Nutrition for People with Kidney Disease

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U.S. Department of Health and Human Services
National Institutes of Health

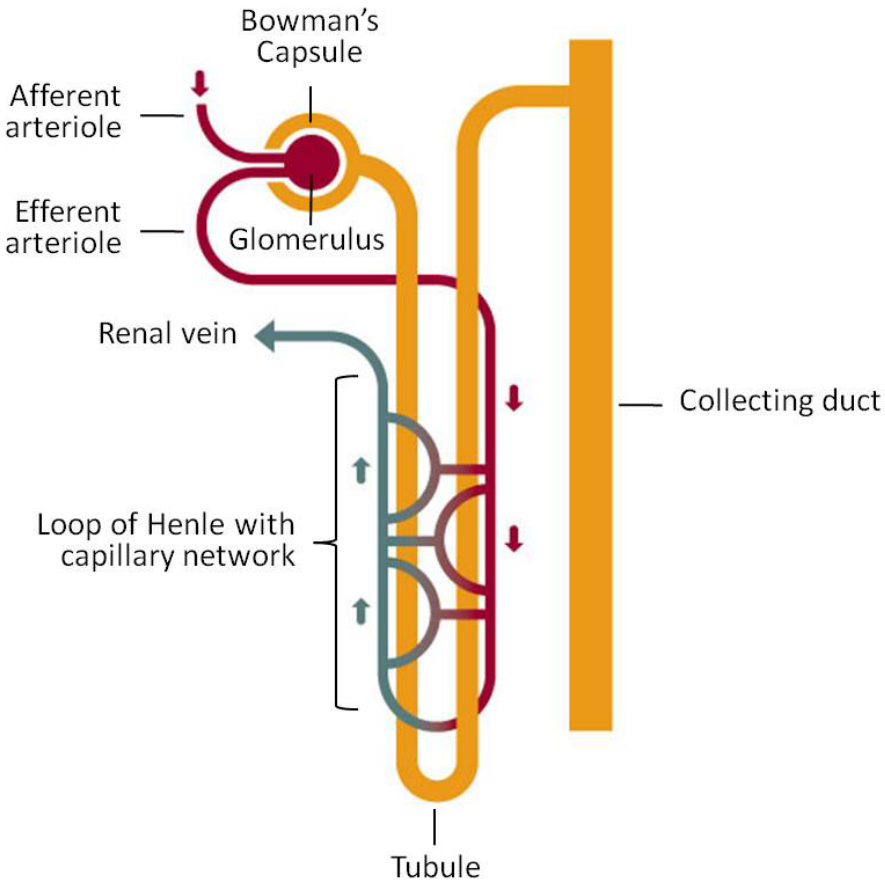
NIDDK NATIONAL INSTITUTE OF DIABETES AND DIGESTIVE AND KIDNEY DISEASES

NKDEP National Kidney Disease Education Program

Topics

- Brief review: nephron anatomy, kidney functions, identifying kidney disease
- Look beyond the ABCs
- Possible interventions for lowering urine albumin (albuminuria)
- Brief review of CKD complications
- Review nutrient profiles of the food groups
- Steps for dietary intervention in CKD

Anatomy review: the nephron



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CKD is reduced kidney function and/or kidney damage

- Chronic Kidney Disease
  - Kidney function
    - Glomerular filtration rate (GFR) < 60 mL/min/1.73 m2 for > 3 months with or without kidney damage
    - AND/OR
  - Kidney damage
    - > 3 months, with or without decreased GFR, manifested by either
      - Pathological abnormalities
      - Markers of kidney damage, i.e., proteinuria (albuminuria)
        - Urine albumin-to-creatinine ratio (UACR) > 30 mg/g

Reference: National Kidney Foundation Kidney Disease Outcome Quality Initiative (KDOQI). Clinical practice guidelines for chronic kidney disease: evaluation, classification, and stratification. Amer J Kid Dis 2002; 39(2 suppl 1):S18–S266.

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The kidneys maintain homeostasis

1. Regulatory function
   - Control composition and volume of blood
     - Maintain stable concentrations of inorganic anions such as sodium (Na), potassium (K), and calcium (Ca)
   - Maintain acid-base balance
2. Excretory function
   - Produce urine
   - Remove metabolic wastes
     - Including nitrogenous waste

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The kidneys have other functions

3. Hormone function
   - Produce renin for blood pressure control
   - Produce erythropoietin which stimulates marrow production of red blood cells
   - Activate 25(OH)D to 1,25 $(OH)_2D$ (active vitamin D)
4. Metabolic function
   - Gluconeogenesis
   - Metabolize drugs and endogenous substances (e.g., insulin)

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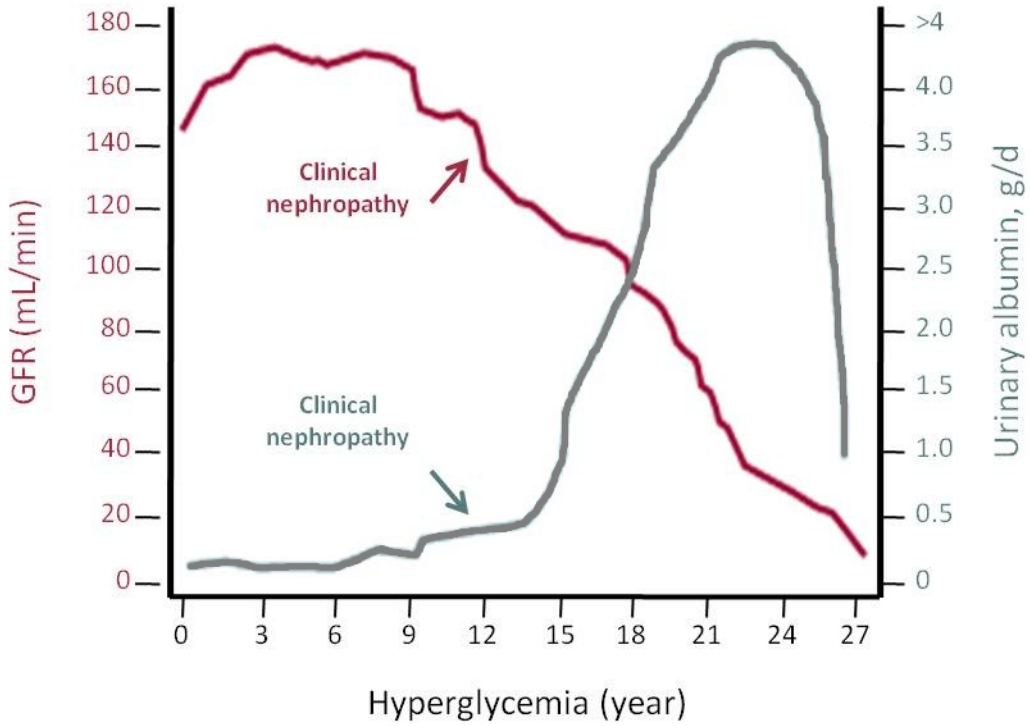
Diabetic kidney disease:

Hyperglycemia causes hyperfiltration,
followed by albuminuria and THEN reduced filtration
(lower GFR)

- Reference: Adapted from Friedman, 1999



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Most would be happy with these ABCs

T.C. is a 57 year old man diagnosed with hypertension in 2003, and diagnosed with diabetes in 2005.

- He does not smoke or drink alcohol.
- A1C 7.2
- Blood pressure 136/82
- LDL 102
- Weight 209#, height 74” (BMI 26.8)

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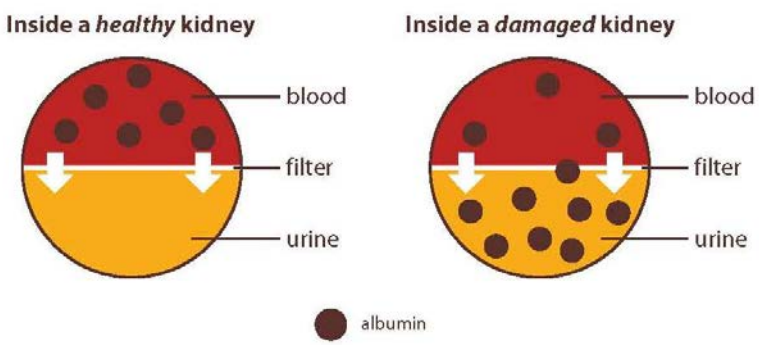
T.C. has kidney damage and normal kidney function

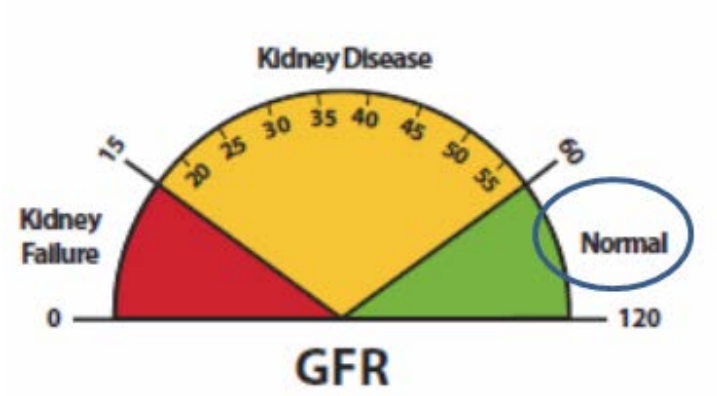
KIDNEY DAMAGE

- Urine albumin-to-creatinine ratio (UACR) 1,356
- Normal is 30 or less

KIDNEY FUNCTION

- Serum creatinine 1.0
- Estimated glomerular filtration rate (eGFR) > 60





KIDNEY DAMAGE
Urine albumin-to-creatinine ratio (UACR) 1,356
Normal is 30 or less

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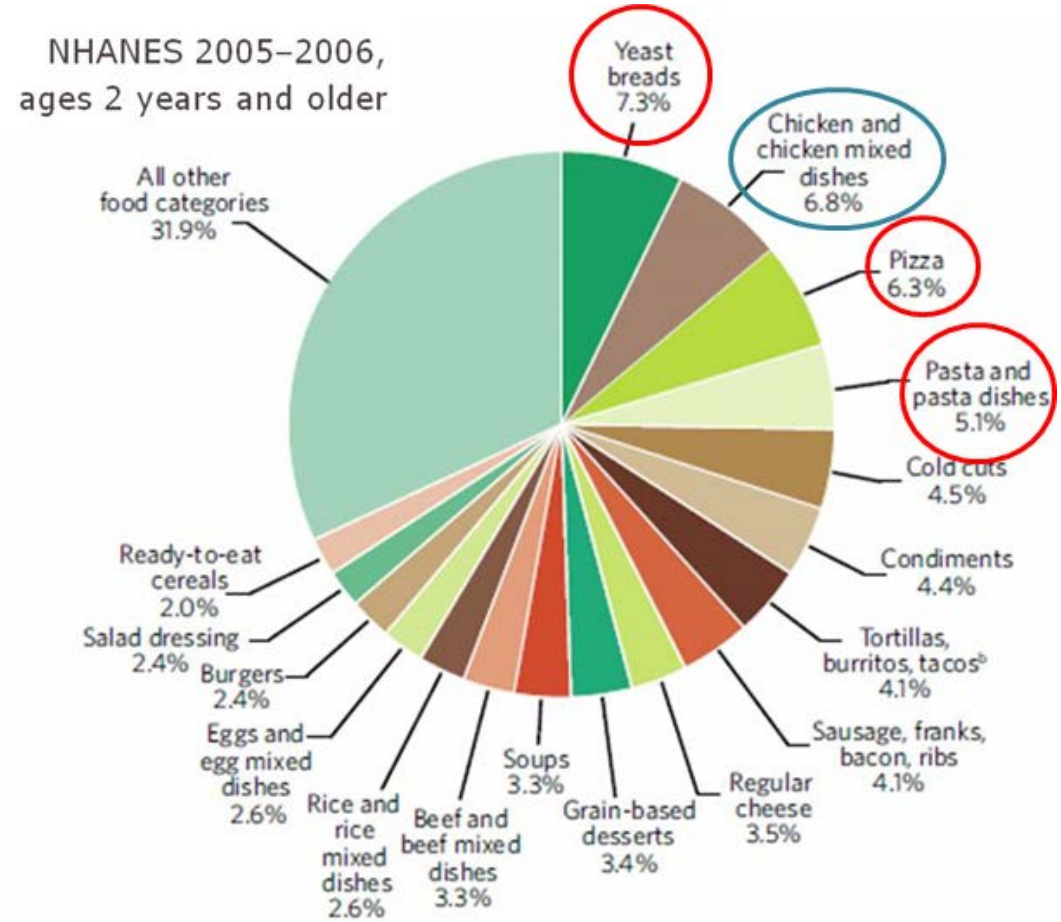
Interventions for reducing urine albumin

- Achieve good control of diabetes early; may help prevent albuminuria
- Control blood pressure
- Reduce sodium intake
- Reduce weight (if obese)
- Reduce protein intake, if excessive
- Achieve tobacco cessation
- Treat infections

Blood pressure control is KEY

- Hypertension:
  - Target blood pressure < 140/90.
  - Angiotensin converting enzyme inhibitors (ACE) or angiotensin receptor blockers (ARBs) are commonly prescribed.
  - ACEi and ARBs reduce urinary excretion of albumin and potassium.
  - Limit sodium to 2,300 mg per day.
  - Avoid salt substitutes.

Many foods contribute to sodium intake



Reference: Dietary Guidelines for Americans, 2010

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Step 1: Choose and fix foods with less salt and sodium

The amount listed is for one 1-cup serving. If you eat two servings, the amount doubles.

Nutrition Facts

Serving Size: 1 cup (228g)

Servings Per Container: 2

Amount Per Serving	
Calories: 260 **Calories from Fat:** 120	
	% Daily Value*
Total Fat 13g	20 %
Saturated Fat 5g	25 %
Trans Fat 2g	
Cholesterol 30mg	10 %
Sodium 660mg	28 %
Total Carbohydrate 31g	10%
Dietary Fiber 0g	0 %
Sugars 5g	
Protein 5g	

Vitamin A	4%	Vitamin C	2%
Calcium	15%	Iron	4%

* Percent Daily Values are based on a 2,000 calorie diet.

This package has two 1-cup servings.

One serving has 28% Daily Value of sodium.

- 5% or less is low.
- 20% or more is high.

For this food label, 28% Daily Value is **high** for sodium.

One serving has 660 milligrams of sodium.

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Blood pressure medications may lower urine albumin <u>and</u> increase risk for hyperkalemia

- These medications include:
  - Angiotensin converting enzyme inhibitors (ACE)
    - Name ends with "PRIL"
  - Angiotensin receptor blockers (ARBs)
    - Name ends with "SARTAN"
- Limit dietary potassium when serum level is elevated.
  - Reference ranges vary; some labs use 3.5-5.0 as normal

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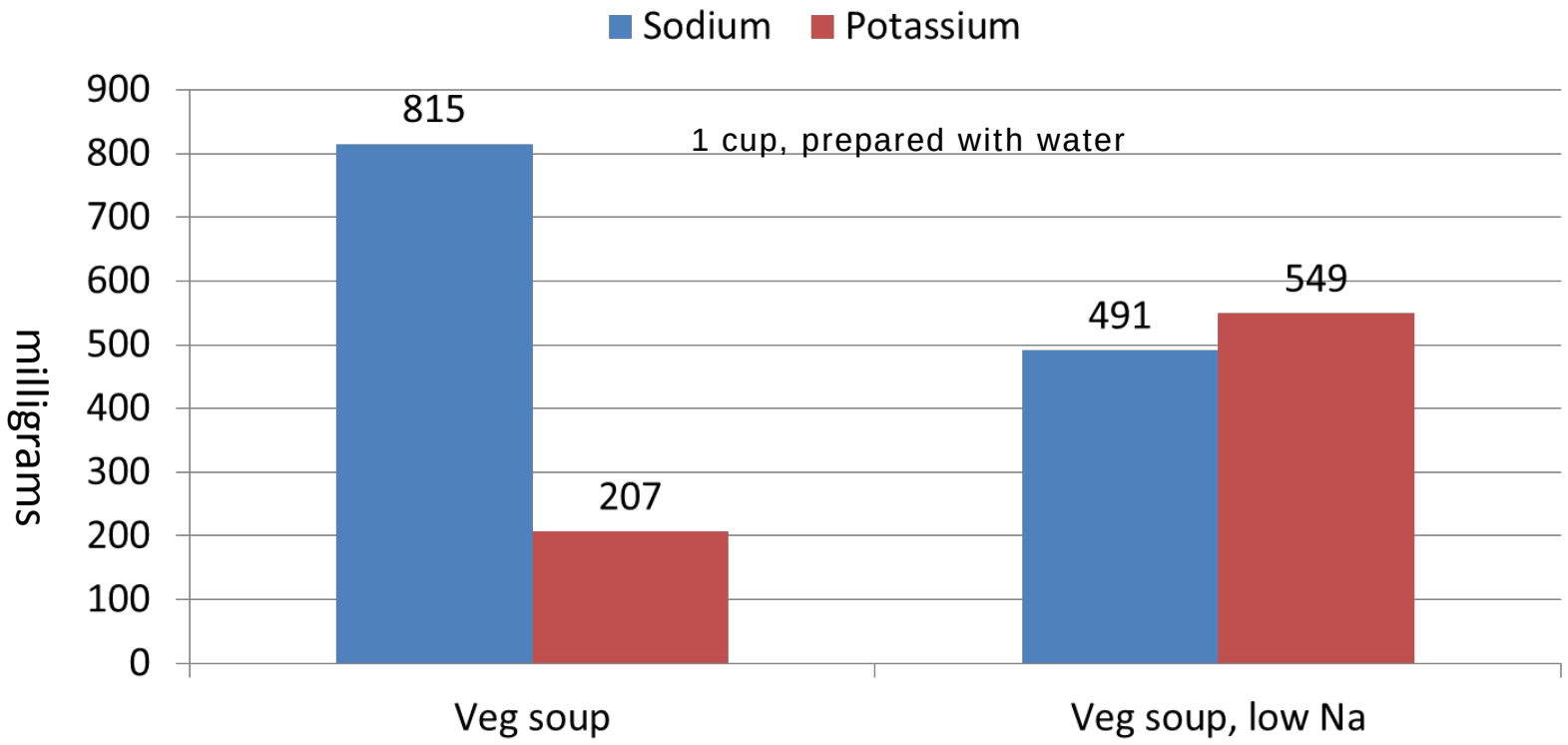
Lower sodium items like canned soups may have potassium chloride instead of salt



Check ingredient list for potassium chloride in lower sodium items.

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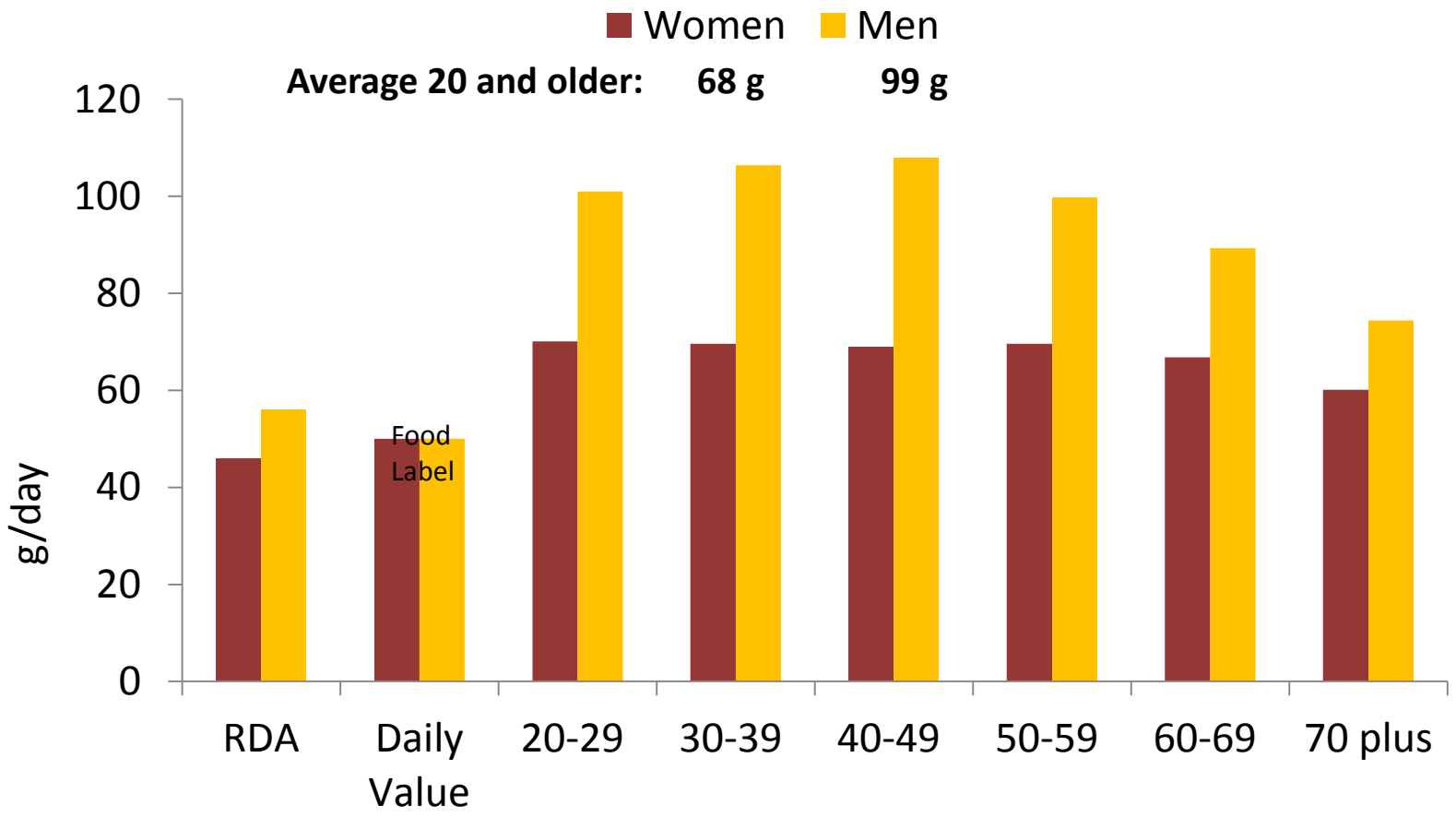
Most Americans eat too much protein

What We Eat in America, NHANES 2009–2010



www.ars.usda.gov (2012), IOM, 2013; FDA, 2013

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High protein diets are <u>not recommended</u>

- <u>Animal protein</u> intake may be a risk factor for increased urine albumin excretion in hypertension *and* diabetes.
- Protein may increase GFR and renal blood flow rates. Animal protein may have greater effect than plant protein.
- Dietary protein is a source of nitrogen, phosphorus (P), potassium (K), and metabolic acids that need to be filtered and excreted by the kidneys. Some may have added sodium.

Friedman. *Am J Kidney Dis* 2004; 44(6):950–962;
Bernstein et al. *J Am Diet Assoc* 2007; 107(4):644–650;
Wrone et al. *Am J Kidney Dis* 2003; 41(3):580–587.

Most protein-rich foods contain phosphorus and potassium; some have added sodium

	Amount	Protein (g)	Sodium (mg)	Phosphorus (mg)	Potassium (mg)
Meat	1 ounce	7.0	145	62	105
Poultry	1 ounce	8.2	24	56	70
Fish & seafood	1 ounce	6.5	51	59	82
Beans & peas	¼ cup	4.0	2	60	182
Egg	1 large	6.3	62	86	63
Egg white*	1 large	3.6	55	5	54
Nuts, seeds	½ ounce	3.3	16	70	93
Milk	1 cup	8.3	103	247	382
Soymilk, fortified*	1 cup	6.4	153	250	284

Data from http://www.nal.usda.gov/fnic/foodcomp/cgi-bin/list_nut_edit.pl

Reference: Marcoe et al. J Nutr Educ Behav 2006; 38(6 suppl): S93–S107.

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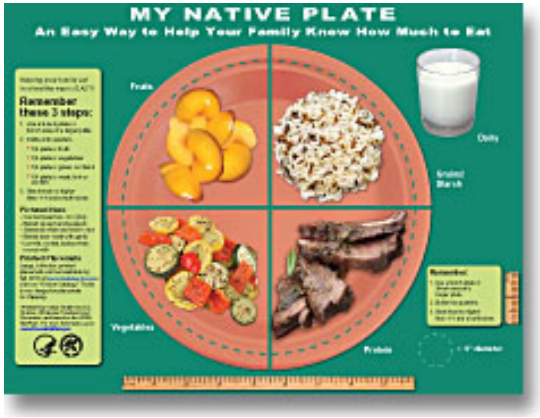
Step 2: Eat the right amount and type of protein

- The RDA for protein is 0.8 g/kg.
- A spontaneous decrease in protein intake may occur as estimated glomerular filtration rate (eGFR) declines.
- CKD patients may report an aversion to certain animal proteins.



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CKD complications and risk for CVD increase as kidney function declines

- Step 3: Choose foods that are heart healthy.
- Fewer functioning nephrons may mean:
  - Blood pressure is harder to control
  - Anemia may develop due to inadequate erythropoietin
  - Inadequate activation of vitamin D (abnormal calcium and phosphorus metabolism) that may lead to bone disease and vascular calcification
  - Toxins build up in the blood, including acid (hydrogen), nitrogen, phosphorus and potassium
  - More frequent low sugars for people with diabetes

CBC and iron studies may be ordered

- Anemia:
  - Damaged kidneys are unable to synthesize sufficient erythropoietin for red cell production.
  - Anemia may cause fatigue and reduced appetite.
  - Taste for meat may decline.
  - May need supplemental oral iron between meals.
  - Supplemental iron should be taken separately from calcium-based phosphate binding medication.
  - Erythropoiesis–stimulating agents and parenteral iron are used more commonly in people on dialysis.

Vitamin D, calcium, phosphorus and PTH levels may be monitored

- Abnormal Mineral Metabolism:
  - Damaged kidneys are unable to activate sufficient vitamin D.
  - Abnormal levels of vitamin D, calcium, phosphorus, parathyroid hormone and fibroblastic growth factor–23 may develop.
  - Different types of renal bone disease may develop.
  - Vascular calcification is a cardiovascular risk factor.
  - Limit dietary phosphorus as needed.
  - Added phosphorus is absorbed more efficiently than natural phosphorus.
  - Avoid foods and beverages with added “phos”.
  - Supplemental vitamin D and phosphate binding medication may be prescribed.
  - Active vitamin D may increase both serum calcium and phosphorus levels.
  - Take binders with meals.

Serum bicarbonate < 22 mEq/L may indicate chronic metabolic acidosis

- Metabolic Acidosis
  - Damaged kidneys are unable to produce enough bicarbonate and cannot excrete excess acid.
  - Accelerates muscle degradation.
  - Reduces albumin synthesis.
  - Exacerbates bone disease.
  - May impair glucose tolerance.
  - Animal protein is a source of metabolic acid.
  - Eating less protein may increase serum bicarbonate.
  - Supplemental base such as sodium bicarbonate may be prescribed. Monitor blood pressure closely when used.

COUNSELING

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Exchanges

Diabetic Exchanges	Carbohydrate (g)	Protein (g)	Fat (g)	Calories
Starch	15	0–3	0–1	80
Fruit	15	-	-	60
Milk	12	8	0–8	100–160
Other carbohydrates	15	Varies	Varies	Varies
Non–starchy veg.	5	2	-	25
Meat/meat substitutes	-	7	0–8+	45–100
Fats	-	-	5	45
Alcohol	Varies	-	-	100

Reference: Adapted from
http://nutritioncaremanual.org/vault/editor/docs/Choose_Your_Foods_lists_bw_Layout_1.pdf

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Selected nutrient in the USDA Food Pattern

Food Group	Protein (g)	Sodium (mg)	Phosphorus (mg)	Potassium (mg)
Grains (1 oz.) Whole	2.4	87	85	91
Refined	2.2	153	33	29
Vegetables (1/2 cup)				
Dark-green	1.6	30	39	229
Red & orange	0.7	41	25	214
Beans & peas	8.0	3	119	363
Starchy	1.7	5	43	286
Other	0.9	57	21	162
Fruit and juices (1/2 cup)	0.7	3	17	213
Milk (1 cup)	8.3	103	247	382
Meat & beans (1 oz.)	6.9	93	63	91
Oils (1 tsp.)	0	13	0	0
Added sugars	0	0	0	0
Solid fats	0	16	1	2

Reference: Marcoe et al. *J Nutr Educ Behav* 2006; 38(6 suppl): S93–S107.

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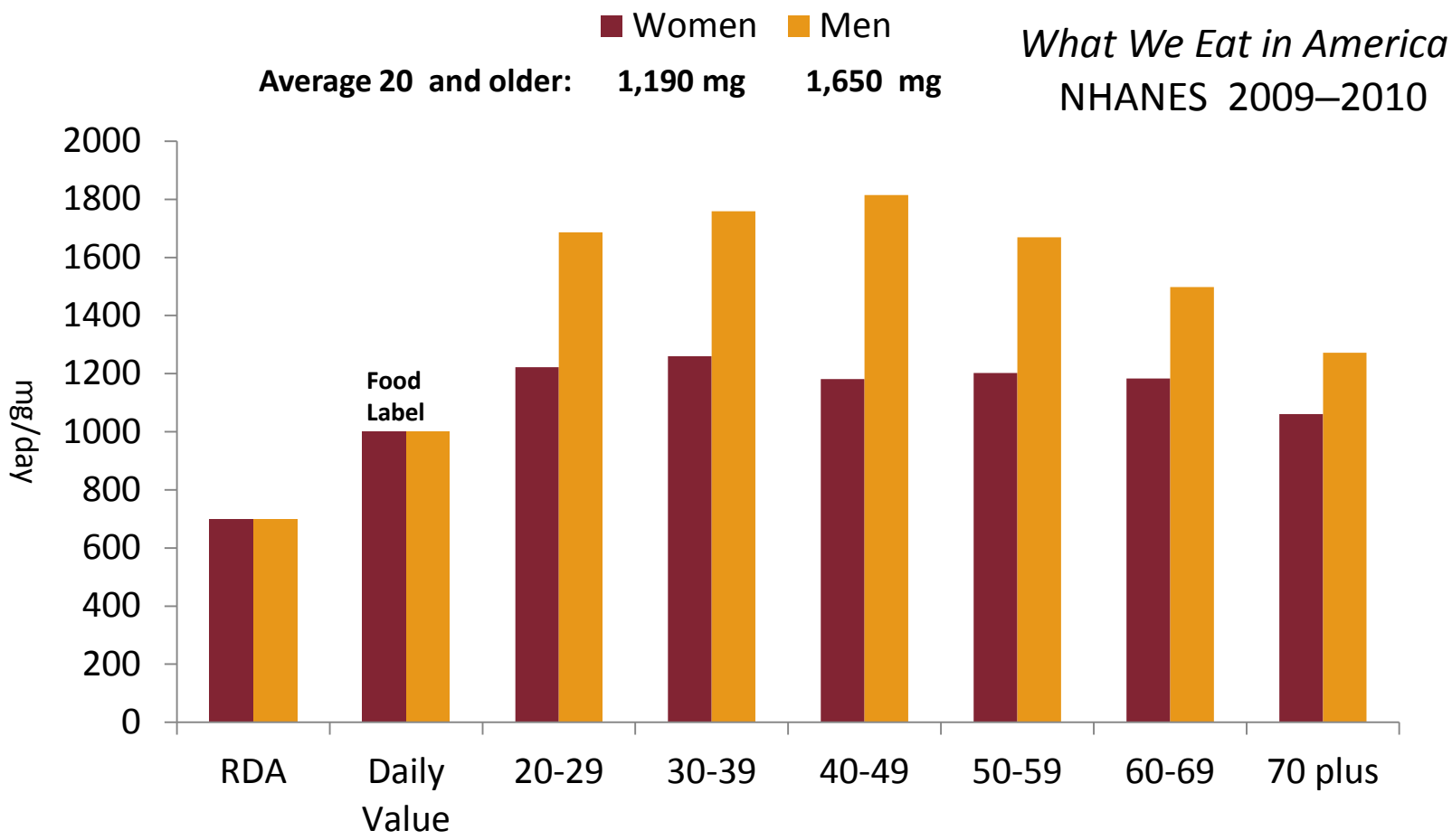
Type of carbohydrate may matter in diabetic kidney disease

Carbohydrate choice	Nutrients of concern for CKD
Milk	Protein, sodium, phosphorus, potassium
Processed grains	Sodium
Whole grains	Phosphorus, potassium
Legumes	Protein, phosphorus, potassium
Starchy vegetables	Potassium
Fruit	Potassium
Sweets and added sugars	May have added phosphorus

Most adults exceed the RDA for phosphorus



ars.usda.gov (2012), FDA (2012), IOM (1997)

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Step 4: Choose foods with less phosphorus

- **Natural phosphorus**
- **40–60%** absorbed
  - Dairy products
  - Meat, poultry, fish
  - Soy (soy milk, tofu)
  - Nuts and seeds
  - Dried beans and peas
  - Whole grains

- **Added phosphorus**
- **> 90%** absorbed
  - Food additives
  - Dietary supplements
  - Calcium fortification

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Kalantar-Zadeh et al. *Clin J Am Soc Nephrol* 2010; 5(3):519–530.

Many products may have added phosphate

Baked goods	Self-rising flour, cake mix, waffle mix, pancake mix, muffin mix, reduced sodium mixes	Monocalcium phosphate Dicalcium phosphate Calcium acid phosphate
Beverages	Dry mixes, fruit juices, soymilk	Tricalcium phosphate
Cereals	Cooked cereals, extruded dry cereals	Tricalcium phosphate
Dairy	Grated cheese, instant puddings	Monocalcium phosphate
Fruit & vegetables	Canned fruits and vegetables	Monocalcium phosphate
Potatoes	Baked potato chips	Monocalcium phosphate
Pharmaceuticals	Vitamin-mineral supplements, enteral products, prescription and over-the-counter tablets	Tricalcium phosphate Dicalcium phosphate

Reference: Adapted from http://www.foodadditives.org/phosphates/phosphates_used_in_food.html

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Use ingredient list to find added phosphorus; look for PHOS

- Phosphorus is not required on Nutrition Facts labels.
- Nutrition Facts labels may list phosphorus, and the % Daily Value used is 1,000 mg.
- Read ingredients for “PHOS” additives.
- Choose a different food if PHOS is listed.

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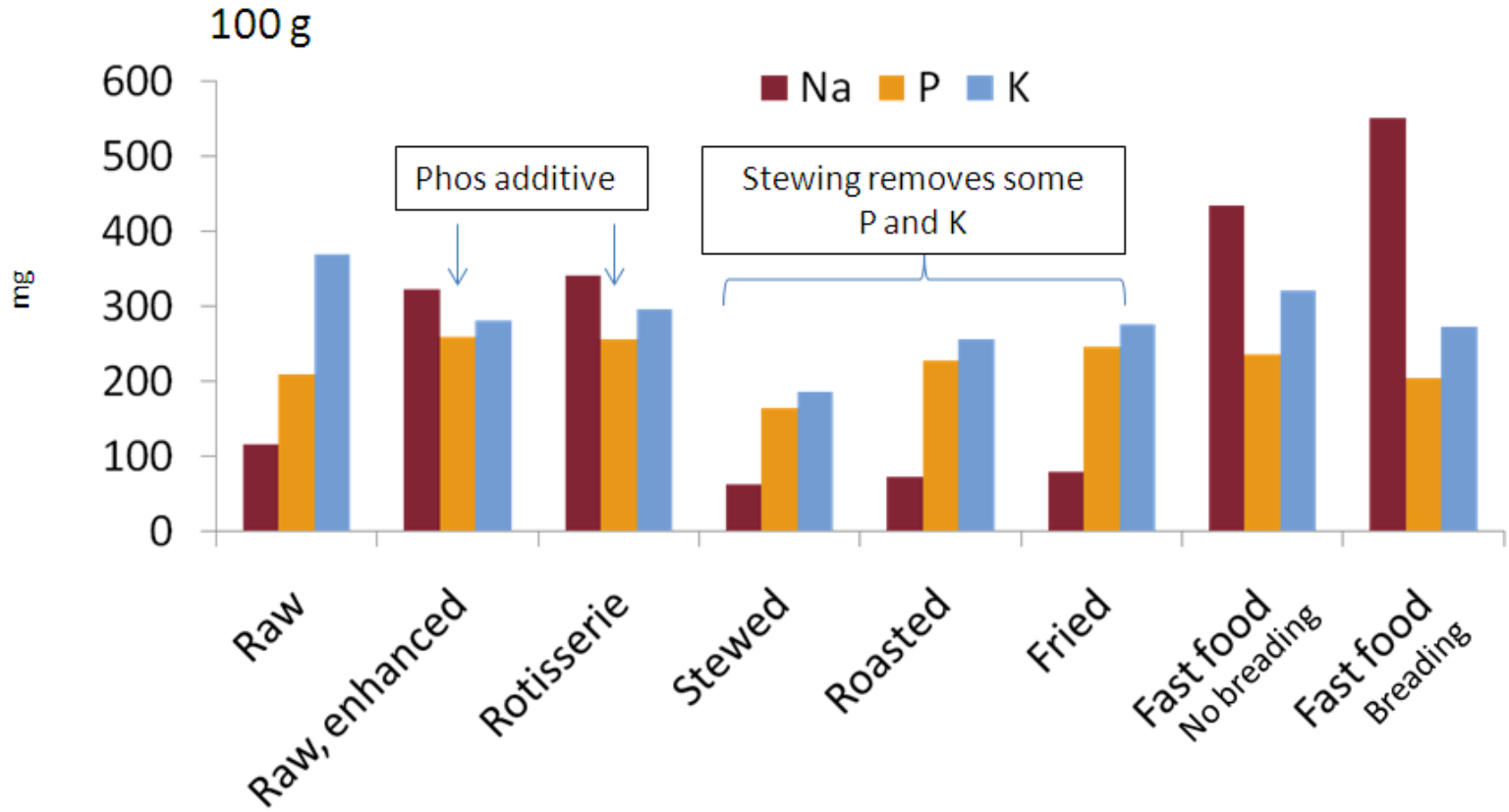
Chicken may be a source of added sodium, phosphorus and potassium



Na = Sodium P = Phosphorus K = Potassium

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Step 5: Choose foods that have the right amount of potassium (when needed)

- Potassium-rich foods
- Salt substitutes
- Herbs and dietary supplement (examples)
  - Noni juice (56 mmol/L)
  - Alfalfa
  - Dandelion
  - Horsetail
  - Nettle
- Medications:
  - K supplements
    - KCl, K citrate
  - Impair excretion
    - ACEi
    - ARBs
    - K+-sparing diuretics
    - Nonsteroidal anti-inflammatory drugs
- Potassium food additives

Palmer, *N Eng J Med* 2004;351(6):585–92;
Hollander-Rodriguez & Calvert, Am Fam Physician 2006;73(2):283–90.

Which is best to treat hypoglycemia in DKD?

Beverage	Serving	Sodium (mg)	Phosphorus (mg)	Potassium (mg)
Diet Cola	12 oz.	28	32	28
Cola	12 oz.	15	37	7
Lemon-lime soda pop	12 oz.	33	0	4
Milk, 1%	8 oz.	107	232	366
Milk, 1%, protein-fortified	8 oz.	127	245	397

Nutrient analysis from USDA National Nutrient Database for Standard Reference
http://ndb.nal.usda.gov/ndb/search/list

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Prepare foods from scratch

Breakfast	Amount	Sodium (mg)	Phosphorus (mg)	Potassium (mg)
Pancake, plain, homemade	4 inch	167	60	50
Pancake, white flour, complete	4 inch	239	127	66
Pancake, whole-wheat, incomplete	4 inch	252	164	123
Hotcake (fast food)	One (of 3)	178	129	86
Egg, white, raw, fresh	1 large	55	5	54
Egg, yolk, raw, fresh	1 large	8	66	19
Commodity dry egg mix	2 Tbsp.	100	78	64
Egg substitute	¼ cup	119	43	128
Scrambled egg (fast food)	One (of 2)	98	133	71

Reference: http://www.nal.usda.gov/fnic/foodcomp/search/

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Enhanced and fortified foods may have sodium, phosphorus, and potassium

Food	Amount	Sodium (mg)	Phosphorus (mg)	Potassium (mg)
Pork tenderloin	100 g (3 oz.)	57 48	267 227	421 358
Pork tenderloin, enhanced	100 g	231	316	567
Soymilk	1 cup	124	126	287
Soymilk with added calcium	1 cup	90	151	156
Soymilk, chocolate	1 cup	129	124	347
Orange juice	½ c.	1	21	248
Orange juice with added calcium *	½ c.	2	59 *	222

* Phosphorus content varies among brands, depending upon calcium compound used (calcium phosphate, calcium citrate, etc.).

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Hypoglycemia

Unexplained improvement in diabetes control and/or increased frequency of hypoglycemia may indicate CKD is progressing.

Treat hypoglycemia without adding potassium *or* phosphorus

- Review medication list for ACEi or ARB.
  - If prescribed, discuss use of glucose tablets or low-potassium juice to treat hypoglycemia.
- Avoid colas and other beverages with added phosphoric acid.
- Milk is a natural source of phosphorus and potassium.
- Chocolate is a natural source of potassium.

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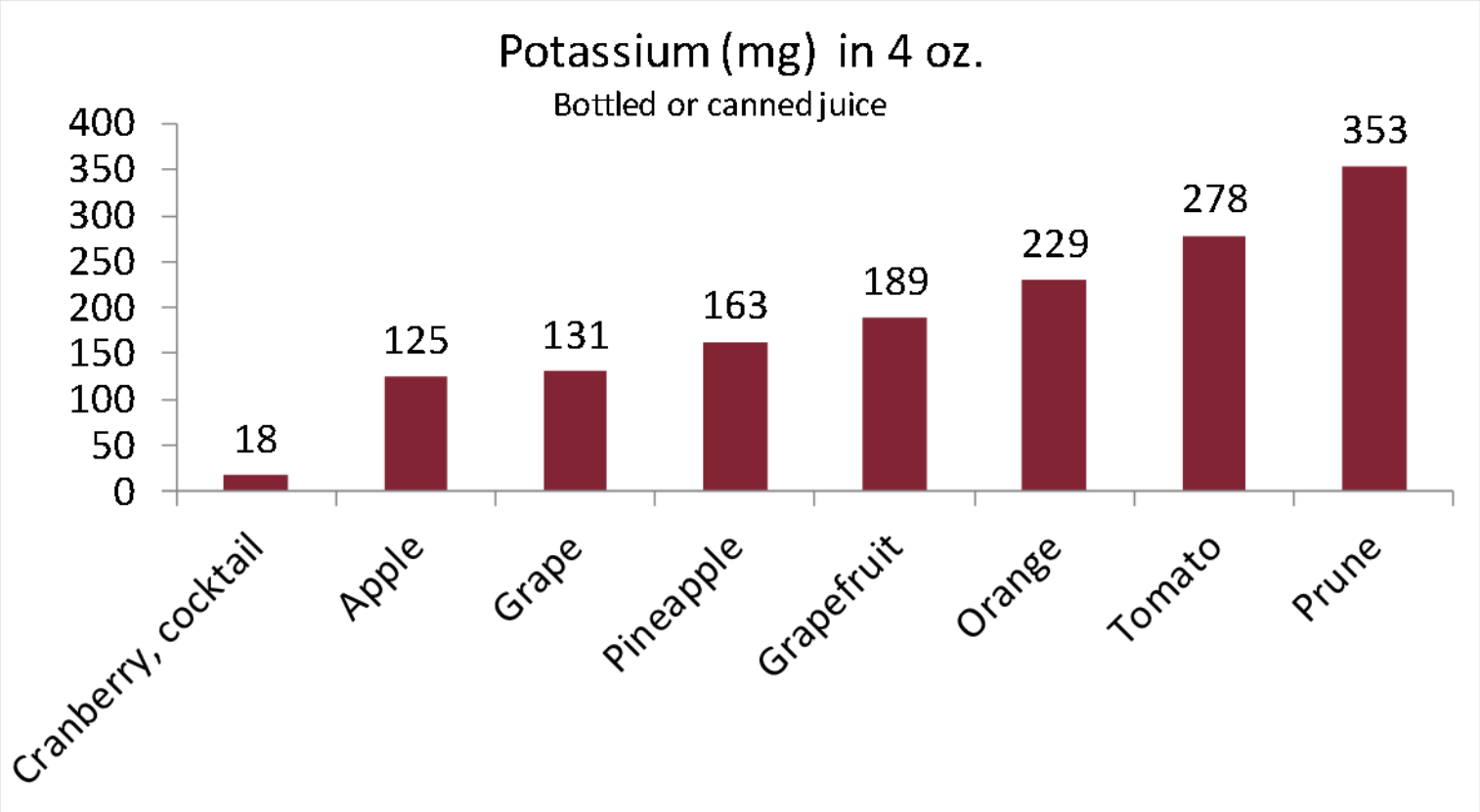
Any "juice" can treat hypoglycemia, even those low in potassium



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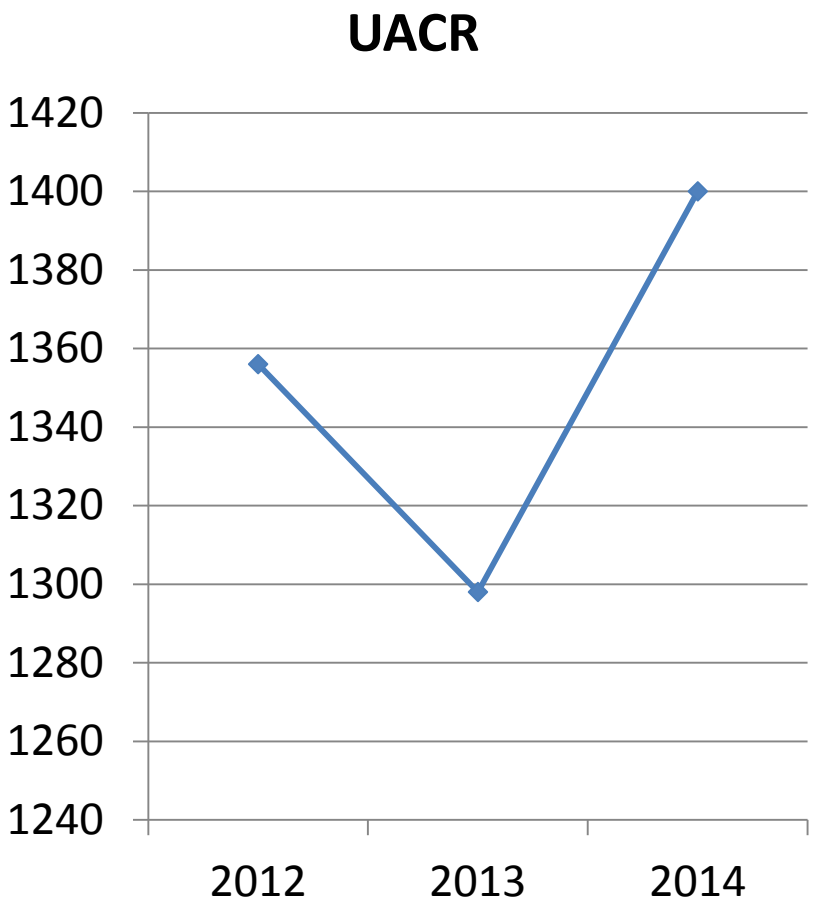
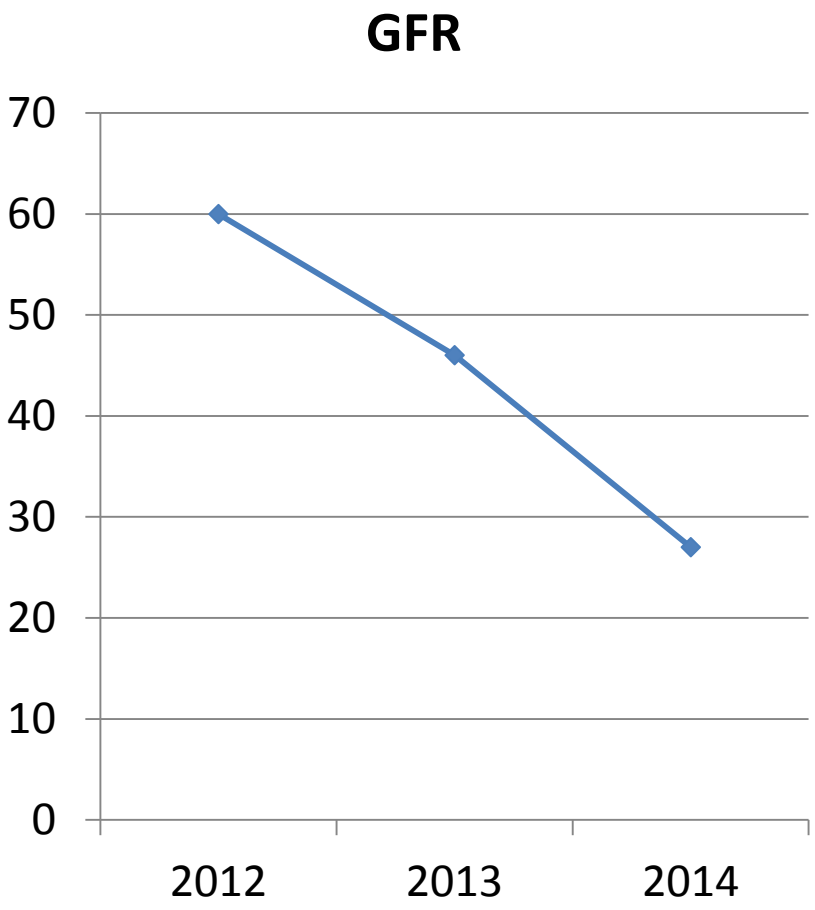
T.C.'s kidney disease progressed rapidly





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The Steps for Eating Right

- Carbohydrates still count:
  - Choose low potassium juice to treat hypoglycemia.
  - Whole grains have more phosphorus and potassium than refined grains.
  - Not all of the phosphorus in whole grains is absorbed (vs. added “phos”).

1. Choose and fix foods with less salt and sodium:
   - Check for ingredient label for sodium.
   - Some lower sodium items may use potassium chloride as sat substitute.
2. Eat the right amount and type of protein:
   - Eat smaller portions of protein foods.
   - Protein is a source of phosphorus, potassium, metabolic acid and nitrogenous waste. Many processed proteins have added sodium, too.

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Individualize Diet Based on Current Needs

3. Choose foods that are heart healthy.
   - Bake, roast, or stew foods instead of frying.
   - Trim fat from meat and remove skin from poultry before eating.
4. Choose foods with less phosphorus.
   - Many packaged foods have added phosphorus. Check for “phos”.
   - When treating lows consider: colas have phosphoric acid, milk substitutes and bottled teas may have added “phos”, milk has natural phosphorus.
5. Limit dietary potassium when serum level is elevated.
   - ACE or ARB use increases risk for hyperkalemia.
   - Use glucose tablets or low potassium juice to treat hypoglycemia.

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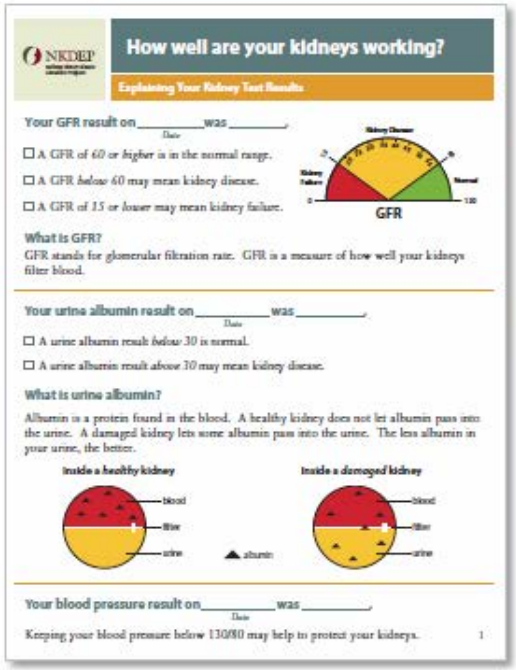
Visual Aids



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How well are your kidneys working?

Explaining Your Kidney Test Results

Your GFR result on _____ was _____.
Date

- ☐ A GFR of *60 or higher* is in the normal range.
- ☐ A GFR *below 60* may mean kidney disease.
- ☐ A GFR of *15 or lower* may mean kidney failure.

GFR

What is GFR?
GFR stands for glomerular filtration rate. GFR is a measure of how well your kidneys filter blood.

Your urine albumin result on _____ was _____.
Date

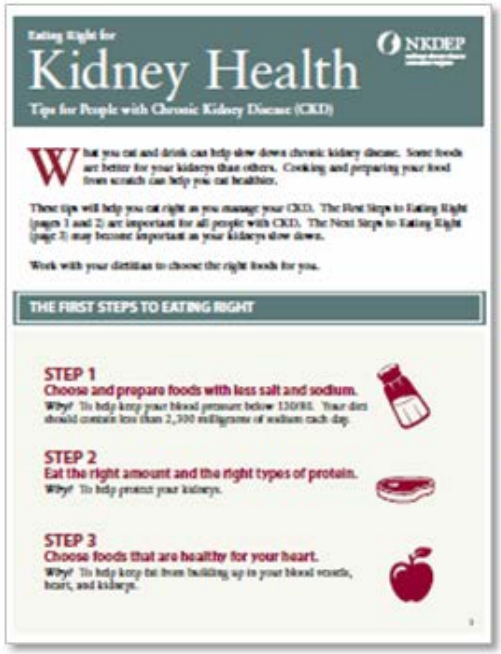
- ☐ A urine albumin result *below 30* is normal.
- ☐ A urine albumin result *above 30* may mean kidney disease.

What is urine albumin?
Albumin is a protein found in the blood. A healthy kidney does not let albumin pass into the urine. A damaged kidney lets some albumin pass into the urine. The less albumin in your urine, the better.

Inside a *healthy kidney* — blood, filter, urine
Inside a *damaged kidney* — blood, filter, urine, albumin

Your blood pressure result on _____ was _____.
Date

Keeping your blood pressure below 130/80 may help to protect your kidneys.



Eating Right for

Kidney Health

NKDEP

Tips for People with Chronic Kidney Disease (CKD)

What you eat and drink can help slow down chronic kidney disease. Some foods are better for your kidneys than others. Cooking and preparing your food from scratch can help you eat healthier.

These tips will help you eat right as you manage your CKD. The First Steps to Eating Right (pages 1 and 2) are important for all people with CKD. The Next Steps to Eating Right (page 3) may become important as your kidneys slow down.

Work with your dietitian to choose the right foods for you.

THE FIRST STEPS TO EATING RIGHT

STEP 1
Choose and prepare foods with less salt and sodium.
Why? To help keep your blood pressure below 130/80. Your diet should contain less than 2,300 milligrams of sodium each day.

STEP 2
Eat the right amount and the right types of protein.
Why? To help protect your kidneys.

STEP 3
Choose foods that are healthy for your heart.
Why? To help keep fat from building up in your blood vessels, heart, and kidneys.

Your

KidneyTestResults

NKDEP

Name _____ Date _____

Chronic Kidney Disease (CKD) Tests	Results	Why It Is Important
Glomerular Filtration Rate (GFR)	CKD is less than 60 Your Result:	GFR estimates how well your kidneys are filtering blood. The goal is to keep your GFR from going down.
Urine Albumin-to-Creatinine Ratio (UACR)	CKD is more than 30 Your Result:	Urine albumin checks for kidney damage. The lower the result, the better.

Other Important Tests	Results	Why It Is Important
Blood Pressure	Goal: Your Result:	High blood pressure makes the heart work harder and can damage blood vessels in the kidneys.
Serum Albumin	Normal: 3.4 to 5.0* Your Result:	Albumin is a protein that helps measure how well you are eating.
Bicarbonate	Normal: More than 22 Your Result:	Bicarbonate measures the acid level in your blood.
Blood Urea Nitrogen (BUN)	Normal: Less than 20 Your Result:	BUN checks how much urea, a waste product, is in your blood.
Potassium	Normal: 3.5 to 5.0* Your Result:	Potassium affects how your nerves and muscles are working. High or low levels can be dangerous.
Calcium	Normal: 8.5 to 10.2* Your Result:	Calcium keeps your bones strong and your heart rhythm steady. CKD can lower the amount of calcium in your bones.
Phosphorus	Normal: 2.7 to 4.6* Your Result:	Phosphorus is important for strong bones and healthy blood vessels. High levels may cause soft bones, hard blood vessels and itchy skin.
Parathyroid Hormone (PTH)	Normal: Less than 65 Your Result:	PTH controls the calcium and phosphorus levels in your blood. It is needed to keep bones and blood vessels healthy.
Vitamin D	Normal: 30 or more Your Result:	Vitamin D is important for bones and heart health.

*Normal range may vary.

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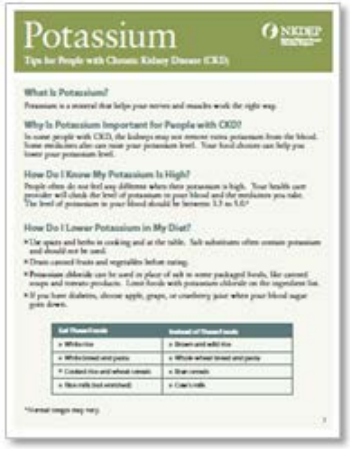
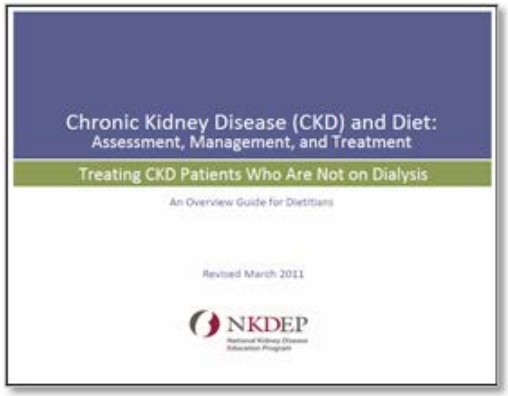
Visual Aids (cont.)





Reference: http://nkdep.nih.gov/resources.shtml

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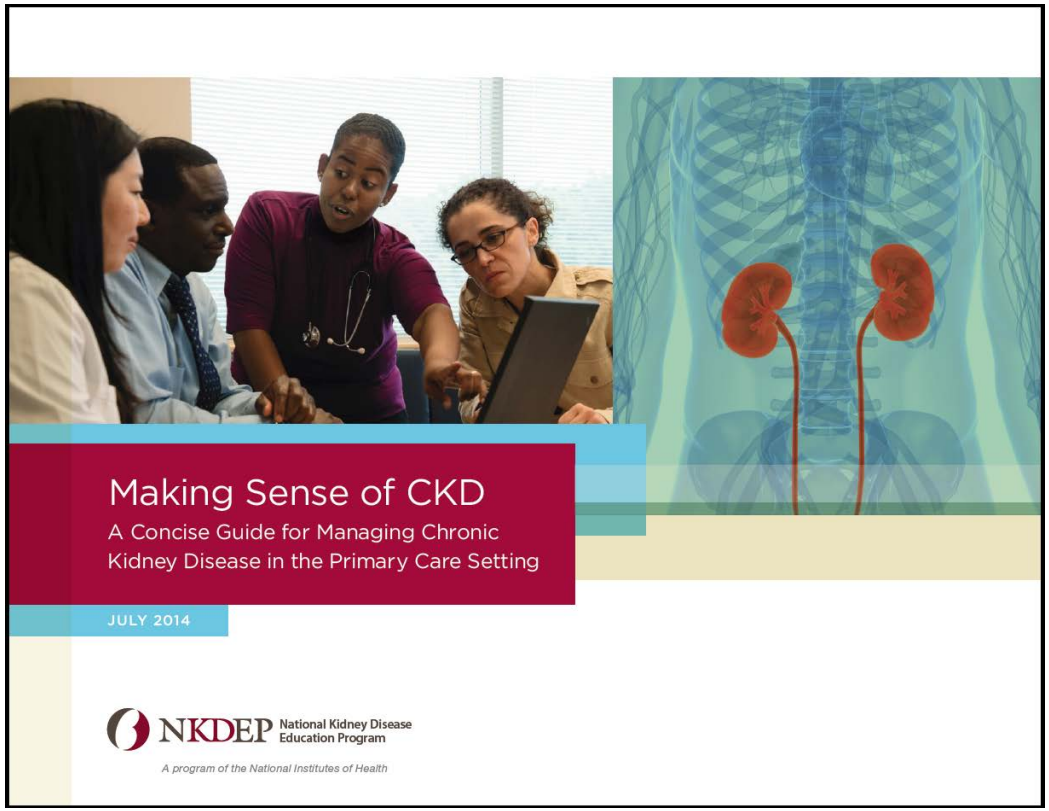
NEW for Primary Care Providers



http://nkdep.nih.gov/resources/ckd-primary-care-guide-508.pdf

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Thank You!

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