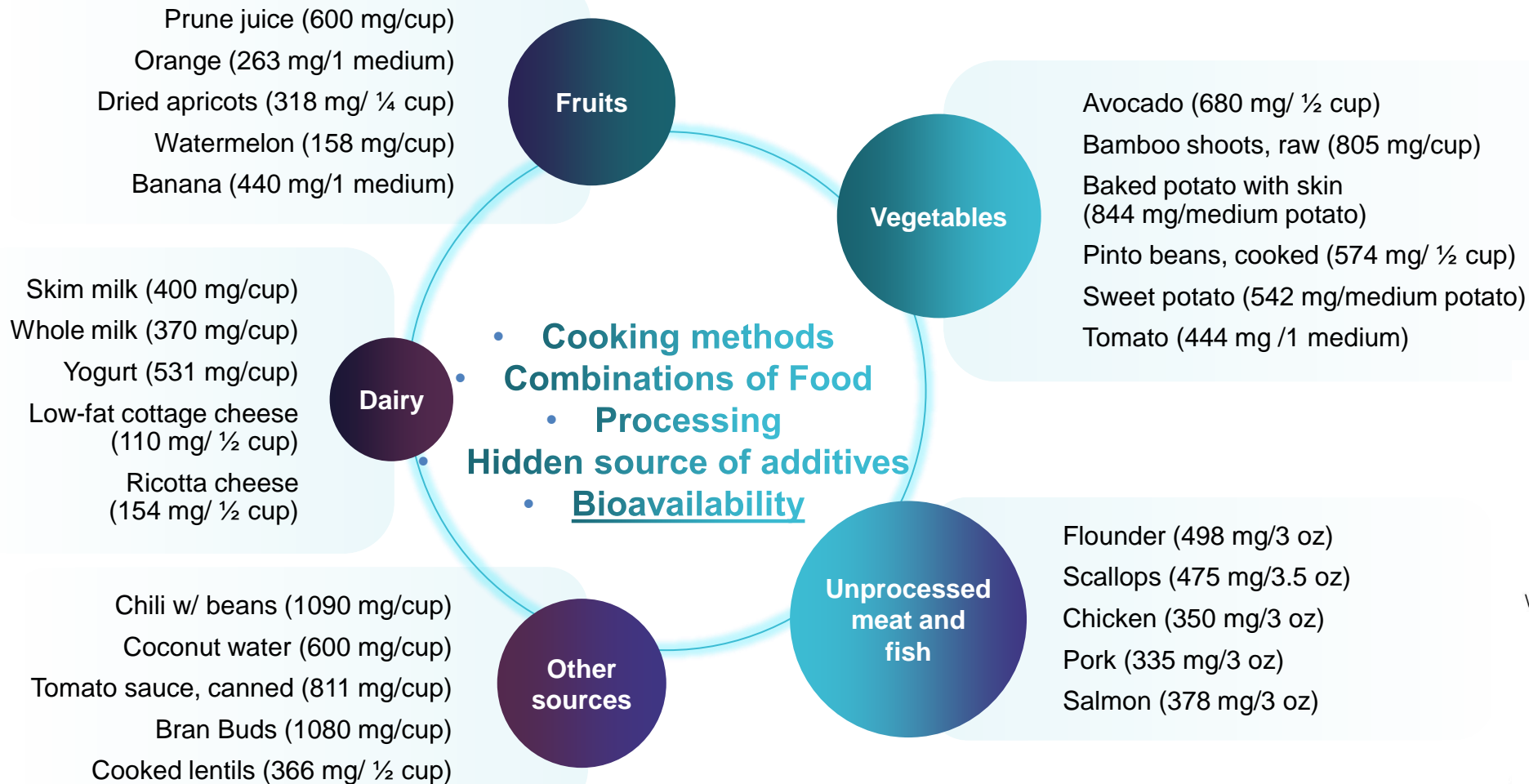


KCl, potassium chloride; KHCO₃, potassium bicarbonate

1. Rabelink TJ, et al. *Kidney Int* 1990;38:942–947; 2. Witzgall H, et al. *J Hypertens* 1986;4:201–205; 3. Sebastian A, et al. *N Engl J Med* 1994;330:1776–1781; 4. Jenkins DJ, et al. *Metabolism* 2001;50:494–503

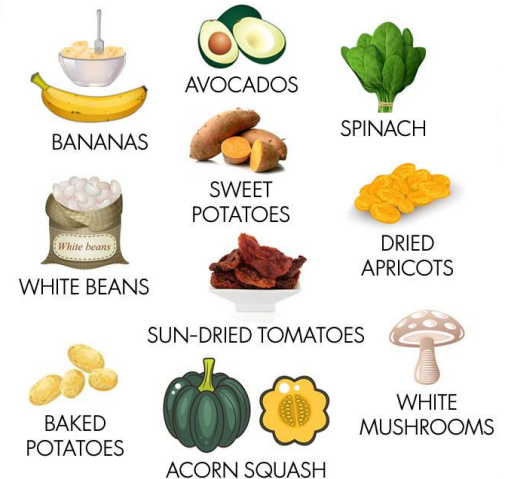


What is there to eat in a K⁺-restricted diet?



TOP 10 POTASSIUM-RICH FOODS

K





Question

Which of the following food sources has the most K⁺?

- a) 1 medium-sized banana
- b) 1 avocado
- c) 3-oz burger
- d) 1 tomato
- e) 1 cup of low-fat yogurt



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The recommendation to avoid K⁺-rich foods in patients with CKD is based on the assumption that dietary intake correlates to serum K⁺ concentration





Macronutrients enhance extrarenal disposal of K⁺ load



Study by Allon et al. showed that oral K⁺ **plus** concomitant oral glucose significantly attenuated the maximal rise in K⁺ in hemodialysis patients compared with K⁺ alone (0.40 ± 0.09 , $P < 0.005$)



Dietary K⁺ bioavailability

Although K⁺ from different foods is chemically equivalent, other nutrients influence K⁺ distribution and excretion



Compared with meat-based foods, plant-based foods high in K⁺ may promote distribution of a greater proportion of dietary K⁺ intracellularly (alkaline and insulin-stimulating) and excretion of K⁺ in stool by increasing fecal bulk



Dietary K⁺ intake in patients with kidney failure – it's doable if:

Successful individualized dietary intervention must balance several factors:

Stage of kidney failure, comorbidities, age, and nutritional status

Individual patient food preferences, lifestyle, and adherence

Multiple nutritional components and drug–nutrient interactions

Dietary intake of K⁺ is a modifiable risk factor for HK; however, strict dietary restrictions in CKD and ESKD may impact nutrition and contribute to worse outcomes

Dietary Therapy and Impact on Hyperkalemia

Modifiable factors that may affect kalemic response to meals	Effect on postprandial hyperkalemia risk and mechanism	Nutrition intervention
Potassium load K content of meals ^a	Drives kalemic response ⁸⁻¹⁴	Limit portion size of high-K foods; prepare foods using wet-cooking methods (discard water); avoid K additives
Fiber content of meal ^b	May reduce K absorption ²⁰	Consume whole-plant foods; limit fruit- and/or vegetable-based juices, soups, sauces, and refined grains
Potassium uptake by cells Carbohydrate content of meals ^a	Insulin activates Na/K-ATPases ²¹	Include carbohydrate-rich foods at meals or snacks (eg, grain products)
Potassium content of diet ^b	Upregulates Na/K-ATPases ²²	Consume a high-potassium diet (eg, adequate fruit and vegetables)
Physical activity ^b Metabolic acidosis ^a	Upregulates Na/K-ATPases ²³ Enhances extracellular output ²⁴	Encourage physical activity and exercise Avoid excess animal-based protein foods (eg, meat, poultry, eggs; acid forming foods); consume adequate fruit and vegetables (base-forming foods)
Potassium excretion Preserve kidney function and potassium removal ^a	Increases K excretion ¹³	Consume whole-plant foods; limit added sugars, refined grains, and sodium intake
Fiber content of diet ^b	Increases K excretion ²⁰	Consume whole-plant foods; limit fruit- and/or vegetable-based juices, soups, sauces, and refined grains

Increased K⁺ intake and cardiorenal outcomes in patients with CKD and ESKD

1

The effects of dietary K⁺ intake on cardiovascular and renal outcomes has primarily been investigated in non-CKD populations¹

2

Findings from epidemiologic studies provide insight into the relationship between dietary K⁺ intake and cardiorenal outcomes in CKD, but these associations require prospective evaluation²

3

RCTs are urgently needed to evaluate whether a high dietary K⁺ intake will contribute to improved cardiorenal outcomes in CKD and ESKD³

Summary: Dietary Recommendations for CVD, CKD, and Heart Failure – Is Potassium the Key?



K⁺

Plant-based diets reduce the risk of CVD, CKD, and Heart Failure



Epidemiologic analyses in a majority of studies indicates high K⁺ intake was associated with cardiorenal benefits ***even in CKD patients***



A re-analysis of dietary counseling for K⁺ intake is warranted



Diet for reducing CVD, CKD and Heart Failure can be plant-based when considerations of types of foods eaten, combinations of foods, and cooking methods