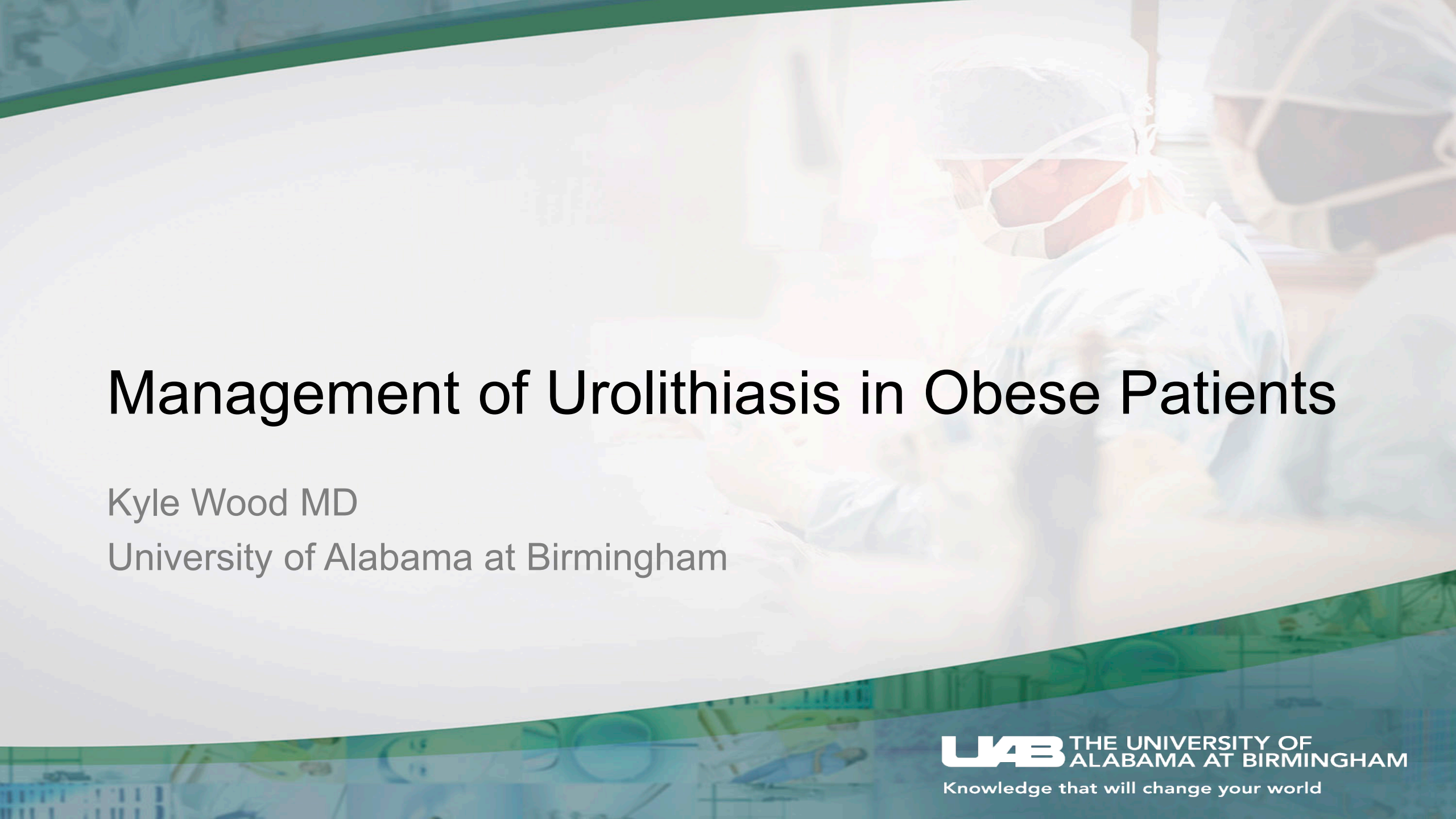




Management of Urolithiasis in Obese Patients

Kyle Wood MD

University of Alabama at Birmingham

Disclosures

- SAB: Novome, Alnylam, Synlogic, Orfan

Management

- Medical/Dietary Management
- Surgical Management

Medical and Dietary Management

- **Epidemiology**
- Stone Composition
- 24 hour urine



Epidemiology: Nephrolithiasis

- Nephrolithiasis affects nearly 11% of men and 7% of women in the United States
- National Health and Nutrition Examination Survey (NHANES)
 - NHANES II (1976-1980): 3.8%
 - NHANES III (1988-1994): 5.2%
 - NHANES (2007-2010): 8.8%
- Men>Women
- Caucasians>African Americans

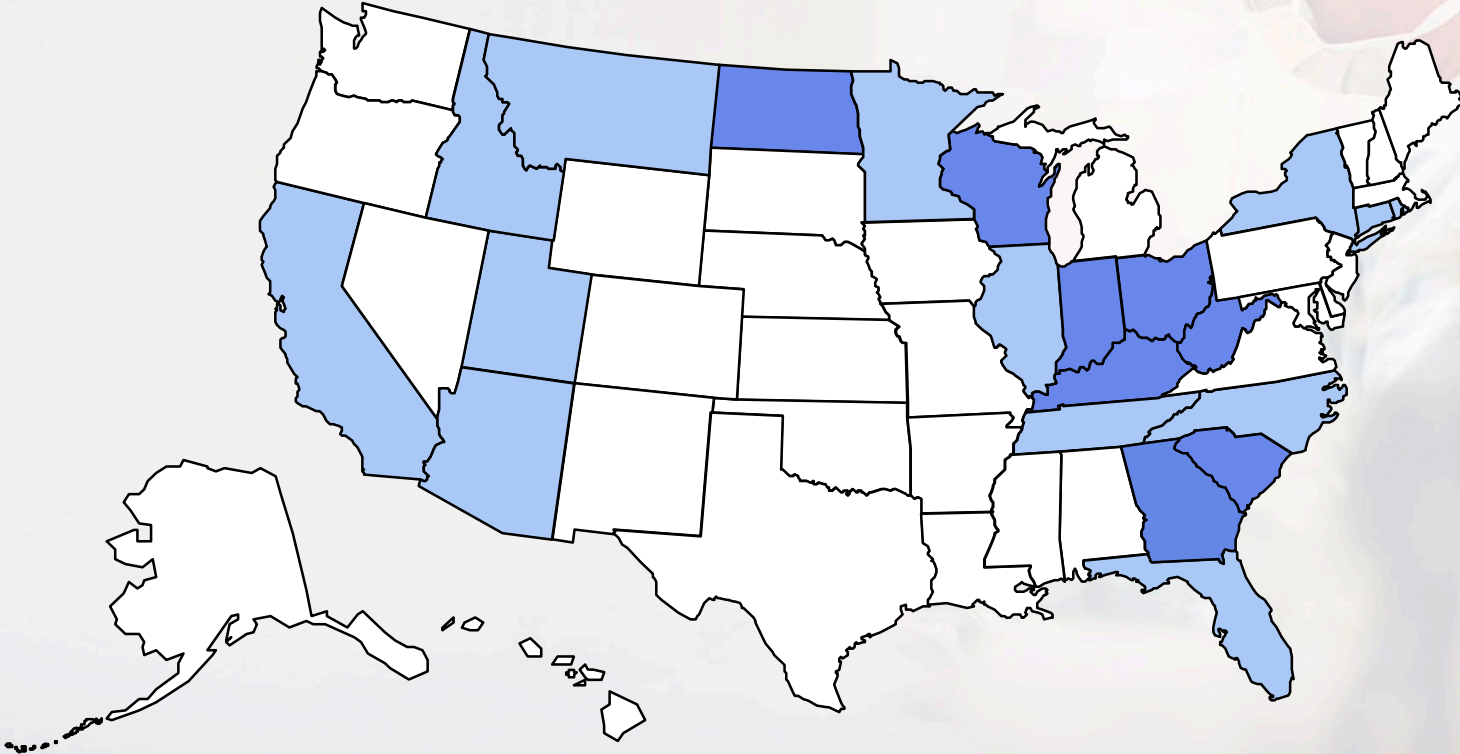


Epidemiology: Obesity

Obesity Trends* Among U.S. Adults

BRFSS, 1985

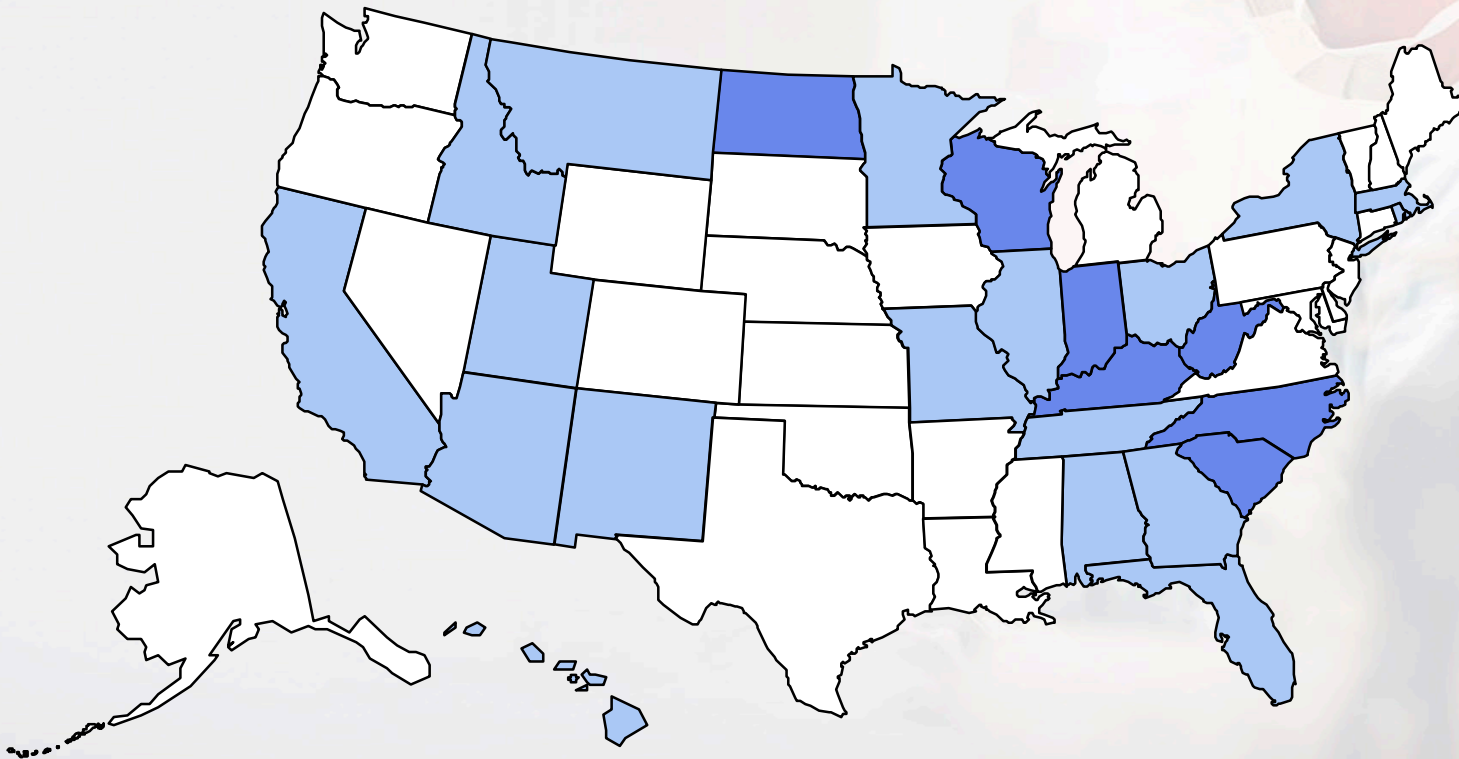
(*BMI ≥ 30 , or ~ 30 lbs overweight for 5' 4" person)



Obesity Trends* Among U.S. Adults

BRFSS, 1986

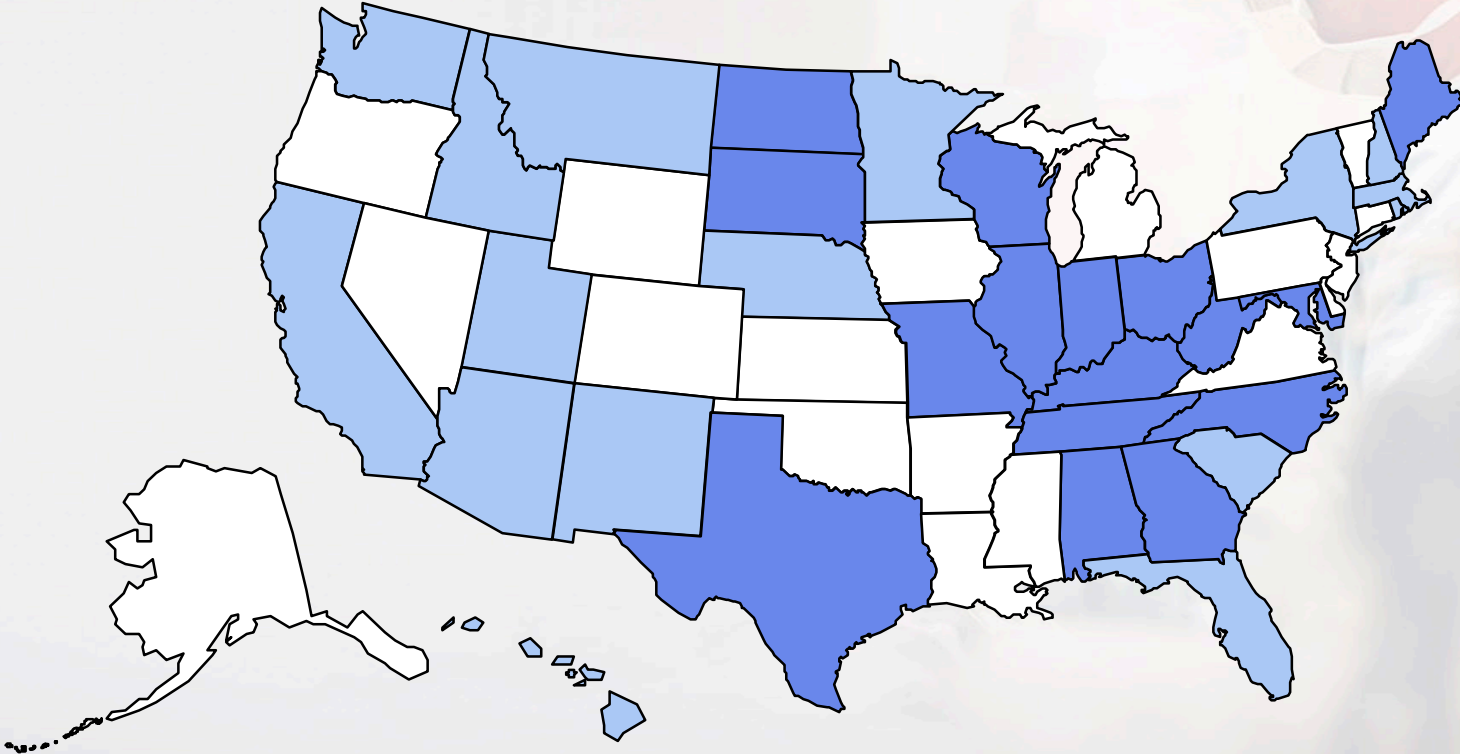
(*BMI ≥ 30 , or ~ 30 lbs overweight for 5' 4" person)



Obesity Trends* Among U.S. Adults

BRFSS, 1987

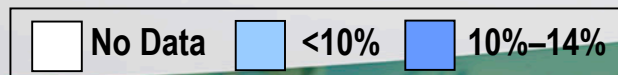
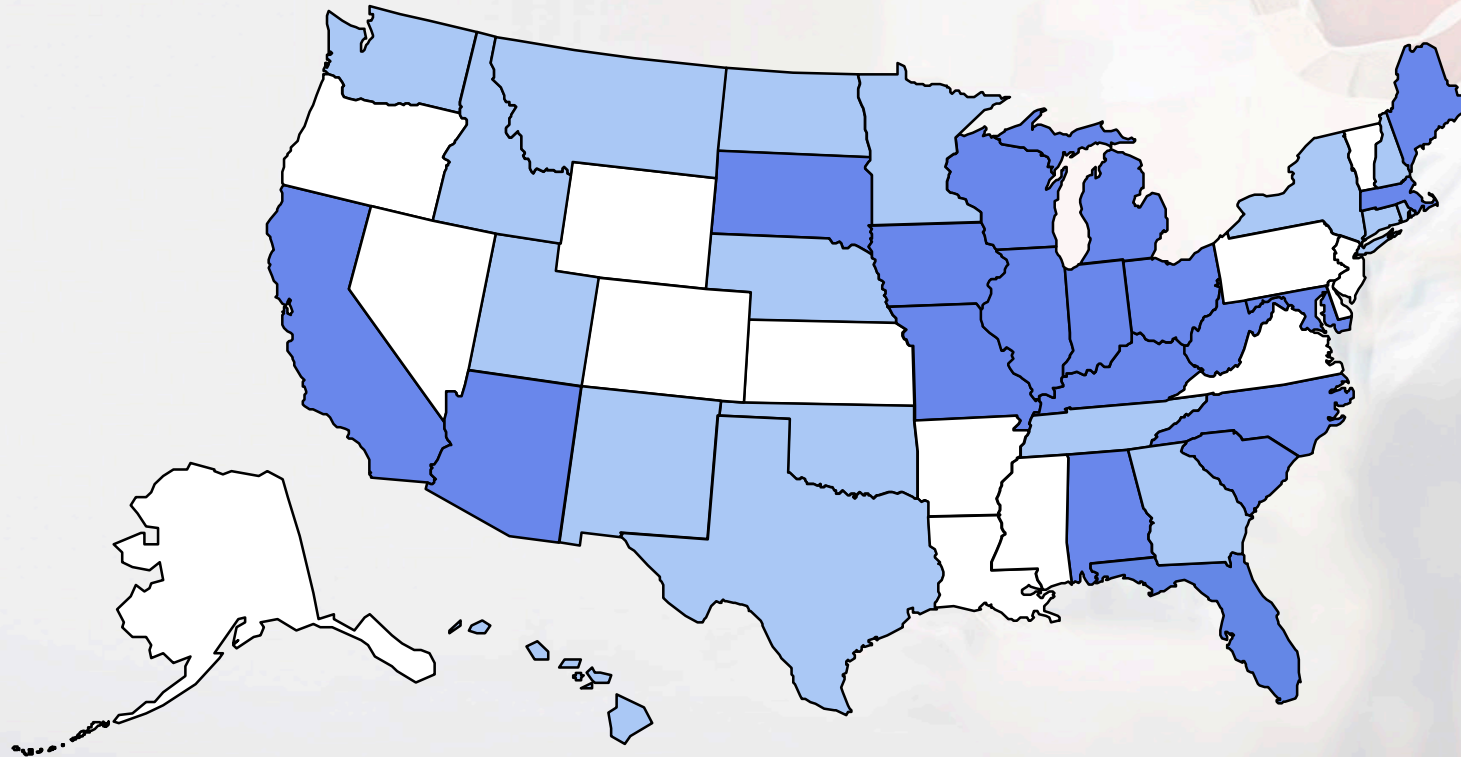
(*BMI ≥ 30 , or ~ 30 lbs overweight for 5' 4" person)



Obesity Trends* Among U.S. Adults

BRFSS, 1988

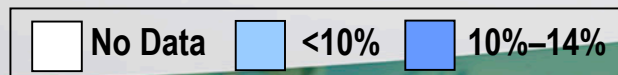
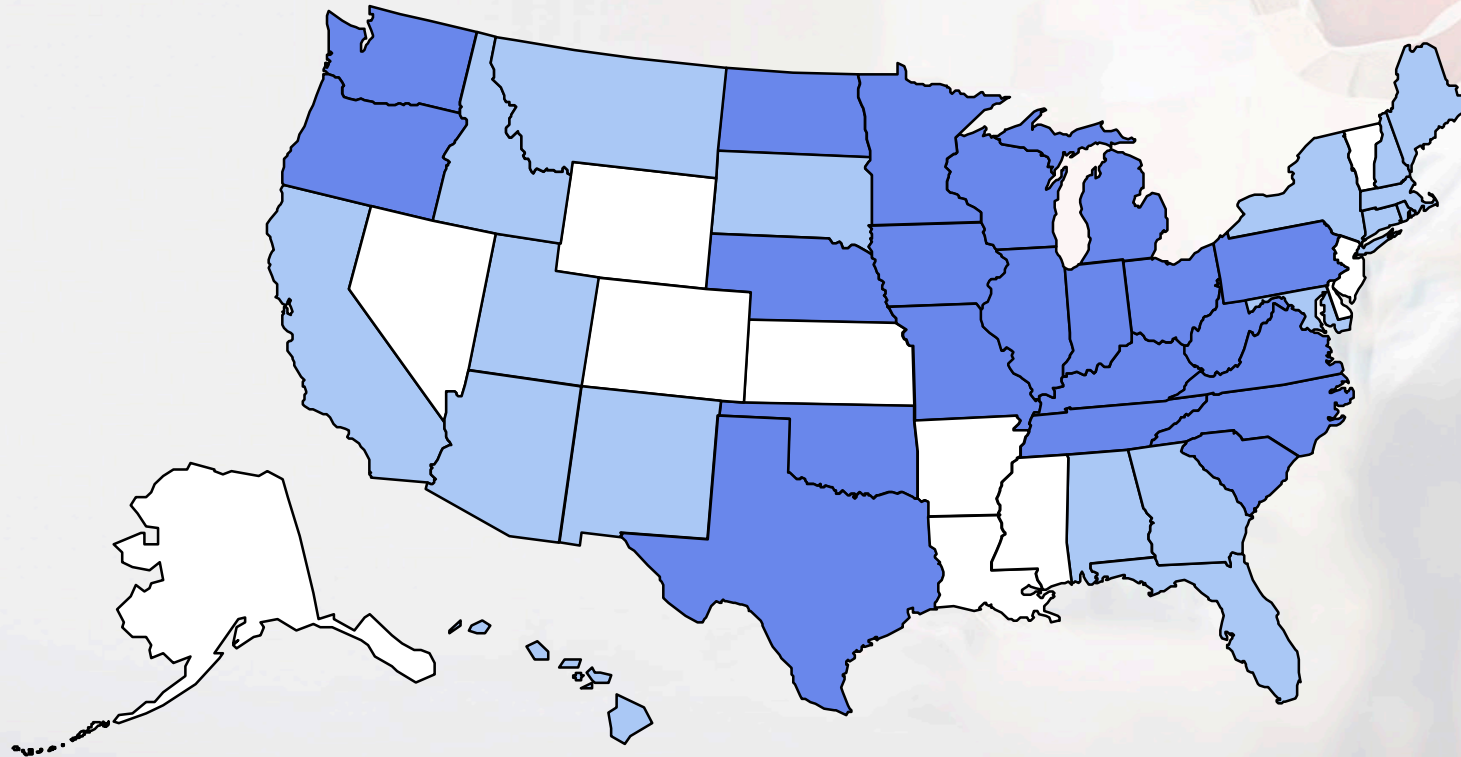
(*BMI ≥ 30 , or ~ 30 lbs overweight for 5' 4" person)



Obesity Trends* Among U.S. Adults

BRFSS, 1989

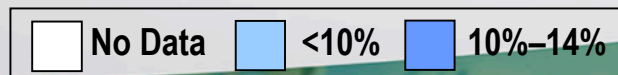
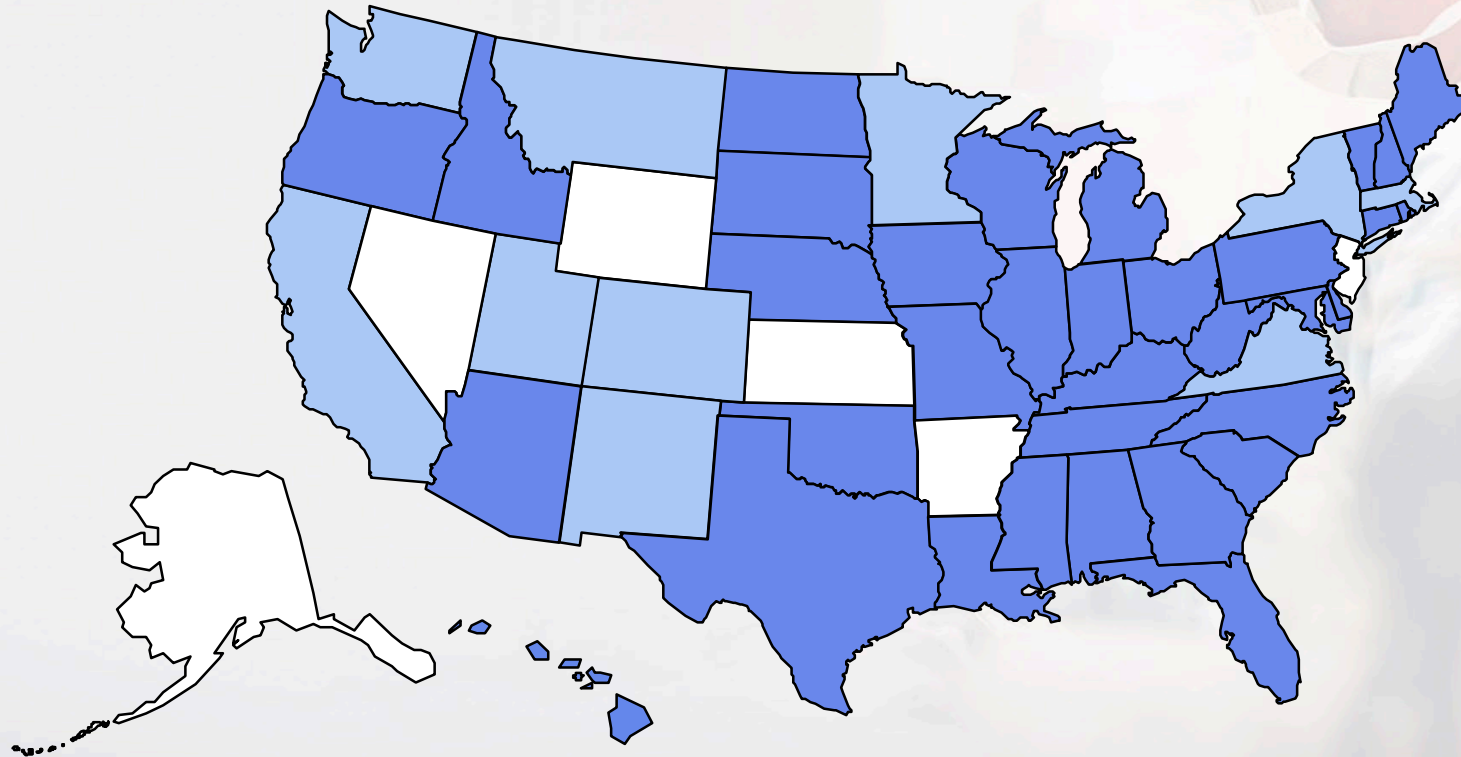
(*BMI ≥ 30 , or ~ 30 lbs overweight for 5' 4" person)



Obesity Trends* Among U.S. Adults

BRFSS, 1990

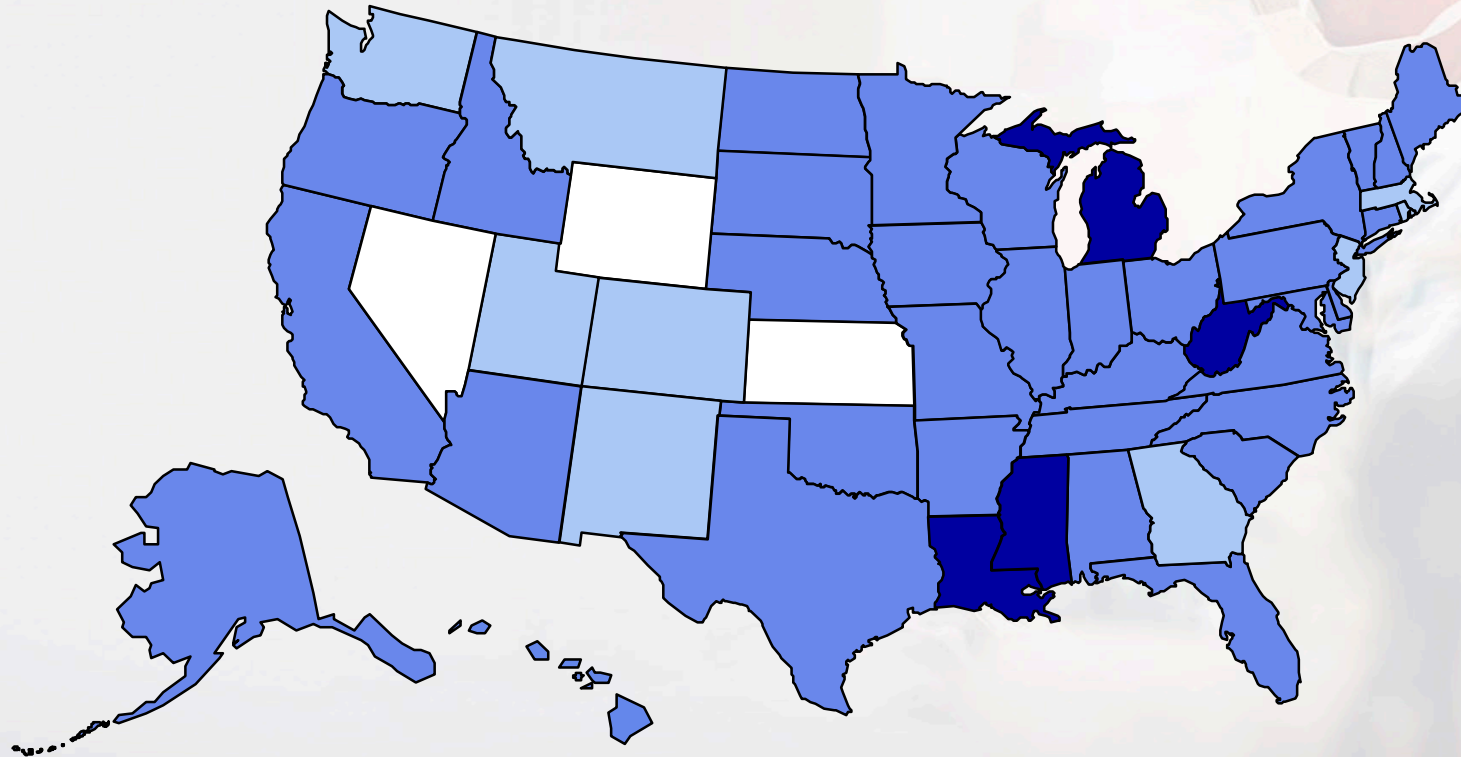
(*BMI ≥ 30 , or ~ 30 lbs overweight for 5' 4" person)



Obesity Trends* Among U.S. Adults

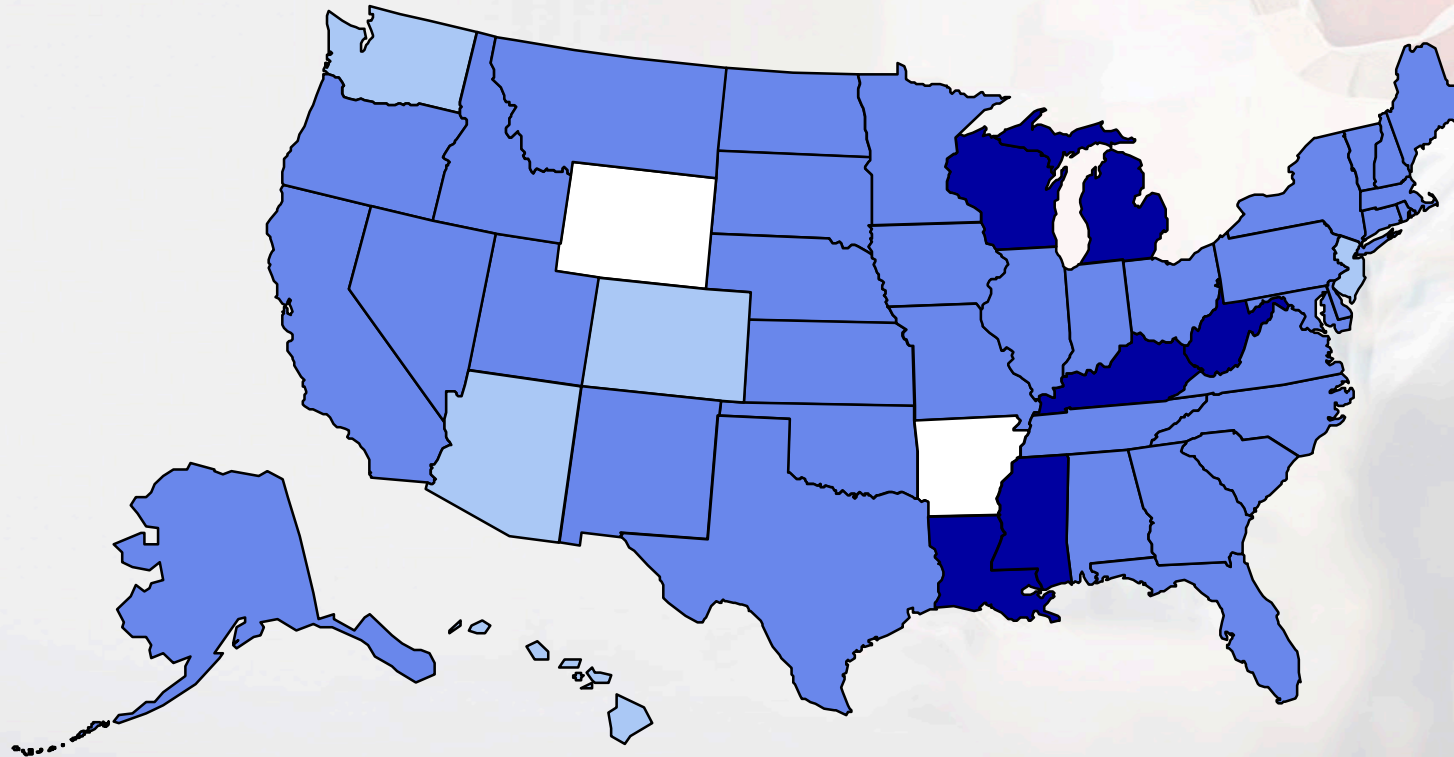
BRFSS, 1991

(*BMI ≥ 30 , or ~ 30 lbs overweight for 5' 4" person)



BRFSS, 1992

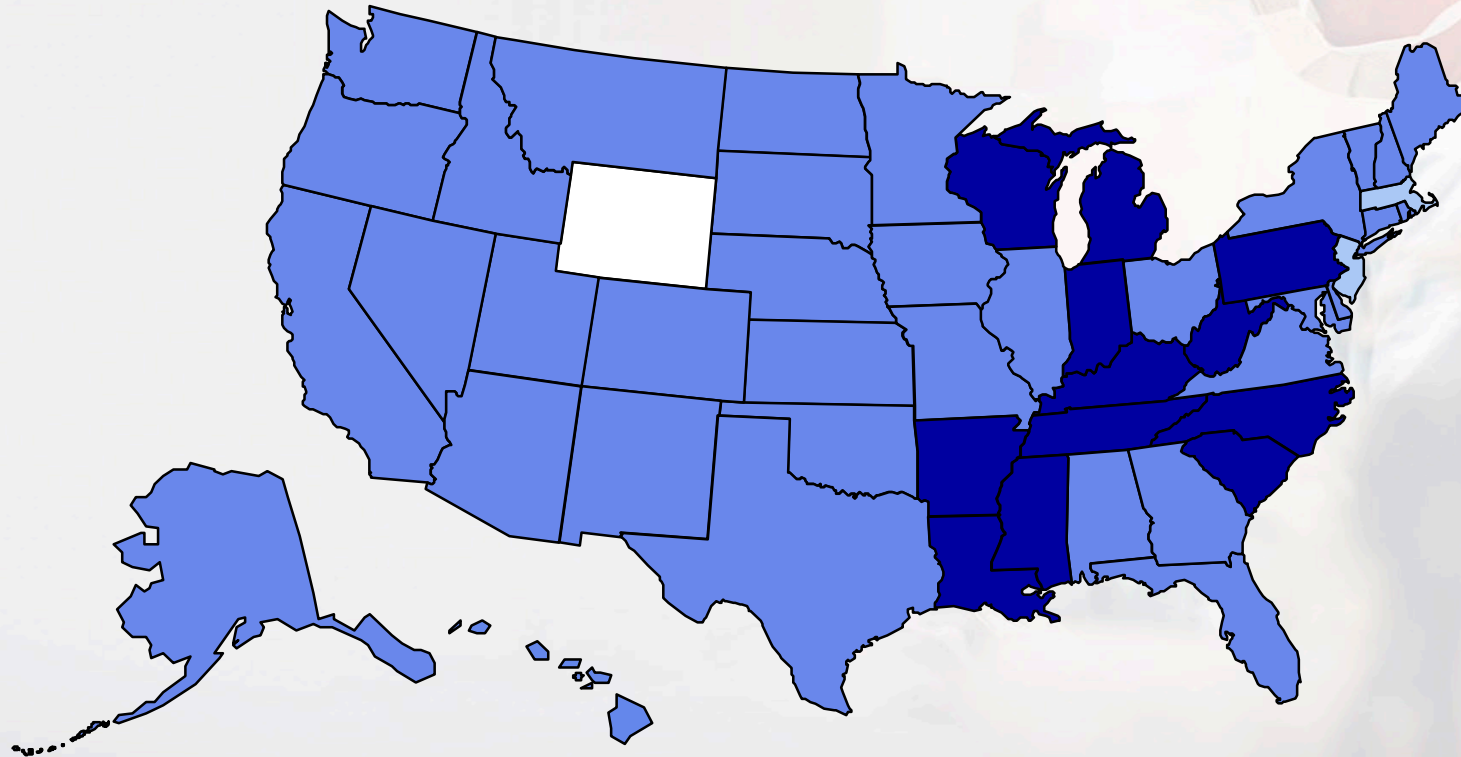
(*BMI ≥ 30 , or ~ 30 lbs overweight for 5' 4" person)



Obesity Trends* Among U.S. Adults

BRFSS, 1993

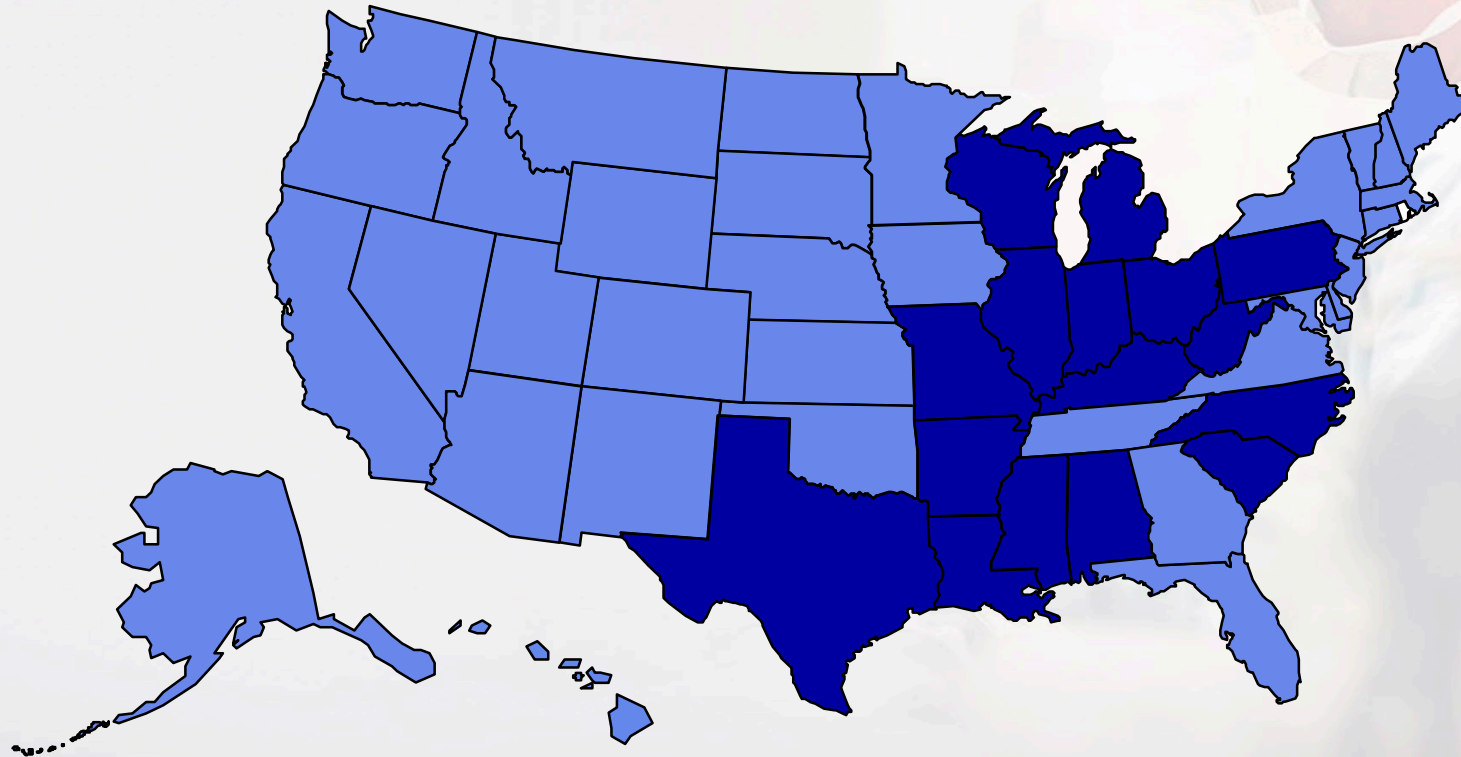
(*BMI ≥ 30 , or ~ 30 lbs overweight for 5' 4" person)



Obesity Trends* Among U.S. Adults

BRFSS, 1994

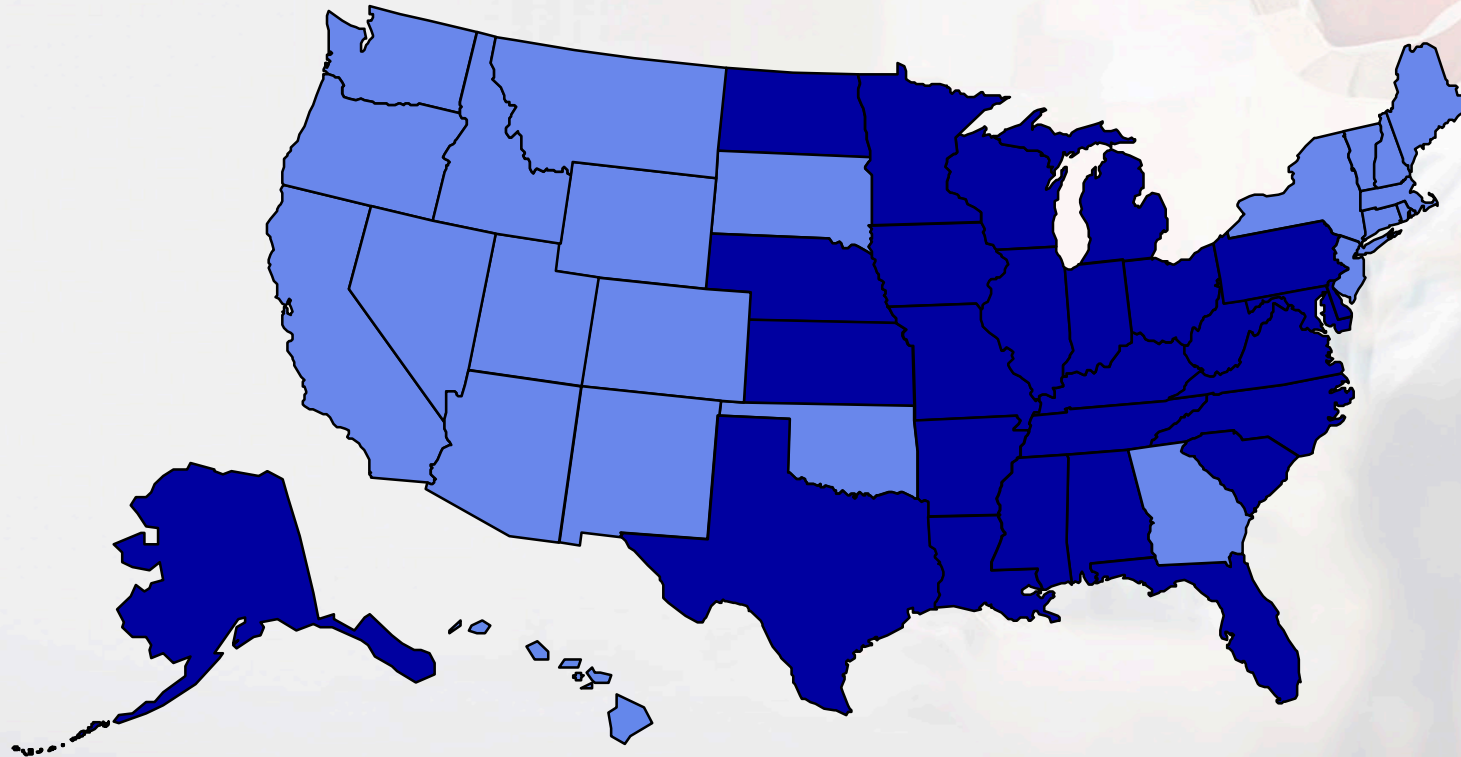
(*BMI ≥ 30 , or ~ 30 lbs overweight for 5' 4" person)



Obesity Trends* Among U.S. Adults

BRFSS, 1995

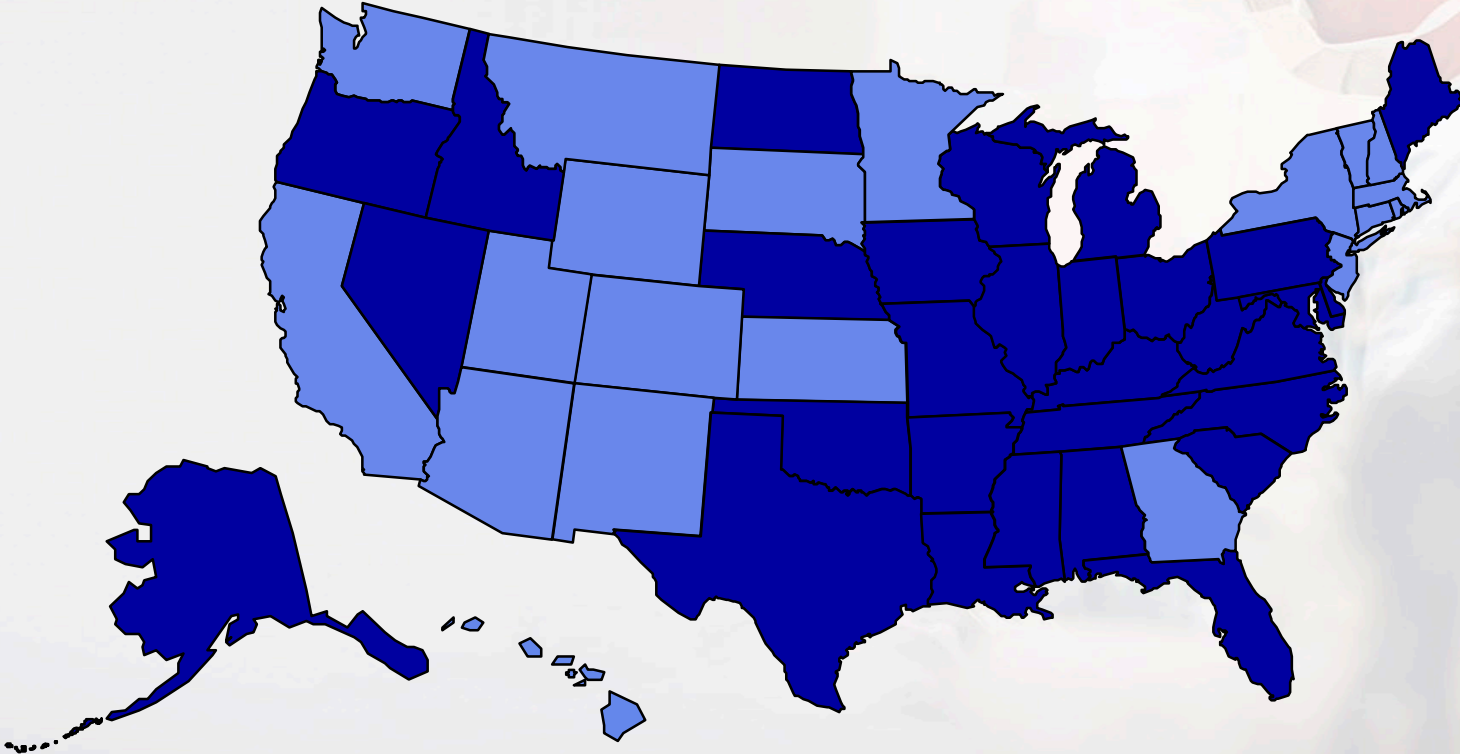
(*BMI ≥ 30 , or ~ 30 lbs overweight for 5' 4" person)



Obesity Trends* Among U.S. Adults

BRFSS, 1996

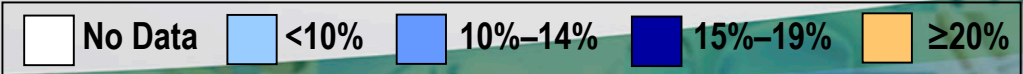
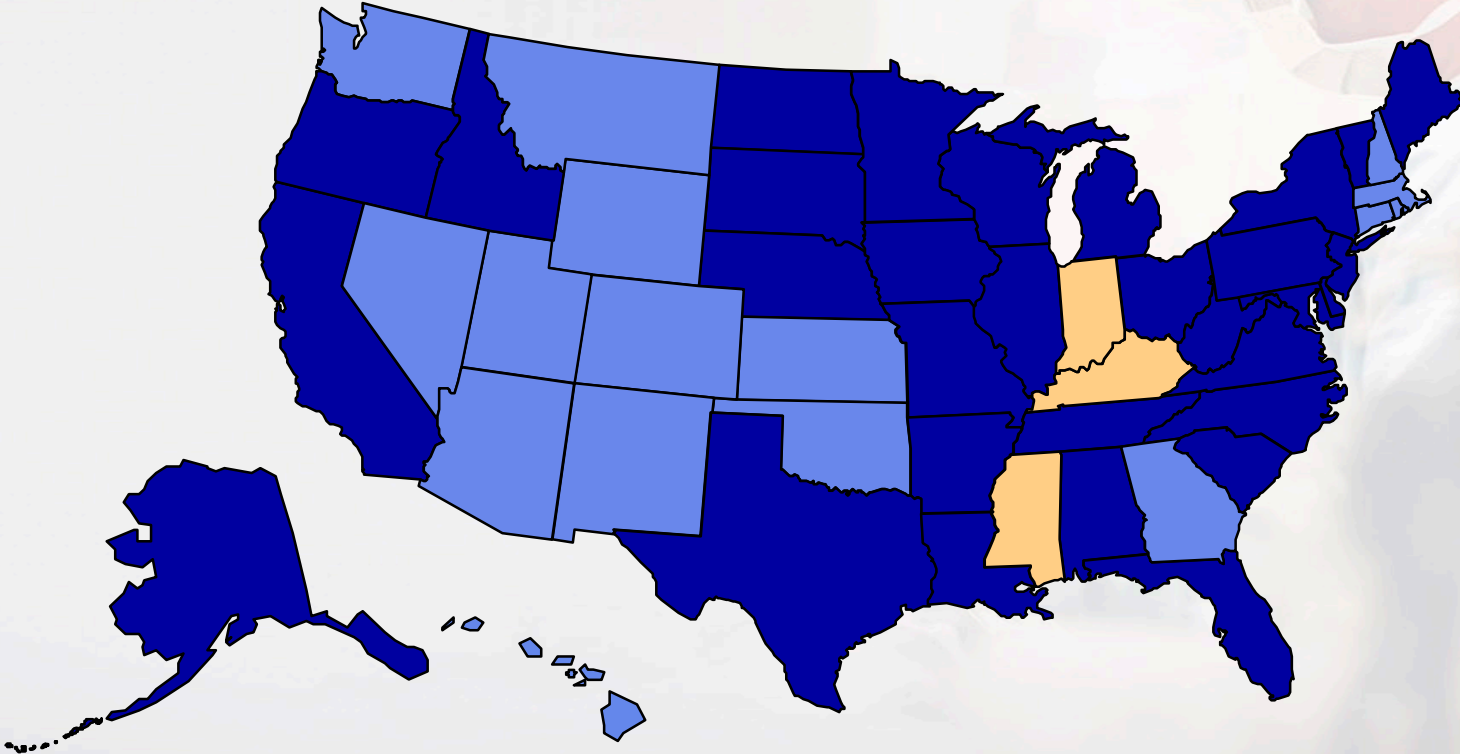
(*BMI ≥ 30 , or ~ 30 lbs overweight for 5' 4" person)



Obesity Trends* Among U.S. Adults

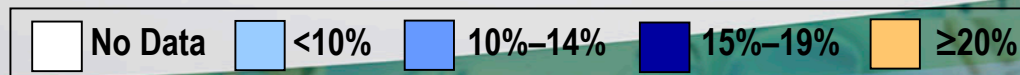
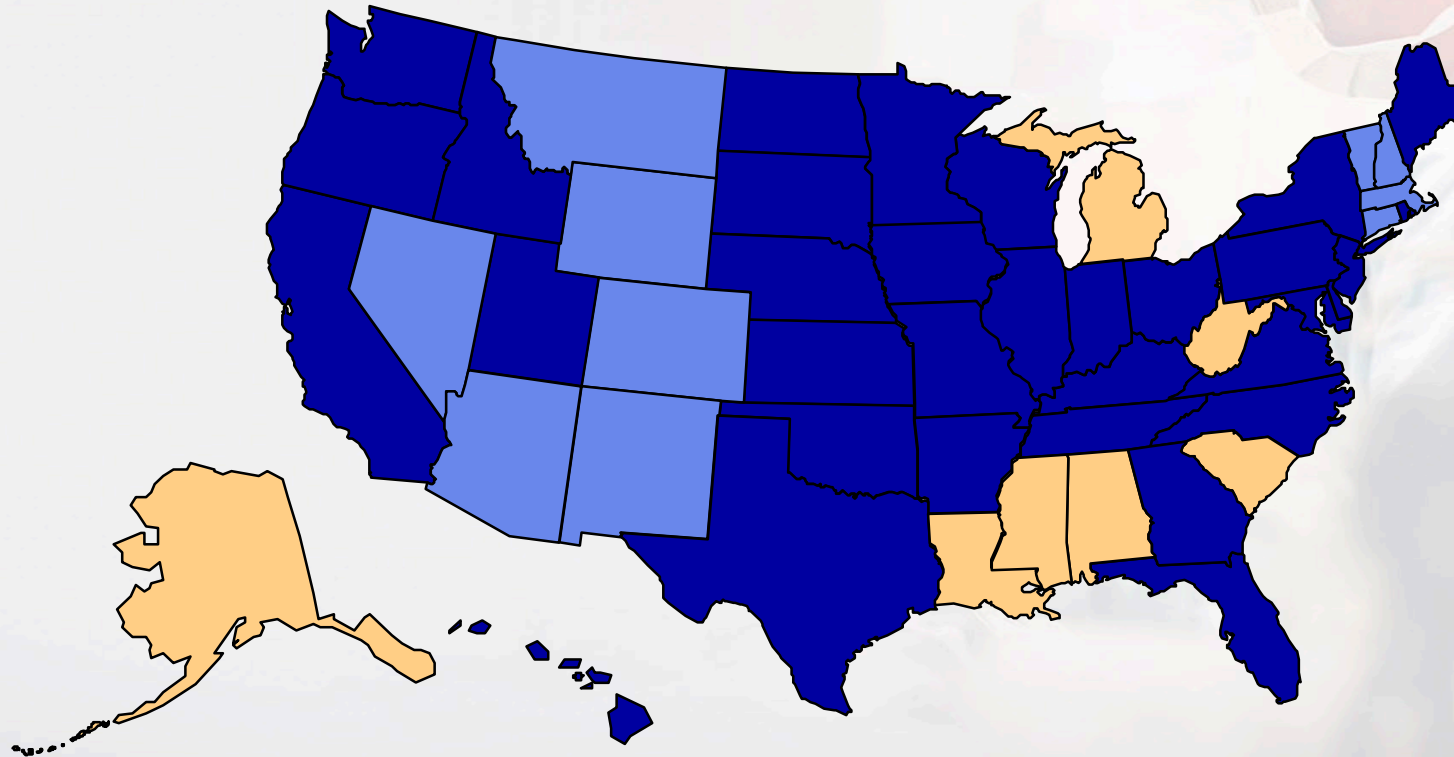
BRFSS, 1997

(*BMI ≥ 30 , or ~ 30 lbs overweight for 5' 4" person)



BRFSS, 1998

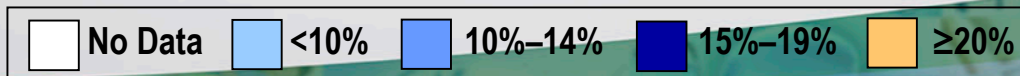
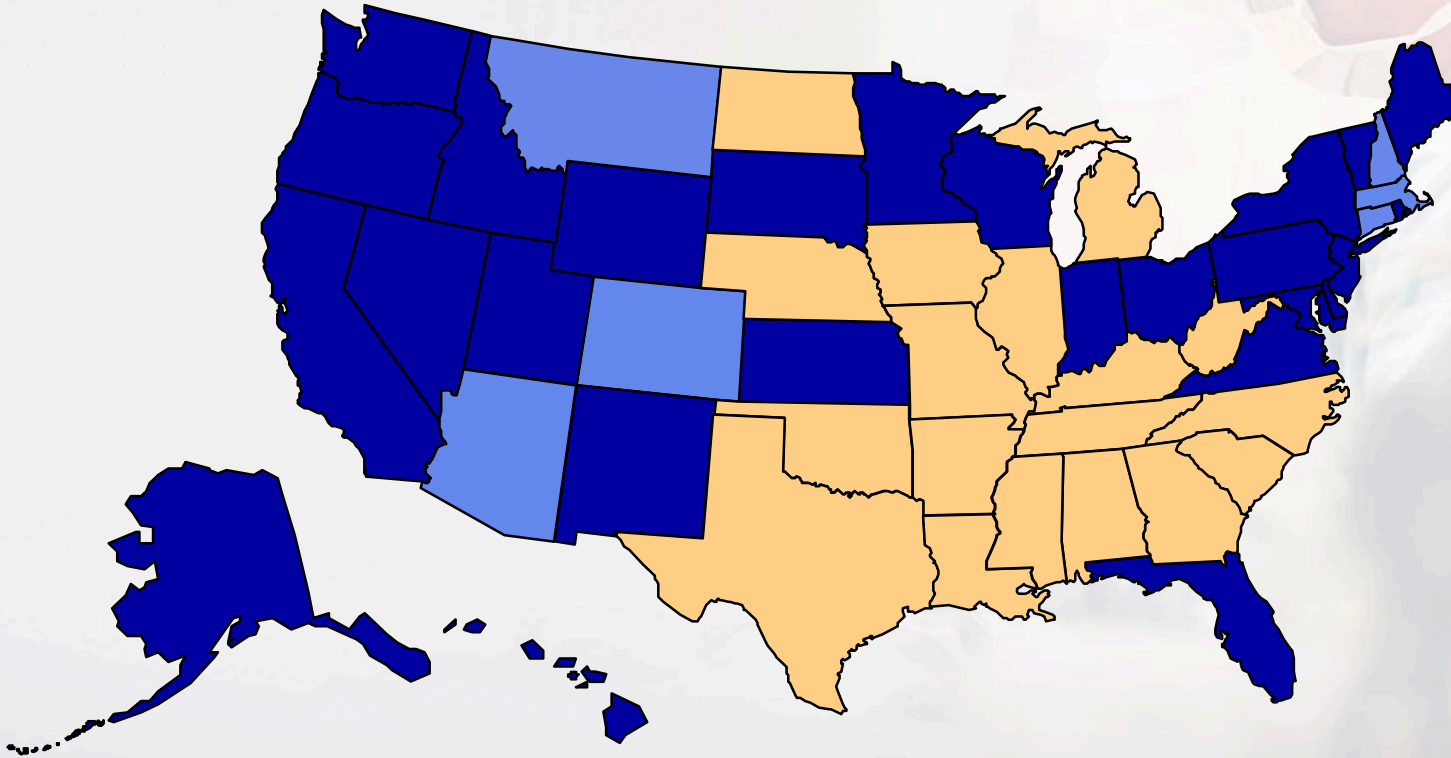
(*BMI ≥ 30 , or ~ 30 lbs overweight for 5' 4" person)



Obesity Trends* Among U.S. Adults

BRFSS, 1999

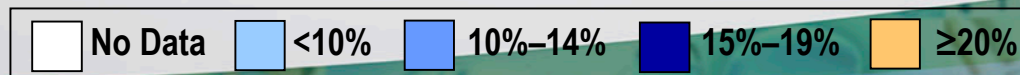
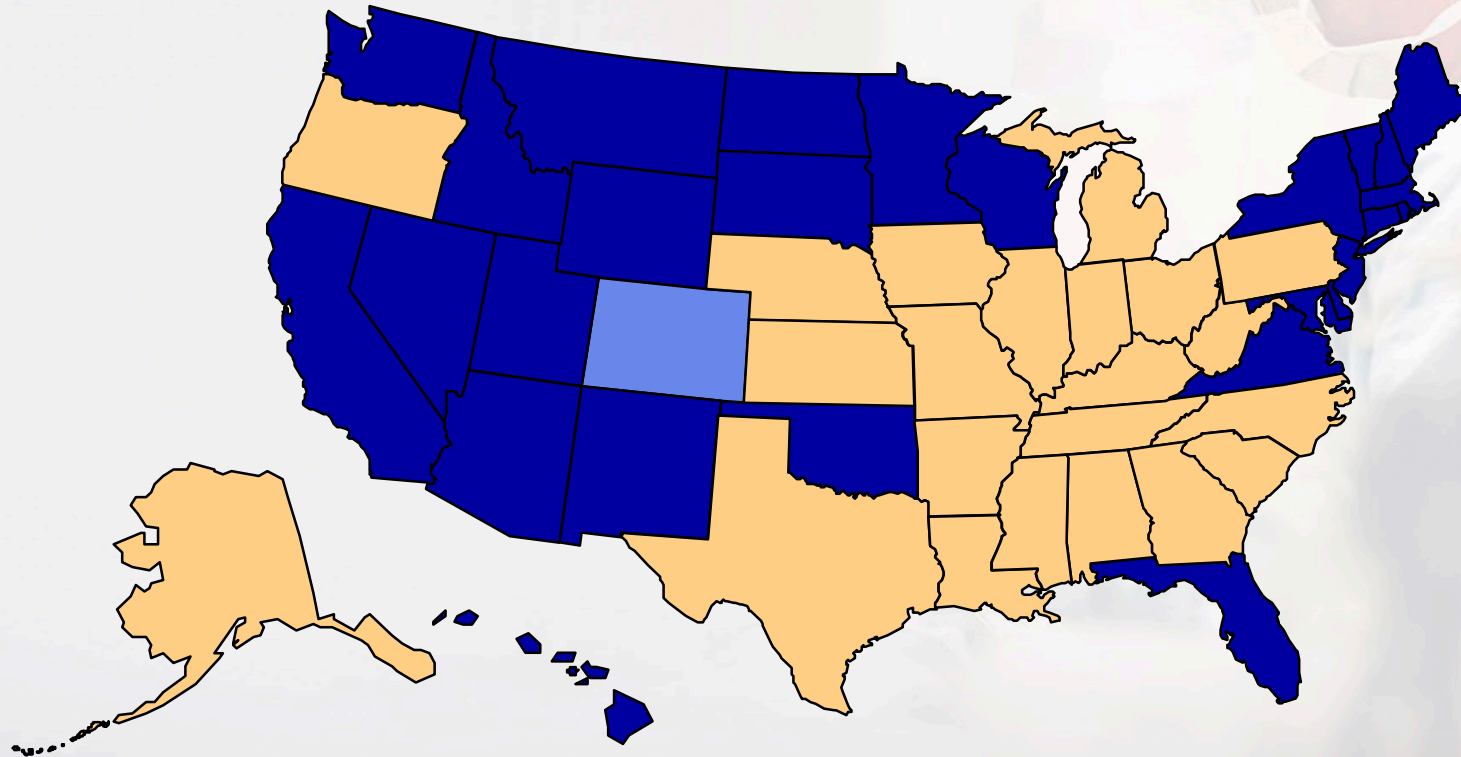
(*BMI ≥ 30 , or ~ 30 lbs overweight for 5' 4" person)



Obesity Trends* Among U.S. Adults

BRFSS, 2000

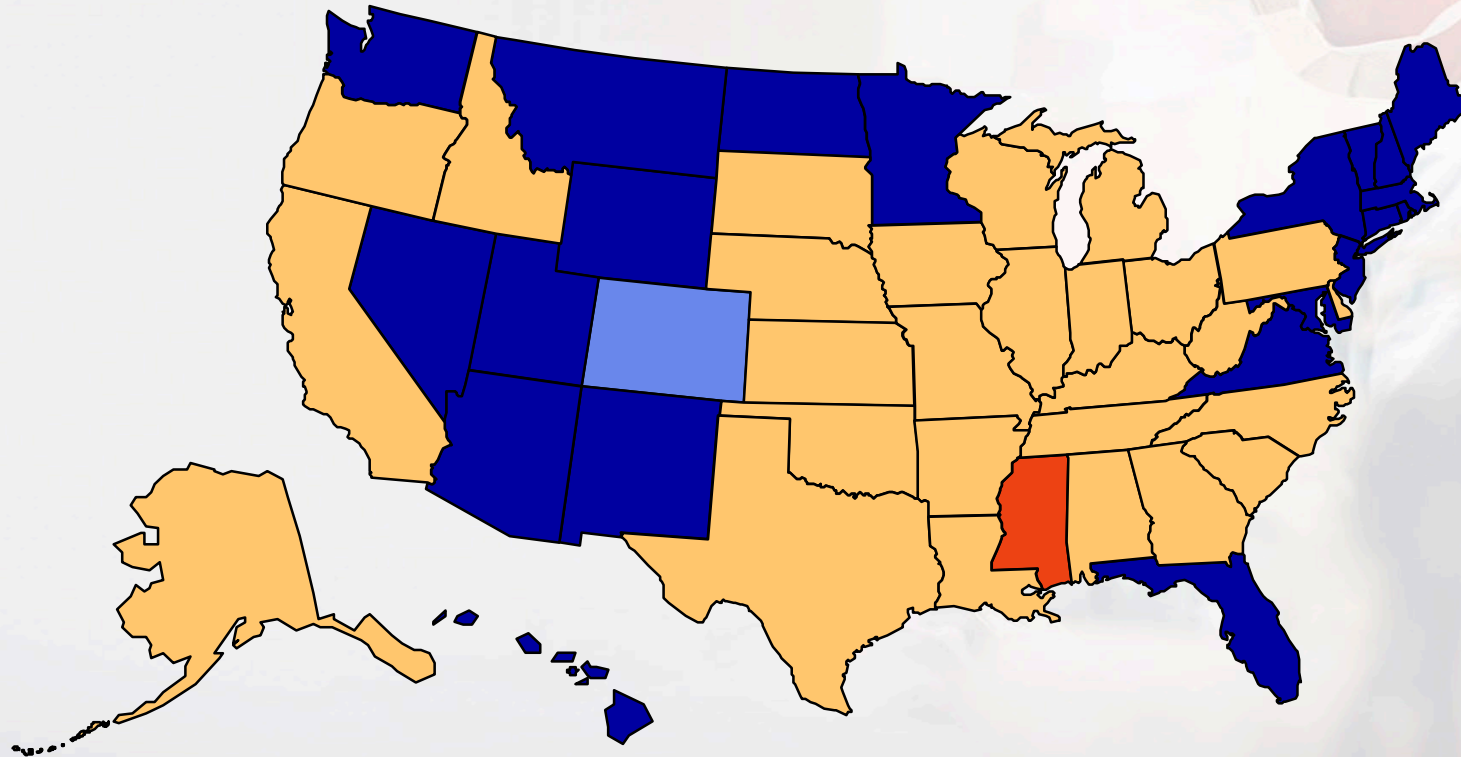
(*BMI ≥ 30 , or ~ 30 lbs overweight for 5' 4" person)



Obesity Trends* Among U.S. Adults

BRFSS, 2001

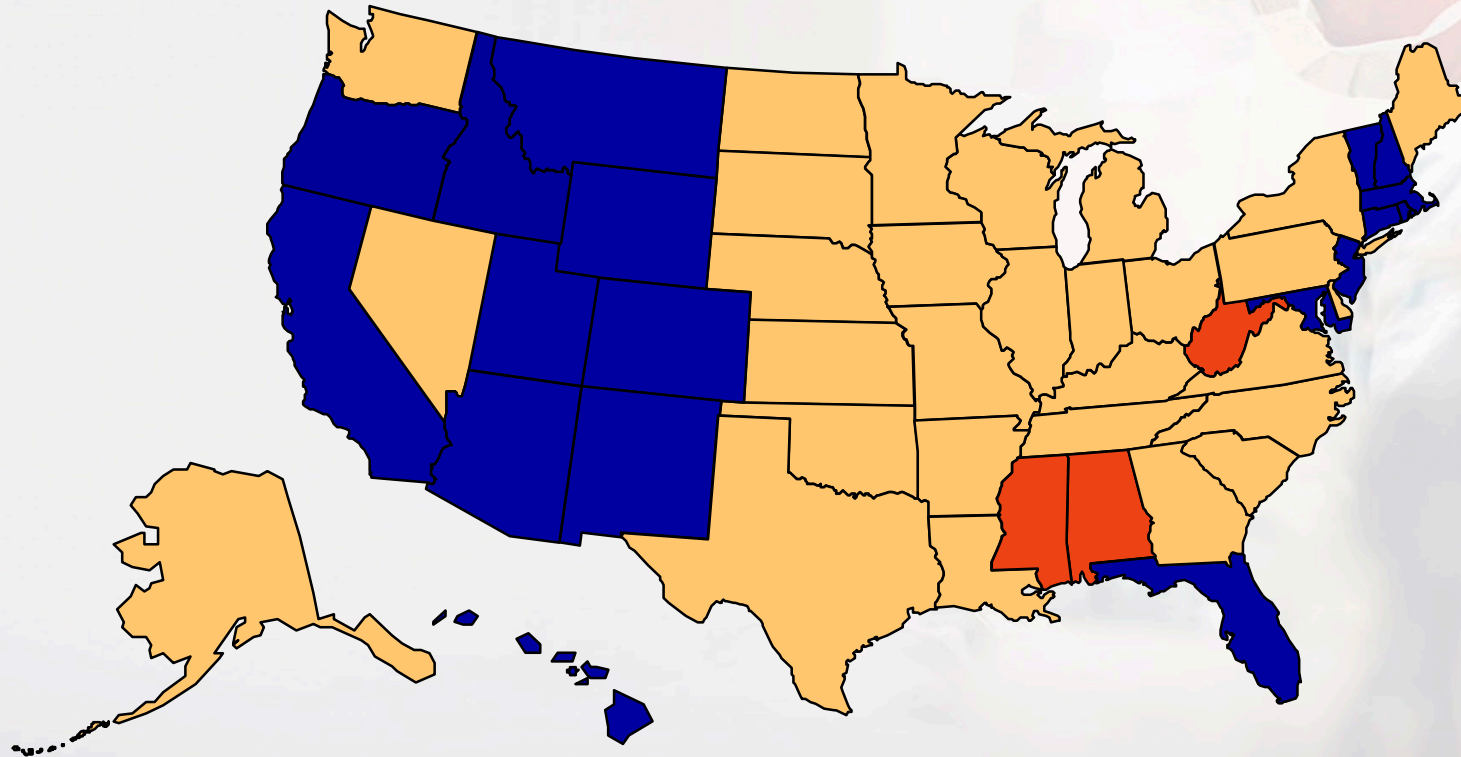
(*BMI ≥ 30 , or ~ 30 lbs overweight for 5' 4" person)



Obesity Trends* Among U.S. Adults

BRFSS, 2002

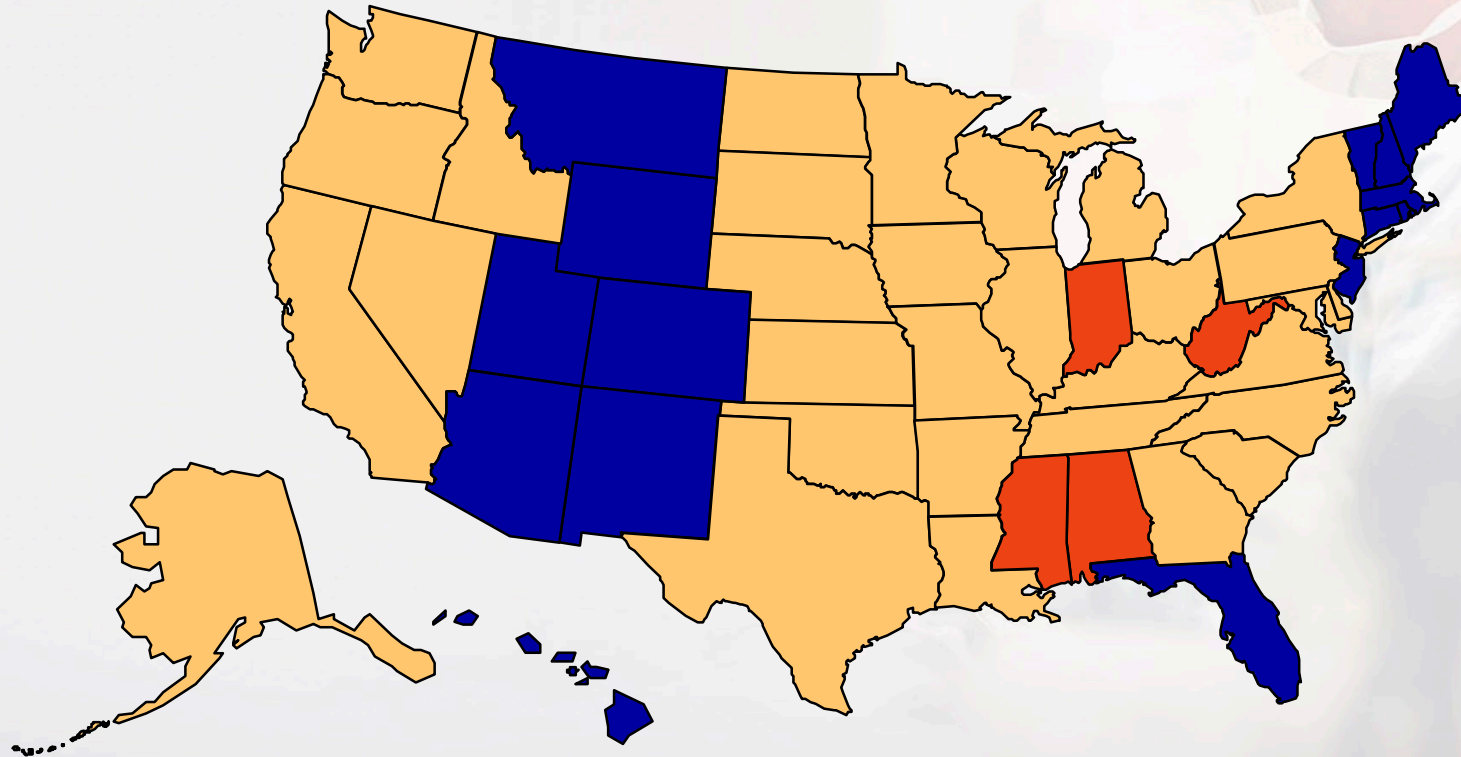
(*BMI ≥ 30 , or ~ 30 lbs overweight for 5' 4" person)



Obesity Trends* Among U.S. Adults

BRFSS, 2003

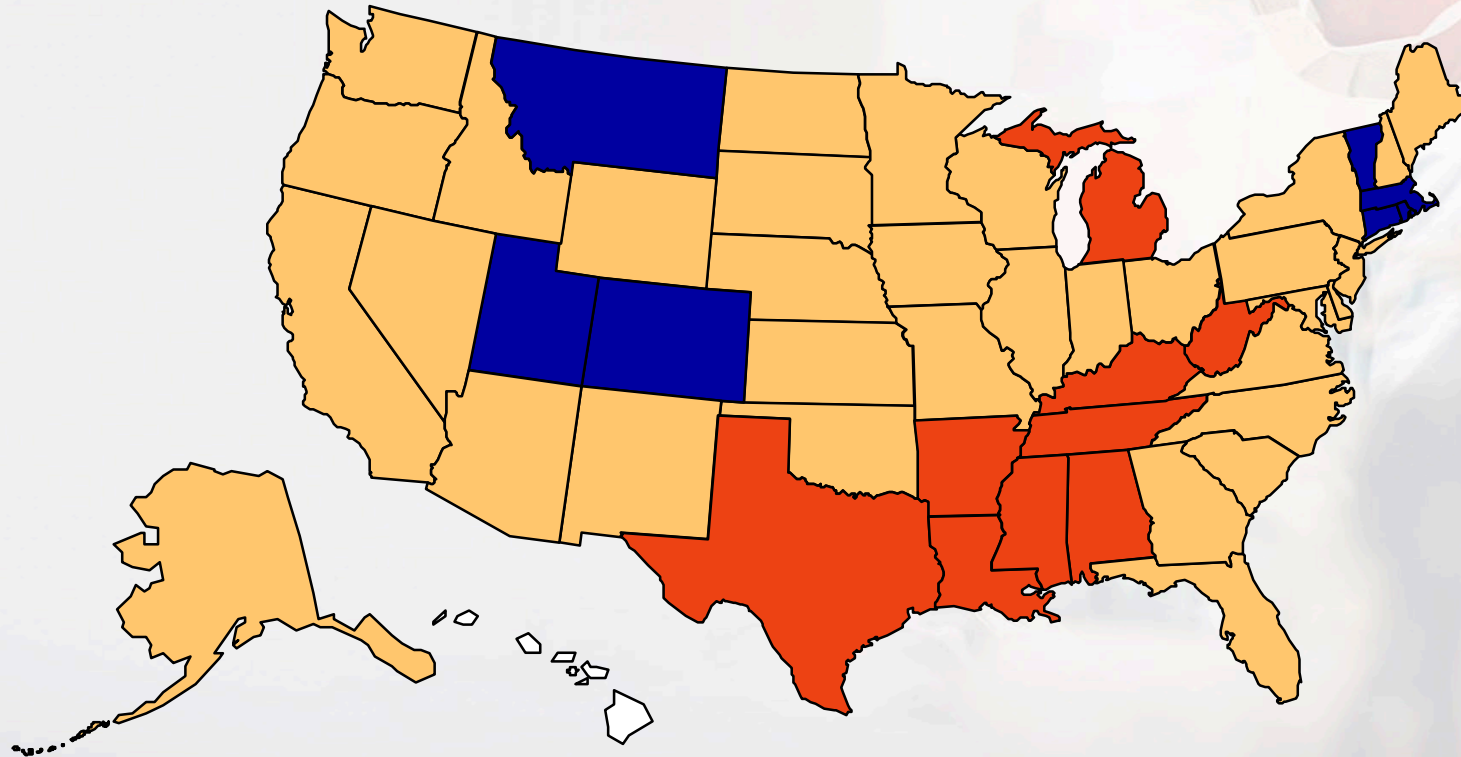
(*BMI ≥ 30 , or ~ 30 lbs overweight for 5' 4" person)



Obesity Trends* Among U.S. Adults

BRFSS, 2004

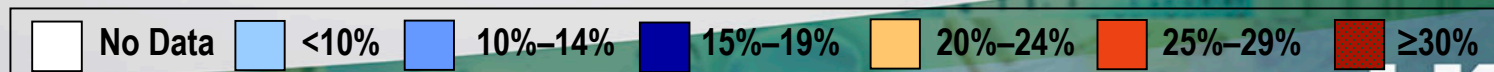
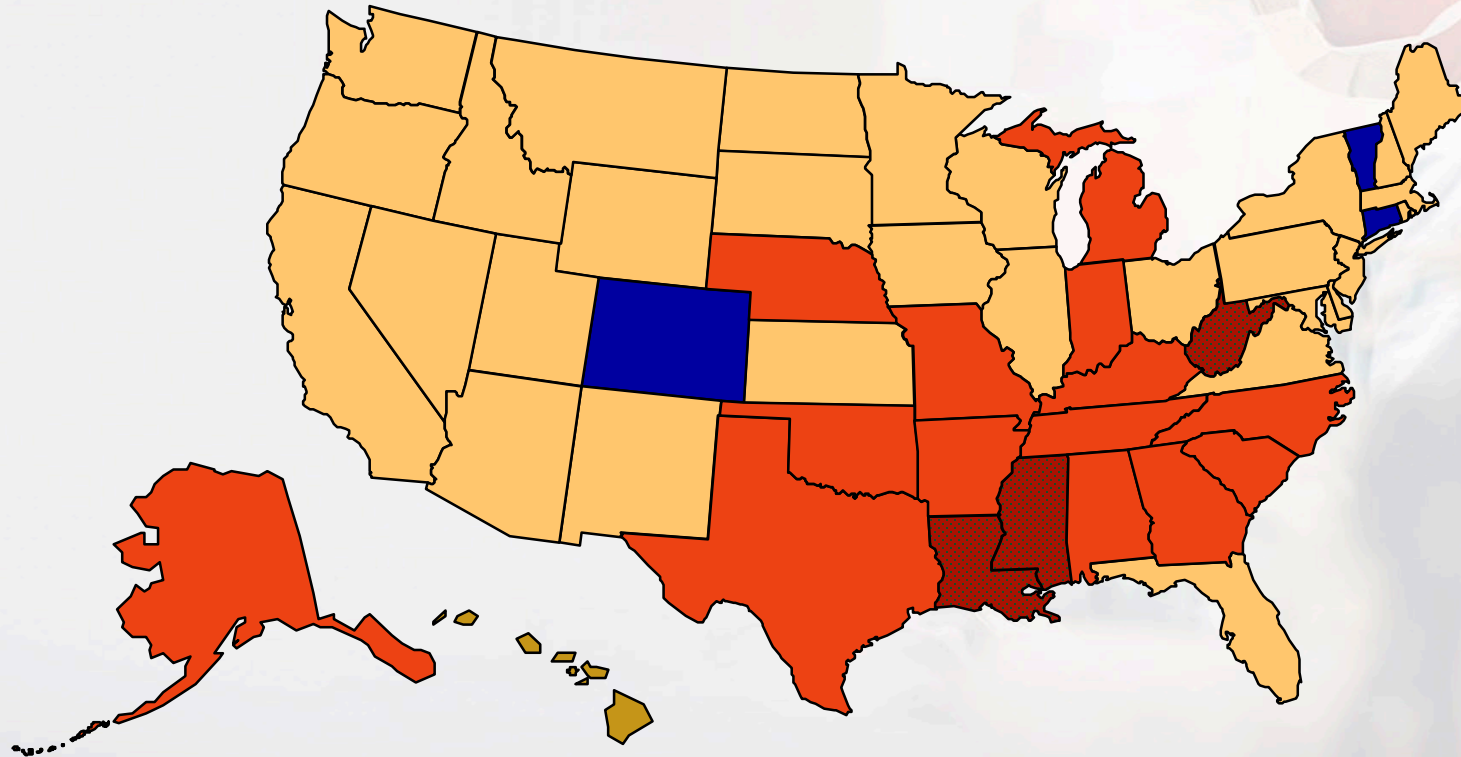
(*BMI ≥ 30 , or ~ 30 lbs overweight for 5' 4" person)



Obesity Trends* Among U.S. Adults

BRFSS, 2005

(*BMI ≥ 30 , or ~ 30 lbs overweight for 5' 4" person)



Age-adjusted Prevalence of Obesity and Diagnosed Diabetes Among US Adults

Obesity (BMI ≥ 30 kg/m²)



Diabetes



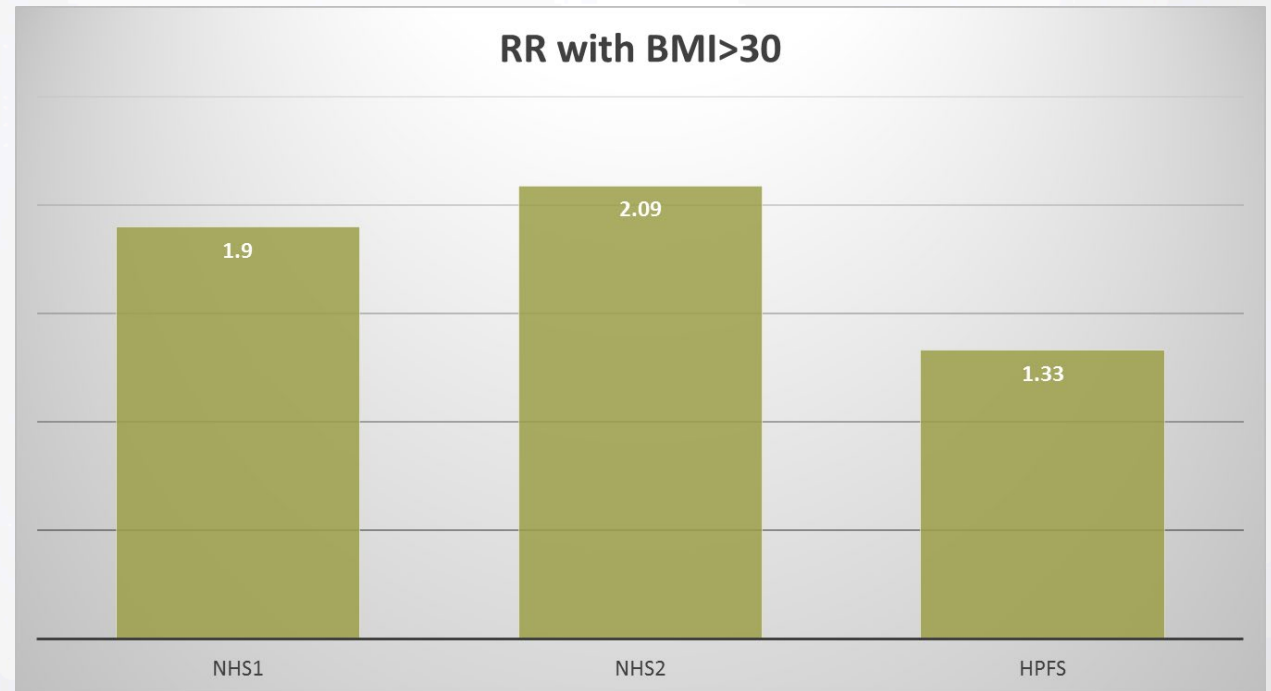
CDC's Division of Diabetes Translation. National Diabetes Surveillance System available at <http://www.cdc.gov/diabetes/statistics>



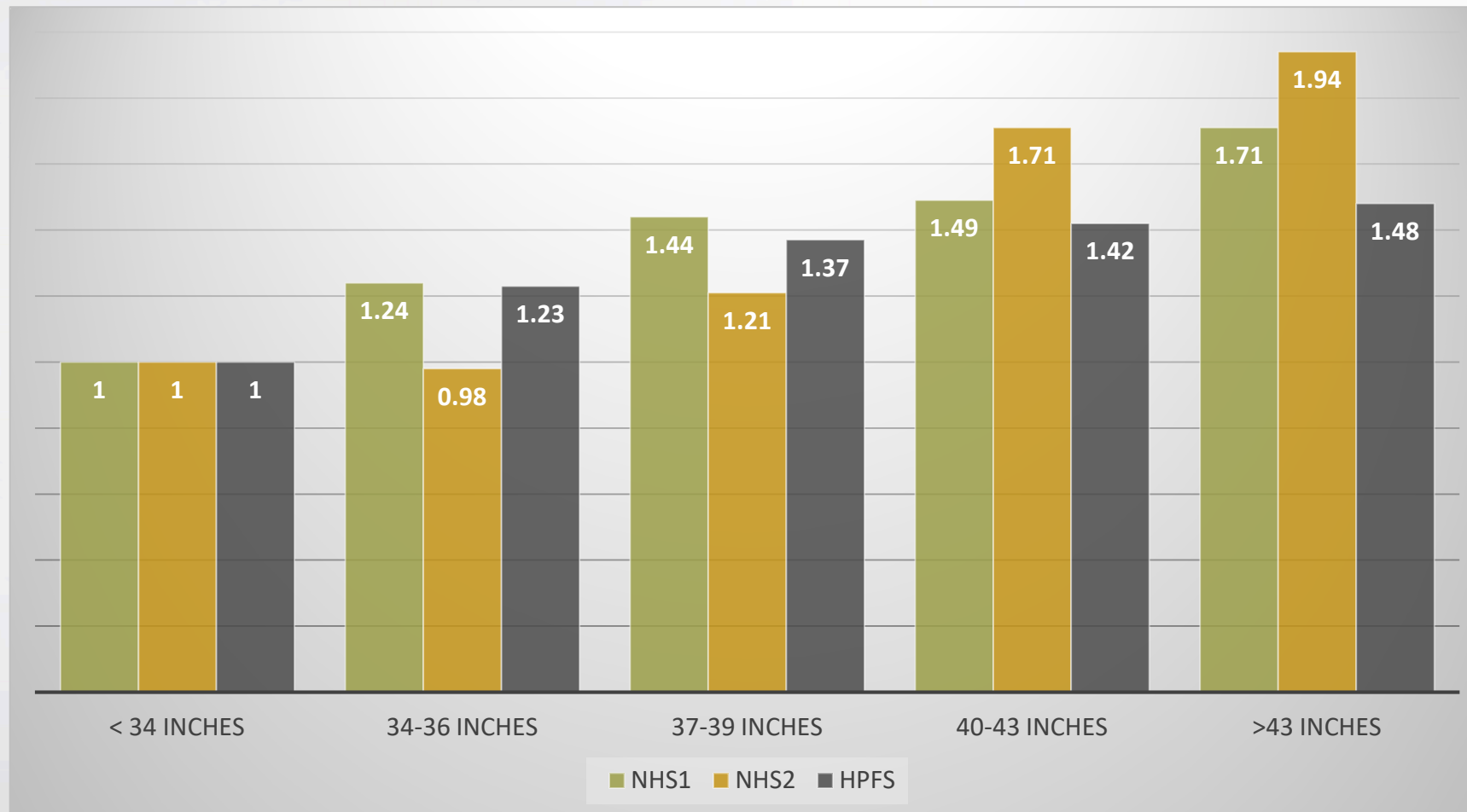
Obesity and Stone Disease

- Relative Risk for BMI>30 versus BMI 21-22.9
 - HPFS RR 1.33
 - NHS I RR 1.90
 - NHS II RR 2.09

Taylor et al. JAMA, 293:455, 2005.

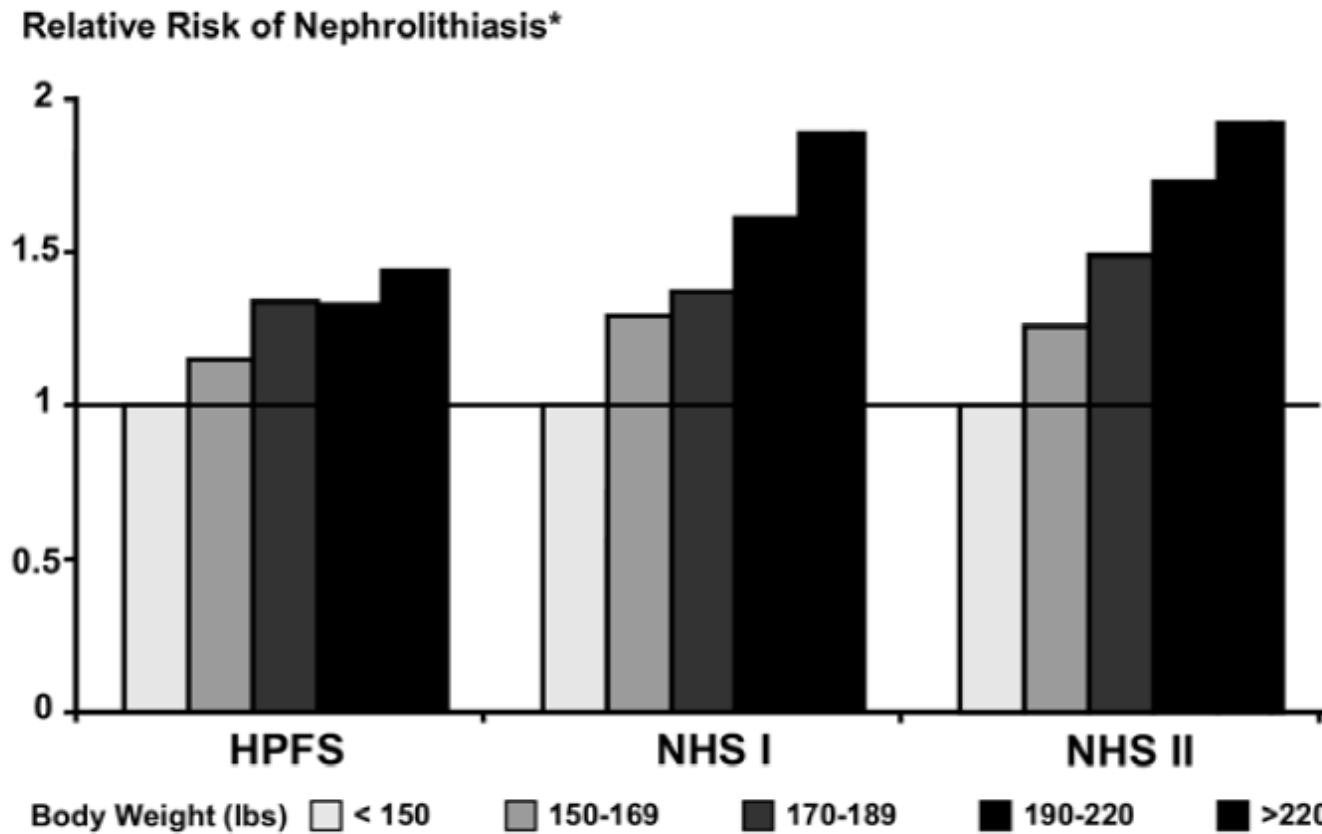


Waist Circumference and Stone Disease



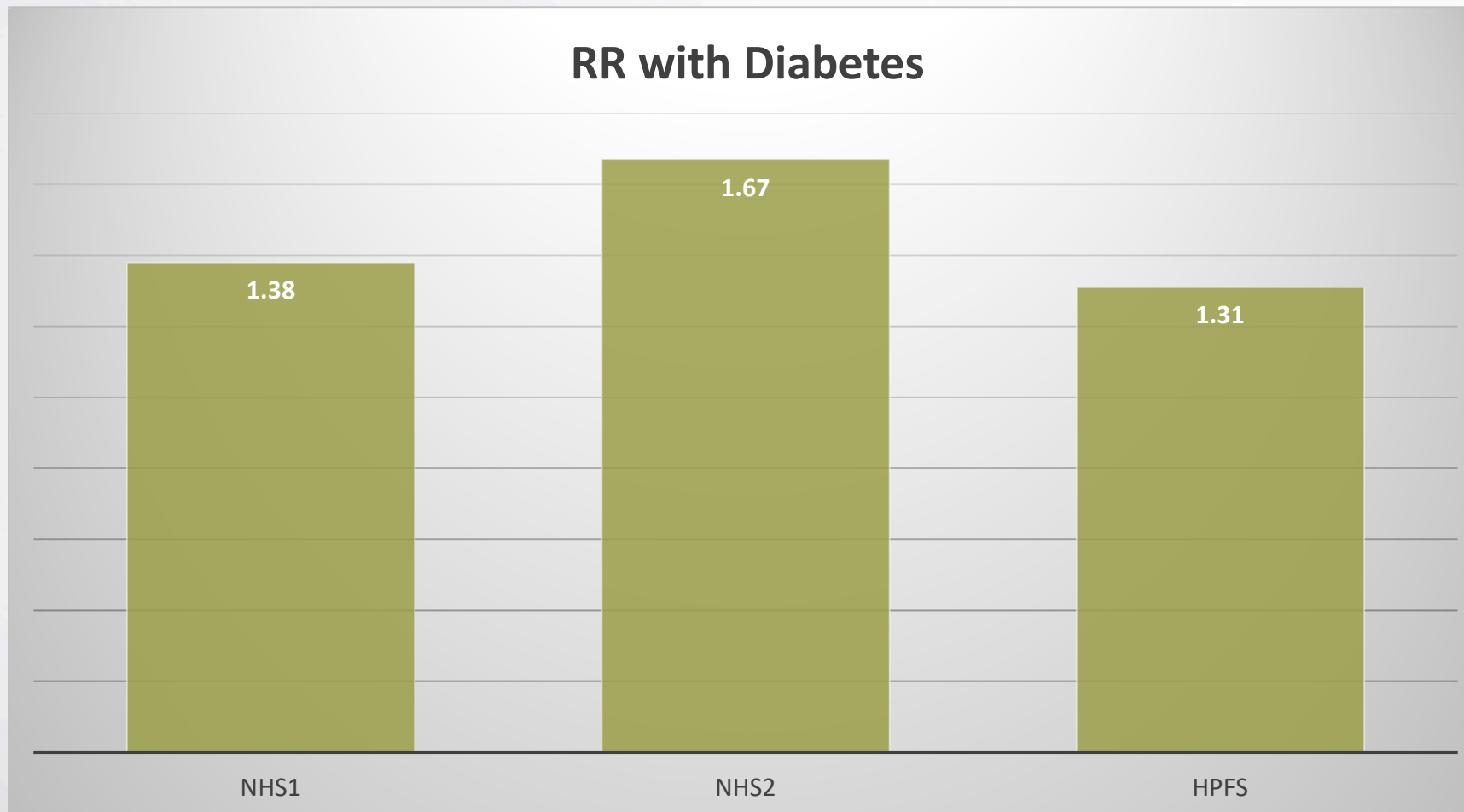
Taylor et al. JAMA, 293:455, 2005.

Body Weight and Stone Disease



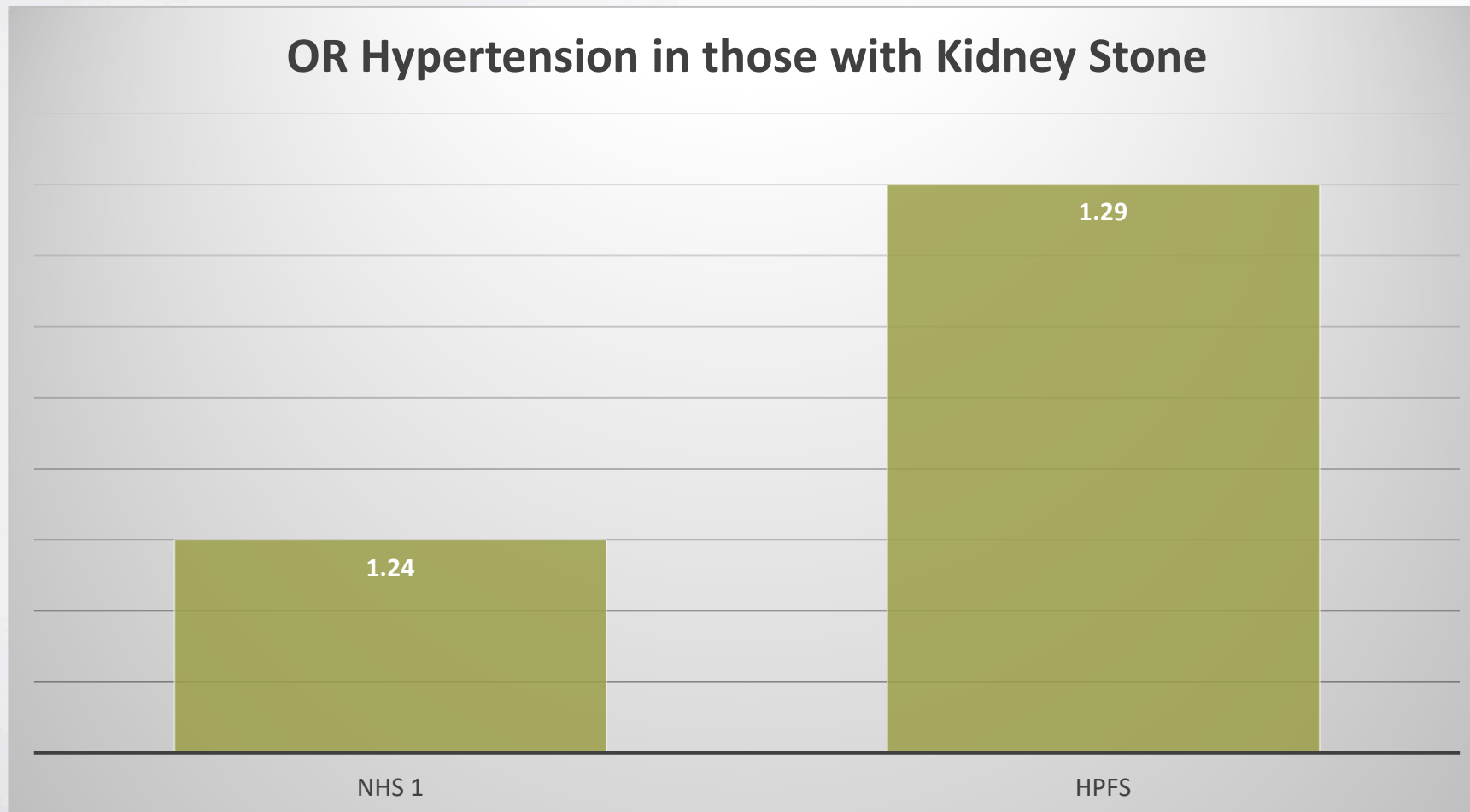
Maalouf, Semin Nephrol, 2008.

Diabetes and Stone Disease



Taylor et al. Kidney International, 68:1230, 2005

Hypertension and Stone Disease

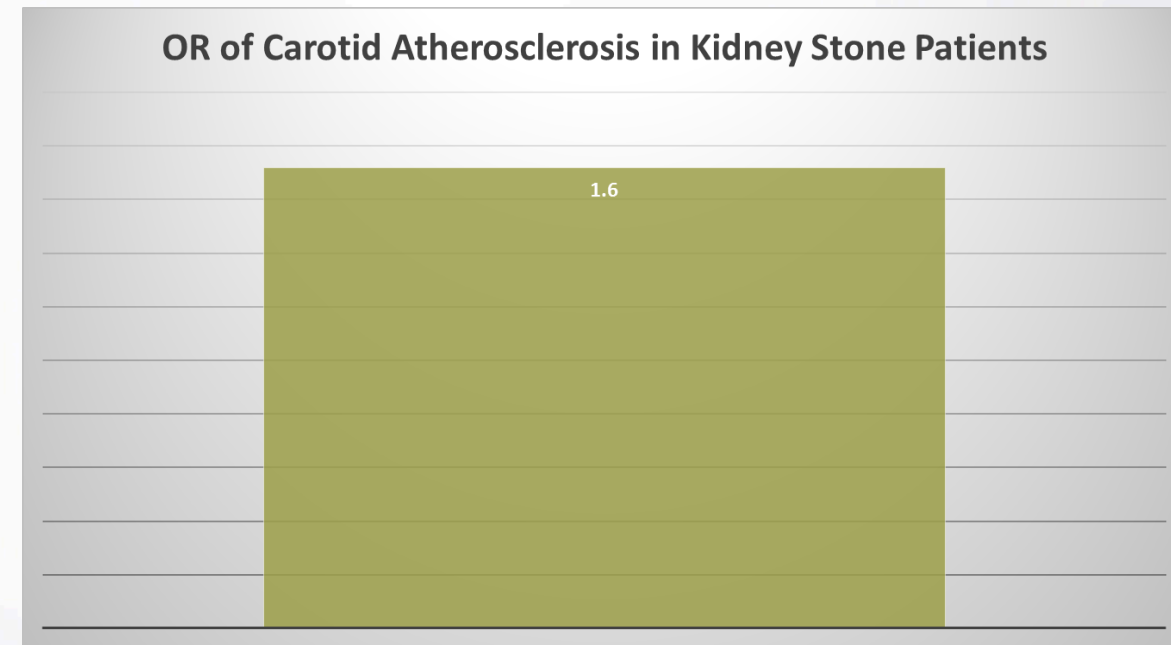


Madore et al. American Journal of Kidney Diseases, 32:802,1998.

Madore et al. American Journal of Hypertension, 11:46, 1998.

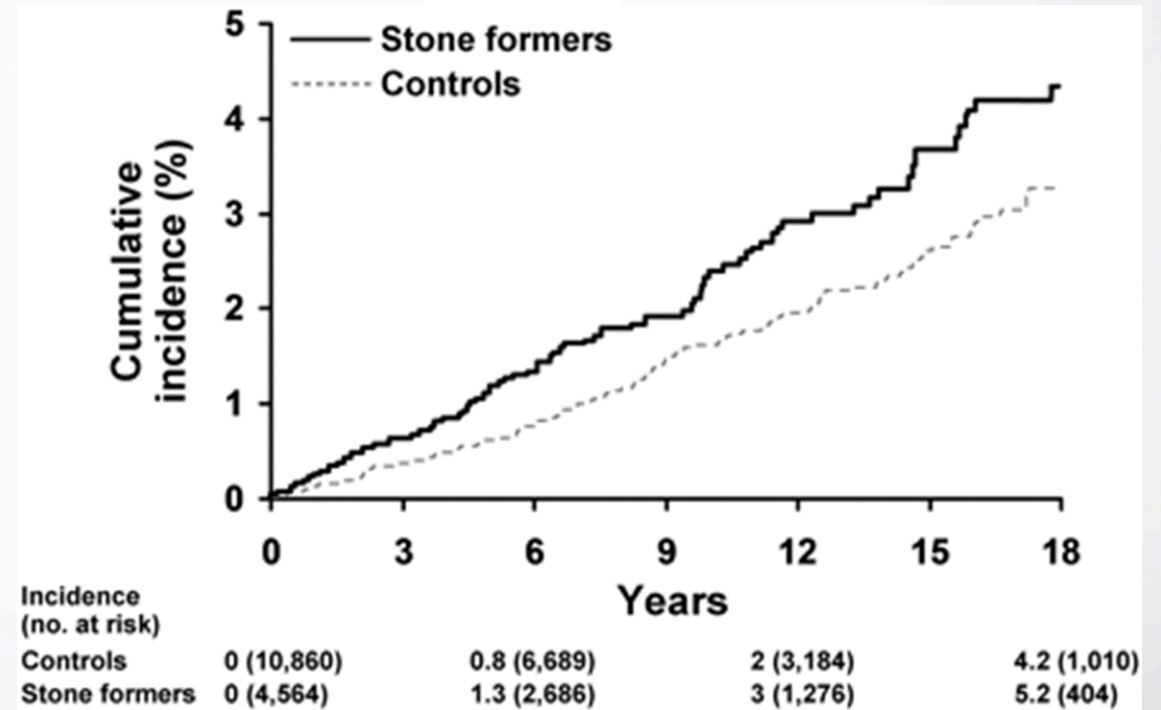
CARTIA Study: Carotid Artery Atherosclerosis and Stone Disease

- CARTIA observational study
- 5,115 ages 18-30 years
- Follow-up at 2, 5, 7,10,15 and 20 years
- Carotid artery IMT (B mode ultrasound)
- 3.9 % reported kidney stone at 20 years



Myocardial Infarction and Stone Disease

- Olmsted County Minnesota
- 4564 stone formers matched to 10,860 controls
- Mean follow-up 9 years
- Adjustment for other medical co-morbidities



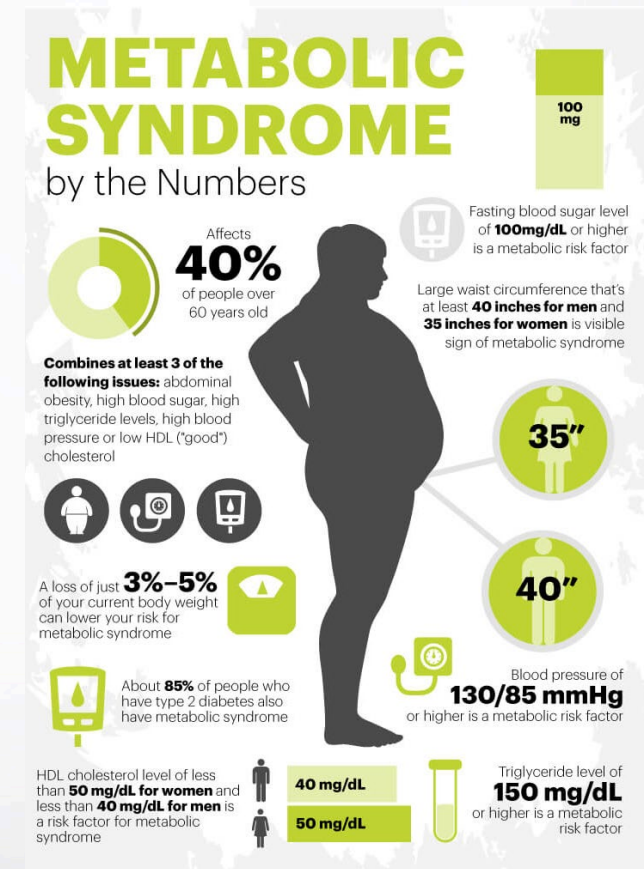
Rule et al. JASN, 21:1641,2010.

Metabolic Syndrome

- Definition:
 - Contains at least 3 of the 5 conditions
 - Central (abdominal obesity)
 - Elevated Blood Pressure
 - Elevated Fasting Plasma Glucose
 - High Serum Triglycerides
 - Low high density lipoprotein (HDL) levels

Metabolic Syndrome and Stone Disease

- NHANES III
 - Self reported stone risk 2x higher in those with metabolic syndrome
 - Correlates with number of factors
 - 0 factors: 3.7%
 - 3 factors: 7.5%
 - 5 factors: 9.8%



West et al. AJKD, 51:741, 2008.

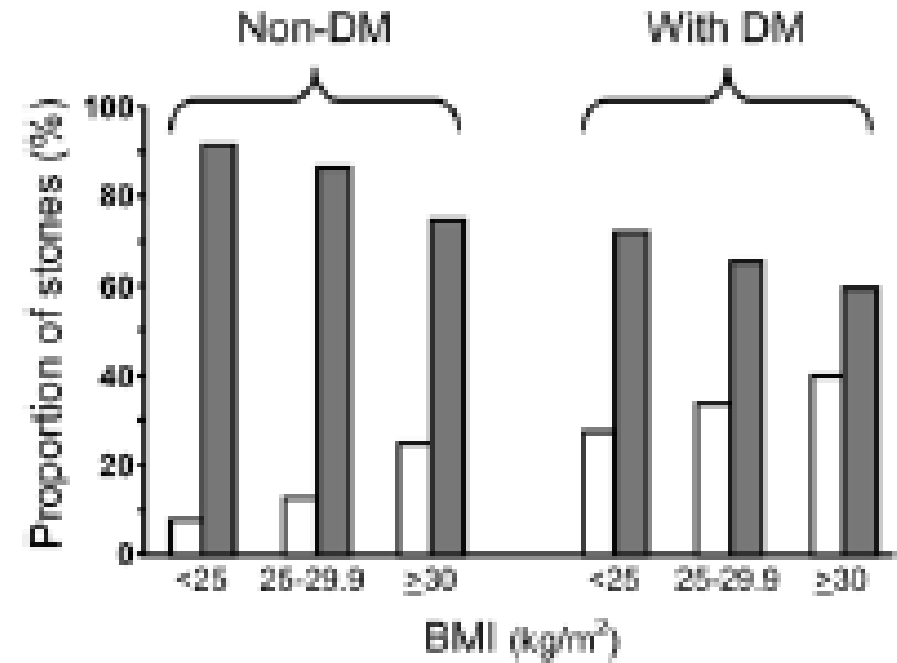
Medical and Dietary Management

- Epidemiology
- **Stone Composition**
- 24 hour urine



Obesity and Stone Composition

- Most associate uric acid stone with obesity
- Still calcium oxalate in most common



Maalouf, Semin Nephrol, 2008.

Medical and Dietary Management

- Epidemiology
- Stone Composition
- **24 hour urine**



Obesity and 24 Hour Urine

- Development of uric acid stones is due to a **low urinary pH**
- Obese individuals tend to **excrete more calcium**
 - Dietary indiscretions including **increased sodium consumption**
- **Oxalate excretion** directly correlates with BMI

UAB/UTSW P20

Urinary Oxalate Excretion and Obesity

- Positive correlation with body weight
- Positive correlation with body surface area
- Positive correlation with obesity
- Positive correlation with BMI

Lemann et al. Kidney International, 49:200, 1996.

Taylor et al. American Journal of Kidney Disease, 48:905,2006.

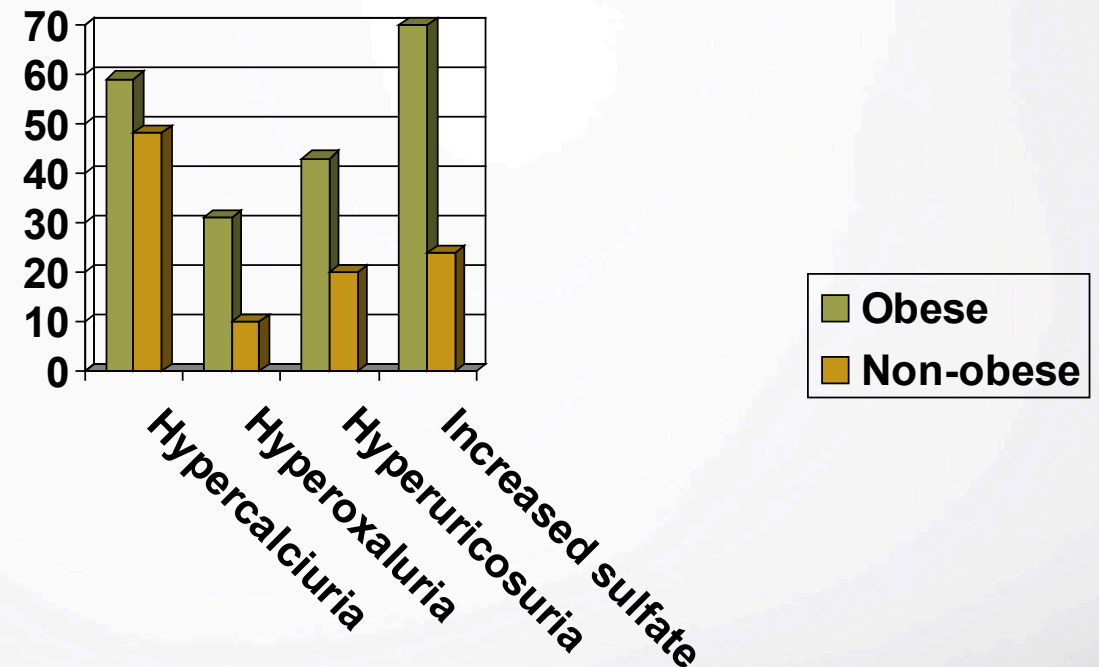
Eisner et al. Urology, 75:1289,2010.

Perinpam et al. Urology, 86:690, 2015.

Ekeruo et al. J Urol. 2004

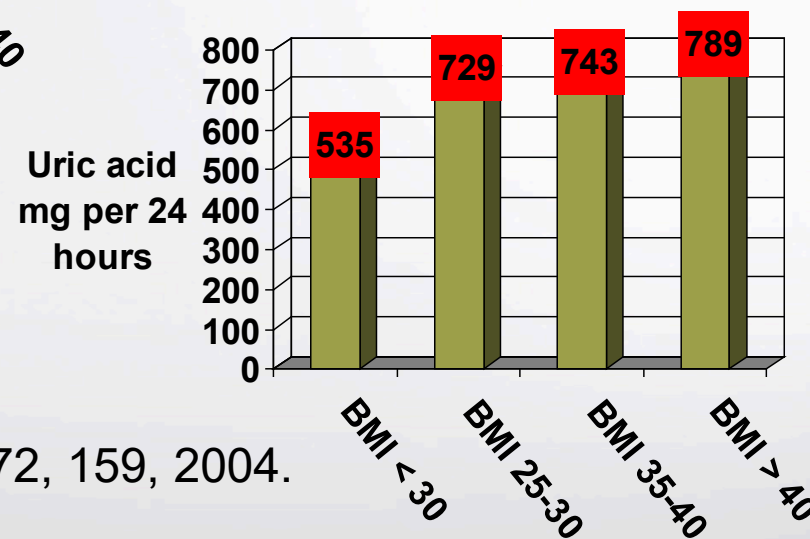
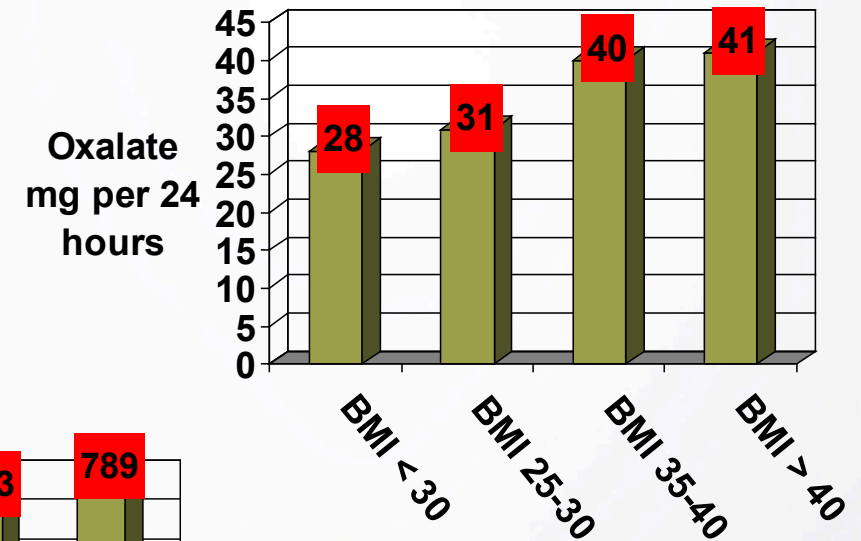
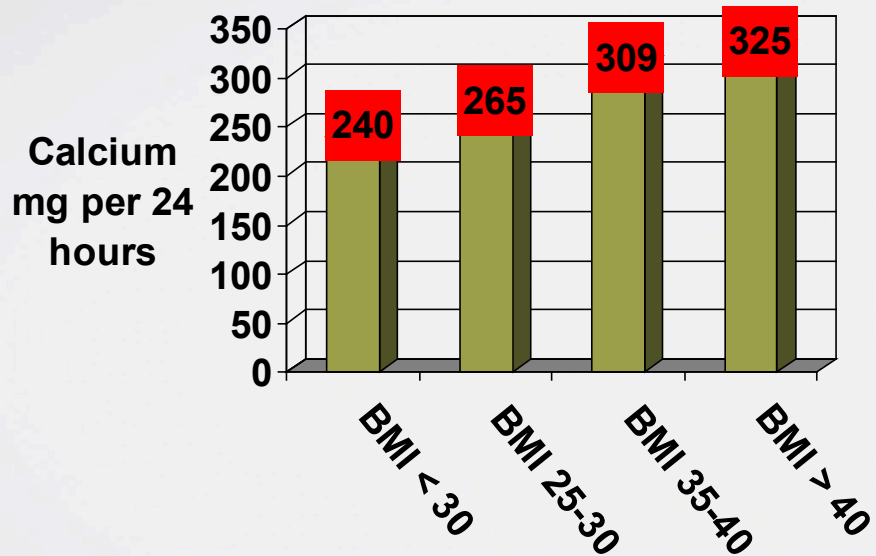
Obesity and 24 Hour Urine

- ↓ Citrate Excretion
- ↓ Urine pH
- ↑ Oxalate Excretion
- ↑ Uric acid
- ↑ Calcium Excretion



Erkero et al. Journal of Urology, 17:159, 2004.

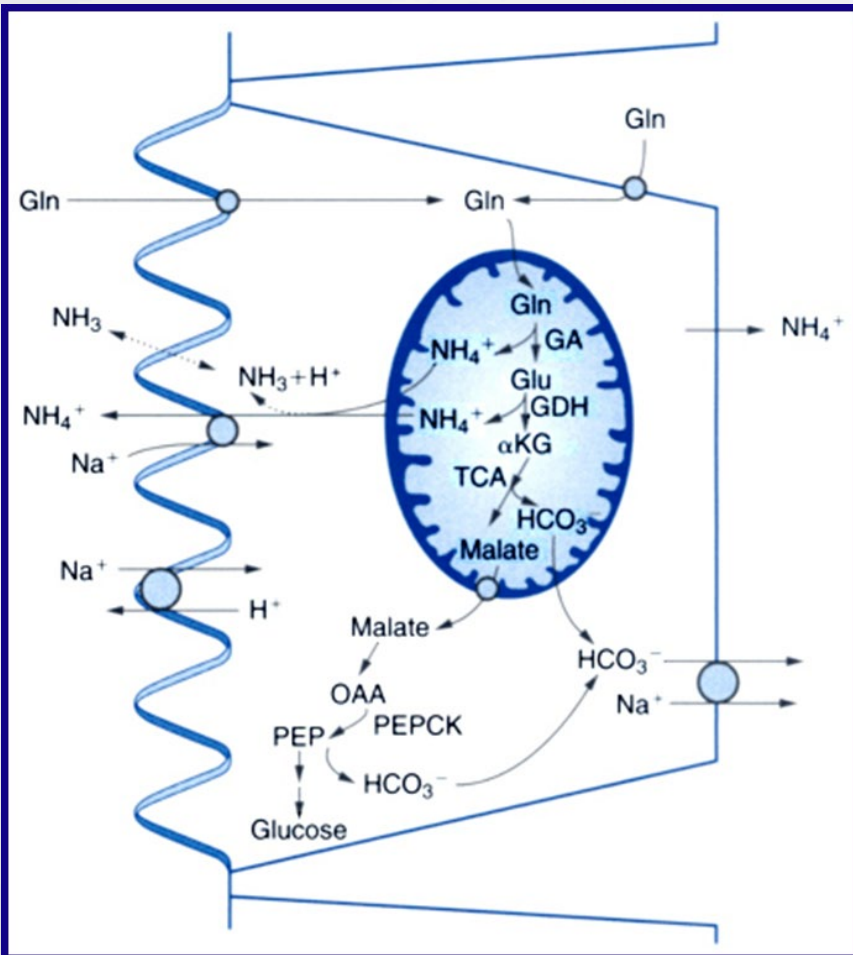
Obesity and 24 Hour Urine



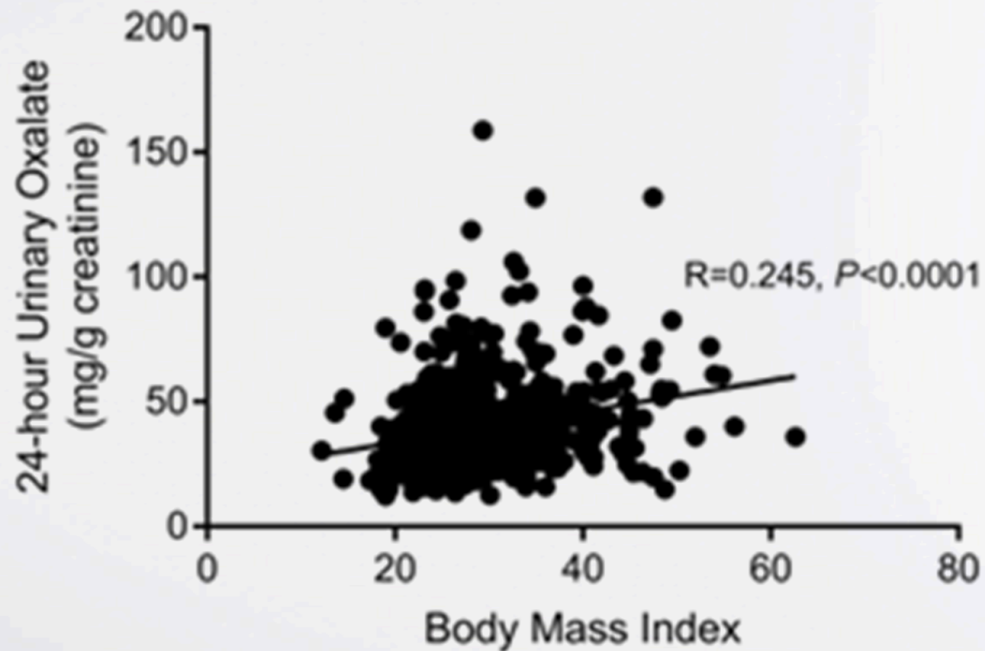
Ekeruo et al. Journal of Urology, 172, 159, 2004.

Urine pH

- Low urine pH is thought to be due to defective production of ammonium in the proximal tubule.
- This metabolism is attenuated with insulin resistance.
- Results in an increase in net acid excretion and a reduction in urine pH

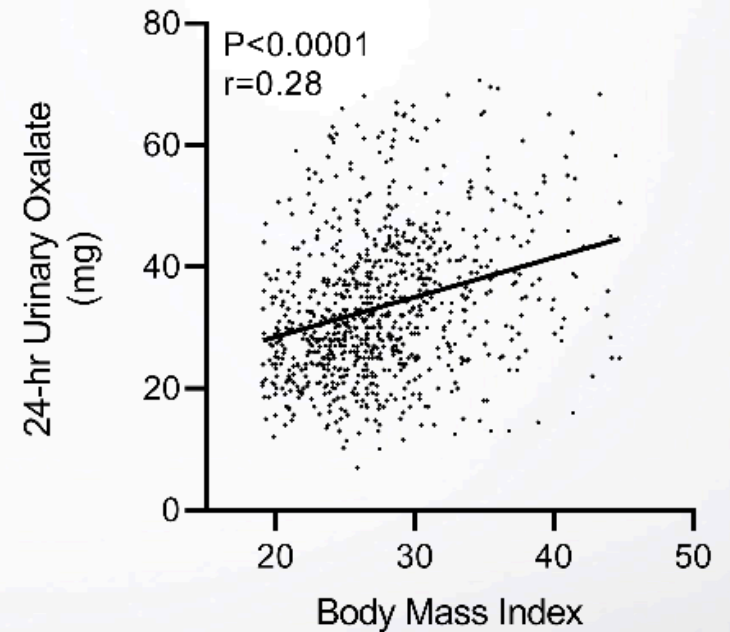


Work at UAB/UTSW



589 stoneformers

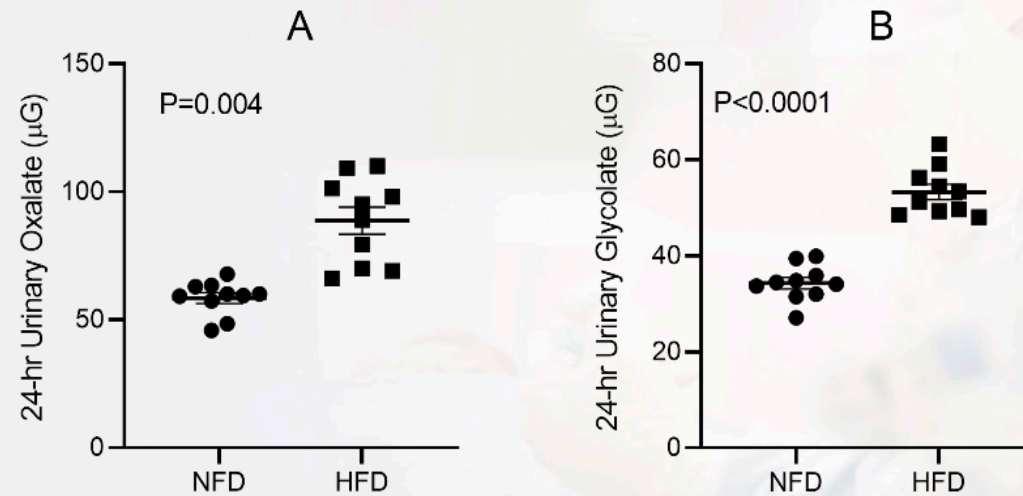
Wood et al. Reviews in Urology. 2019



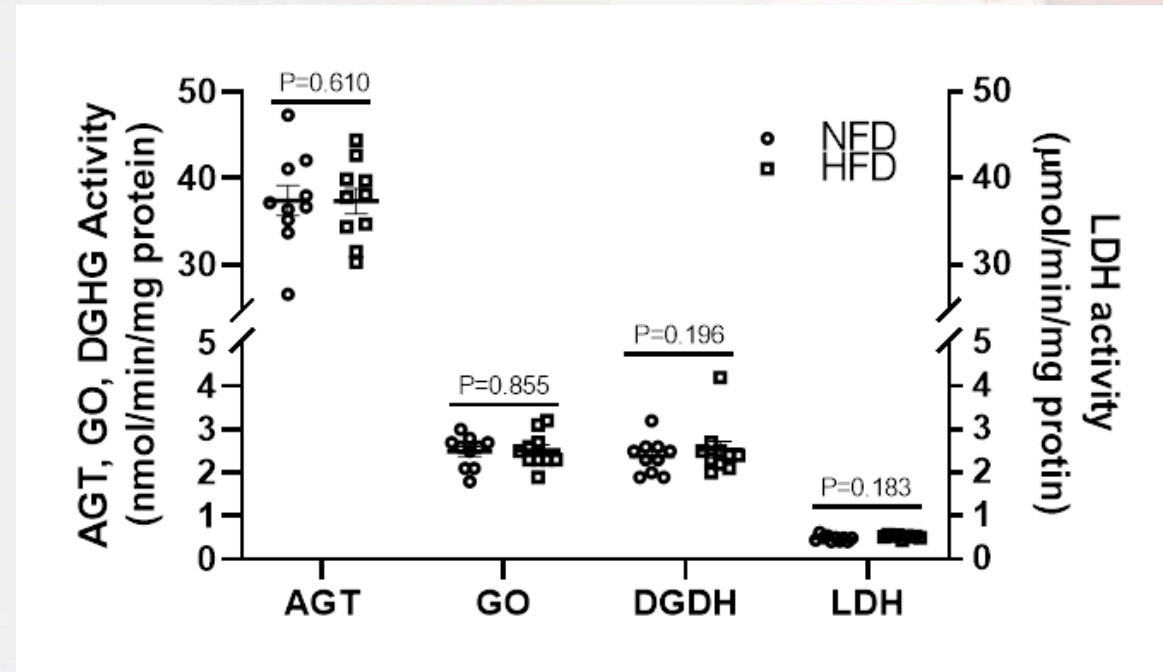
900 CaOx stoneformers
from UTSW and UAB

	CaOx Stone Formers	
	BMI 18.5 to < 25 kg/m ² (n=311)	BMI 30 to 45 kg/m ² (n=238)
24-hr Urinary Oxalate (mg/day)	30 ± 10	38 ± 12

Animal Studies at UAB



Animal Studies at UAB



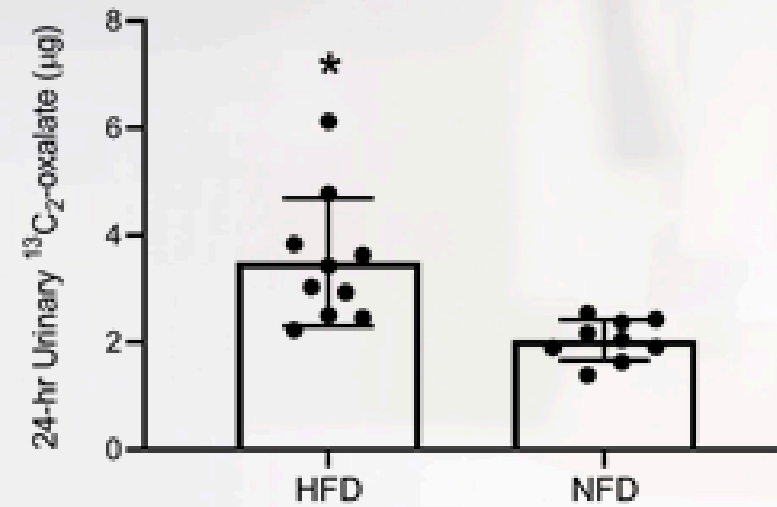


Figure 24-hr urinary $^{13}\text{C}_2$ -oxalate excretion after subcutaneous bolus injection of 2 μmoles $^{13}\text{C}_2$ -glycolate in mice after 10 weeks feeding of either a 17% kcal fat diet (LFD) or 45% kcal fat diet (HFD) $^{13}\text{C}_2$ -oxalate was measured by IC/MS.

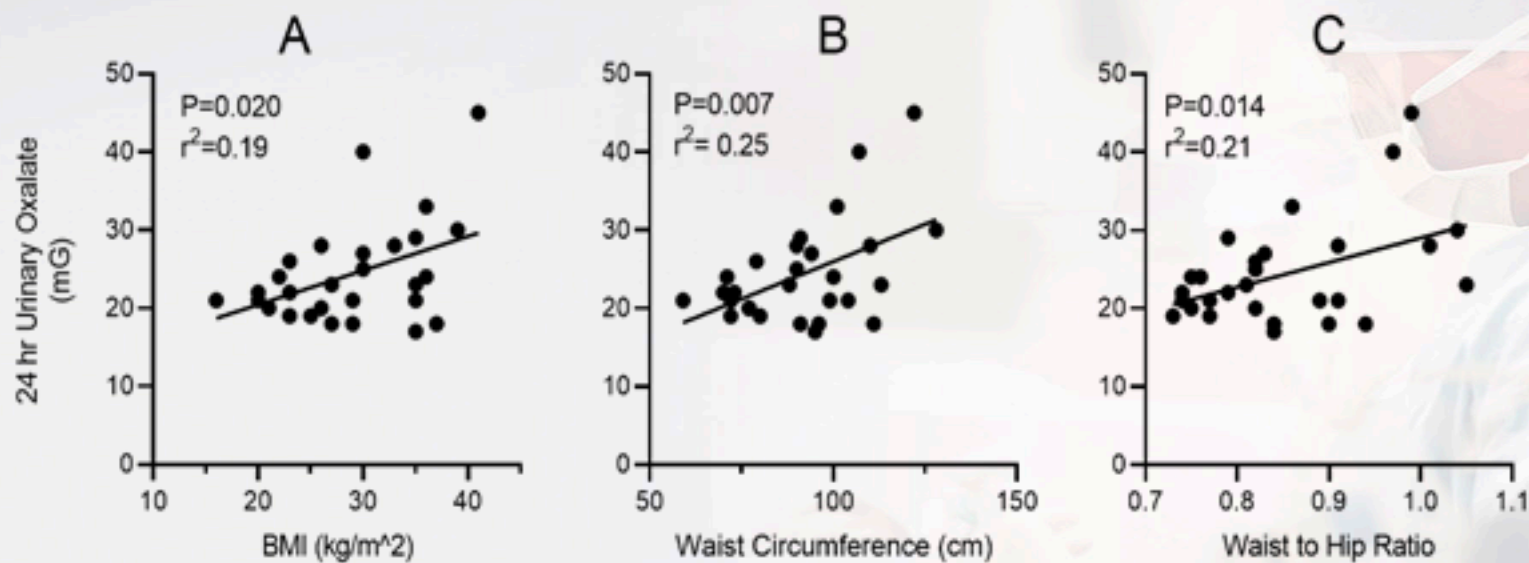


Figure Correlation between 24-hr urinary oxalate excretion and BMI (Panel A), waist circumference (Panel B) and waist to hip ratio (Panel C) of healthy subjects on a low oxalate controlled diet.

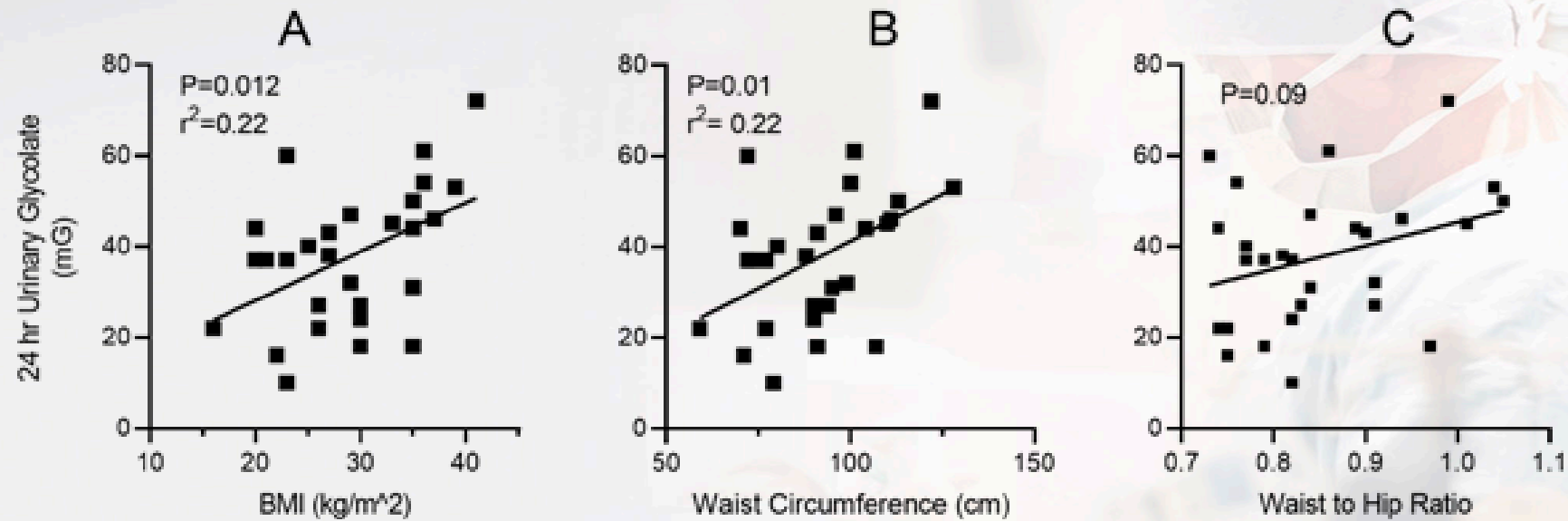
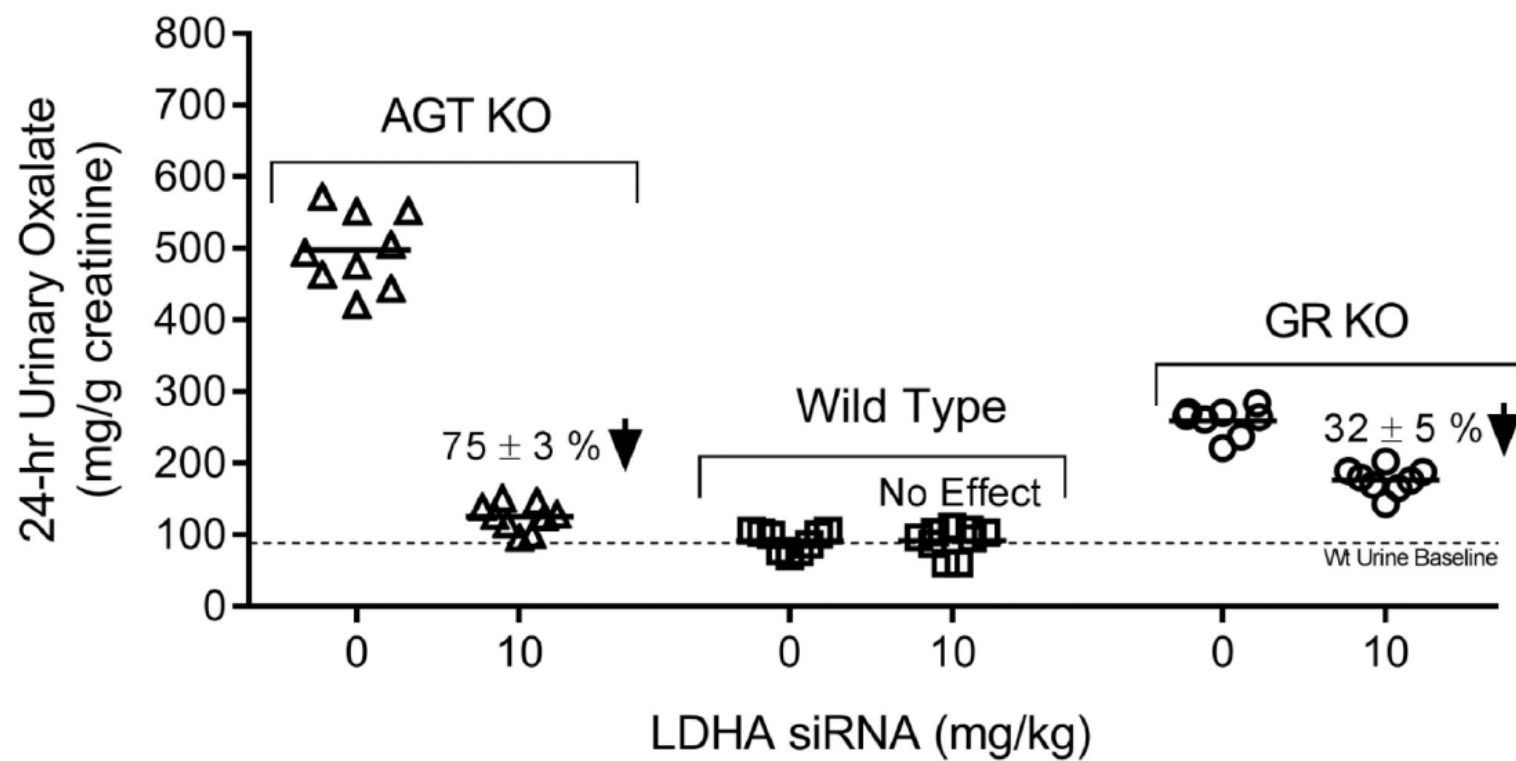
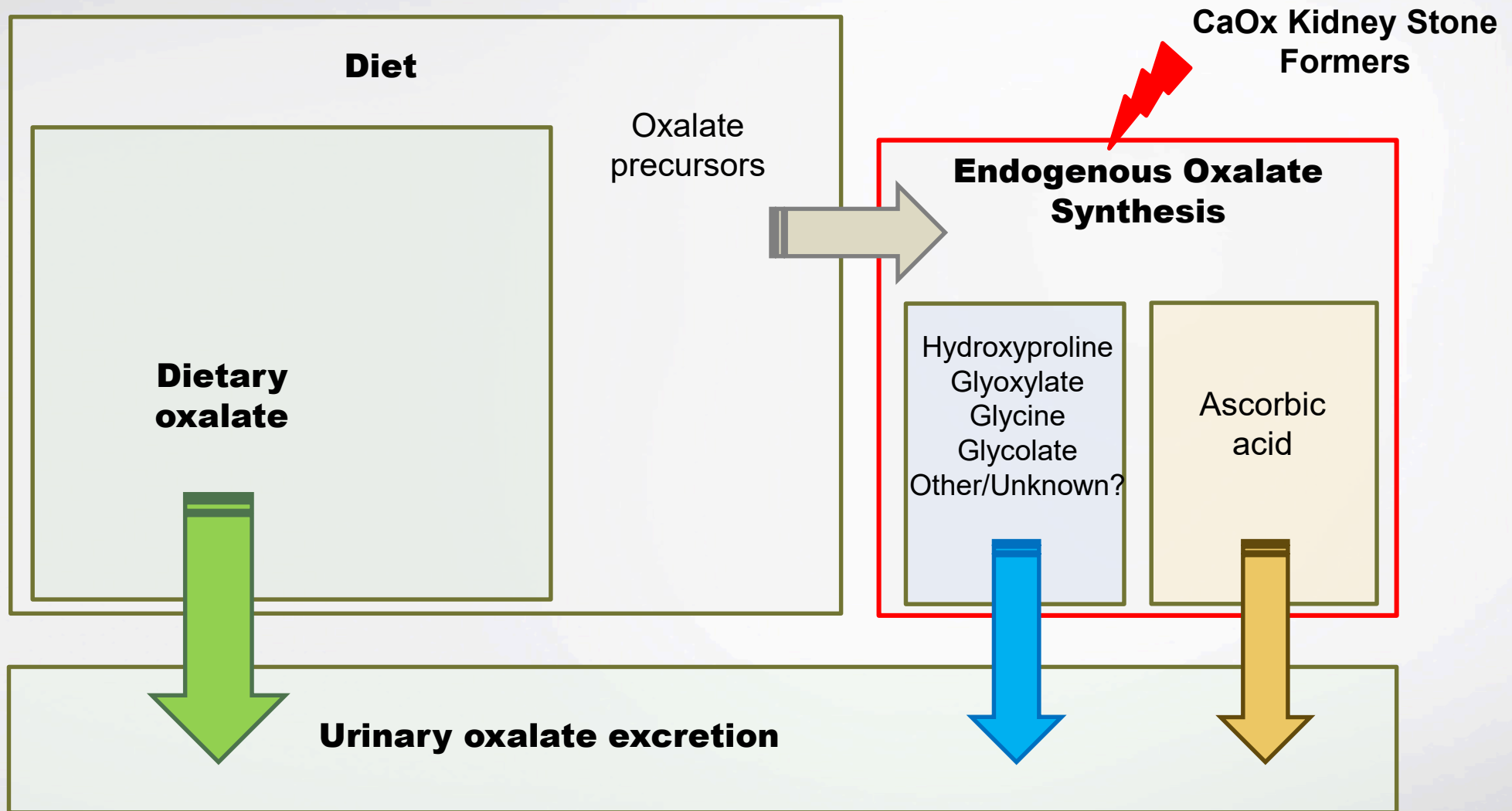


Figure Correlation between 24-hr urinary glycolate excretion and BMI (Panel A), waist circumference (Panel B) and waist to hip ratio (Panel C) of healthy subjects on a low oxalate controlled diet.





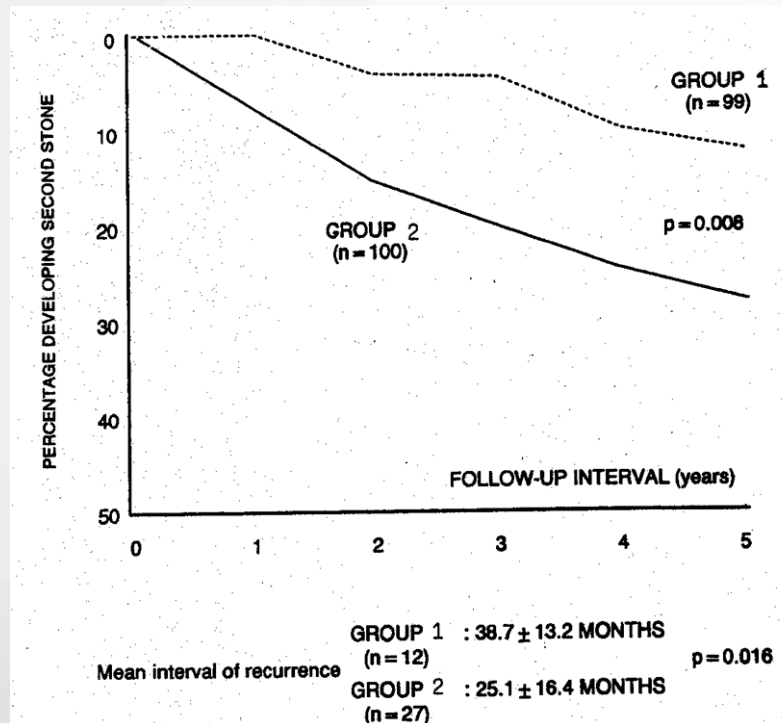
Medical and Surgical Management

- **Interventions**
- **Surgical Issues**
- **Conclusions**



Interventions: Guideline Statement

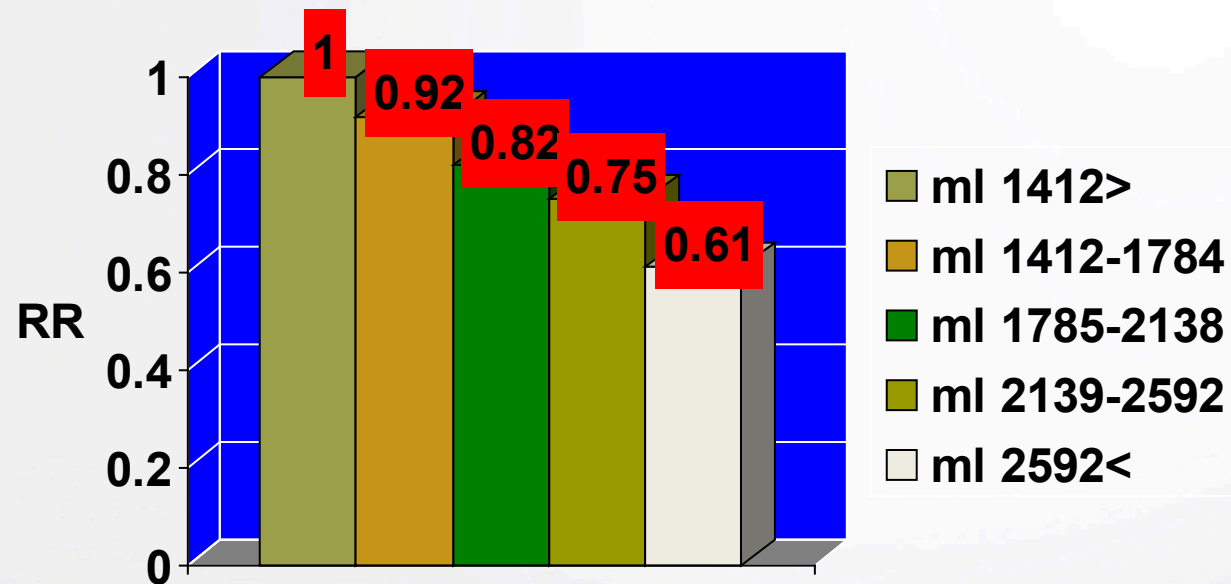
- Clinicians should recommend to all stone formers a fluid intake that will achieve a urine volume of at least 2.5 liters daily. (Standard; Evidence strength: Grade B.)



Borghi et al. J Urol 1996
Mar; 155(3): 839-843

Intervention: Fluid Intake

Relative Risk of Stone



Curhan et al. Annals of Internal Medicine, 126:497, 1997 (NHS I)

Interventions: Uric Acid Stone and Dissolution Therapy

- Hydration
- pH manipulation between 6.0-7.0
 - Potassium Citrate 20mEq BID
 - Sodium Citrate 30mEq BID
 - Sodium Bicarbonate
- pH diary
- Allopurinol for hyperuricosuric states

Intervention: Guideline Statement

- Clinicians should counsel patients with **calcium stones and relatively high urinary calcium excretion** to limit sodium intake and consume 1000-1200 mg of dietary calcium per day.
(Standard; Evidence Strength: Grade B)

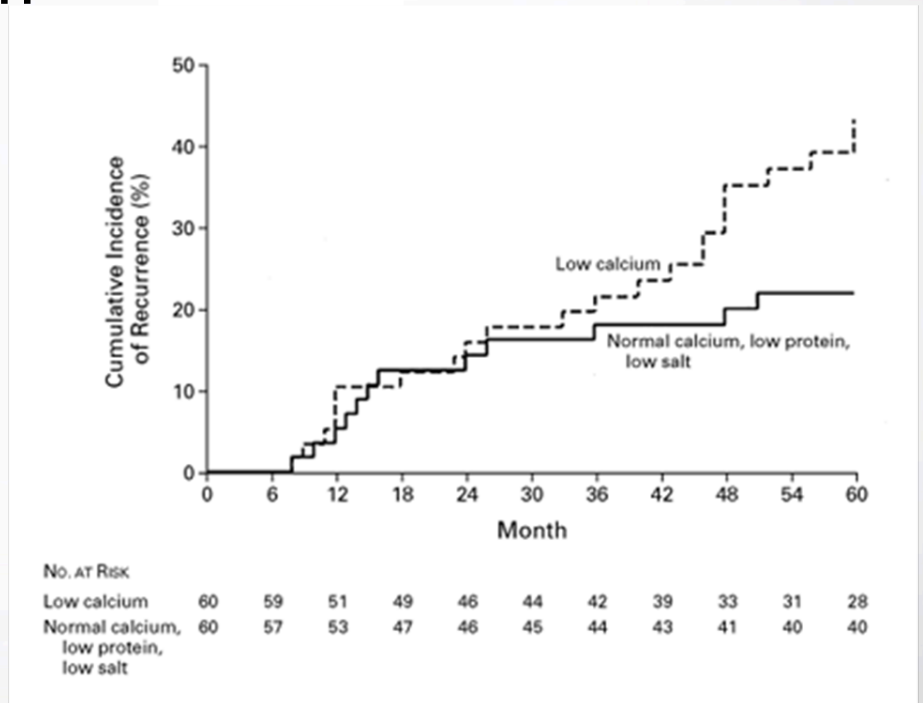
Intervention: Limit Salt, Normal Calcium

- Increased salt, increases urinary calcium and decreases urinary citrate

Sakhaee et al. Journal of Urology, 150:310,1993

- WHI observational study, sodium intake divided into quintiles
- Risk increased 61% in highest quintile

Sorensen et al. Journal of Urology,187:1645, 2012.



Borghi et al. NEJM; 346: 77, 2002.

Intervention: Guideline Statement

- Clinicians should counsel patients with calcium oxalate stones and relatively high urinary oxalate to limit intake of oxalate-rich foods and maintain normal calcium consumption (expert opinion)

Vitamin C and Stone Disease

- 1-2 grams per day to CaOx stoneformers
- Increases oxalate excretion 33-61%
- Increases risk of stone formation with >1 gram per day

Kidney International, 63:1066, 2003.

Journal of Urology, 170:397, 2003.

J Am Soc Nephrol, 15:3225-3232, 2004.



Intervention: Guideline Statement

- Clinicians should encourage patients with calcium stones and relatively low urinary citrate to increase their intake of fruits and vegetables and limit non-dairy animal protein (expert opinion).



Intervention: Guideline Statement

- Clinicians should counsel patients with uric acid stones or calcium stones and relatively high urinary uric acid to limit intake of non-dairy animal protein (expert opinion).



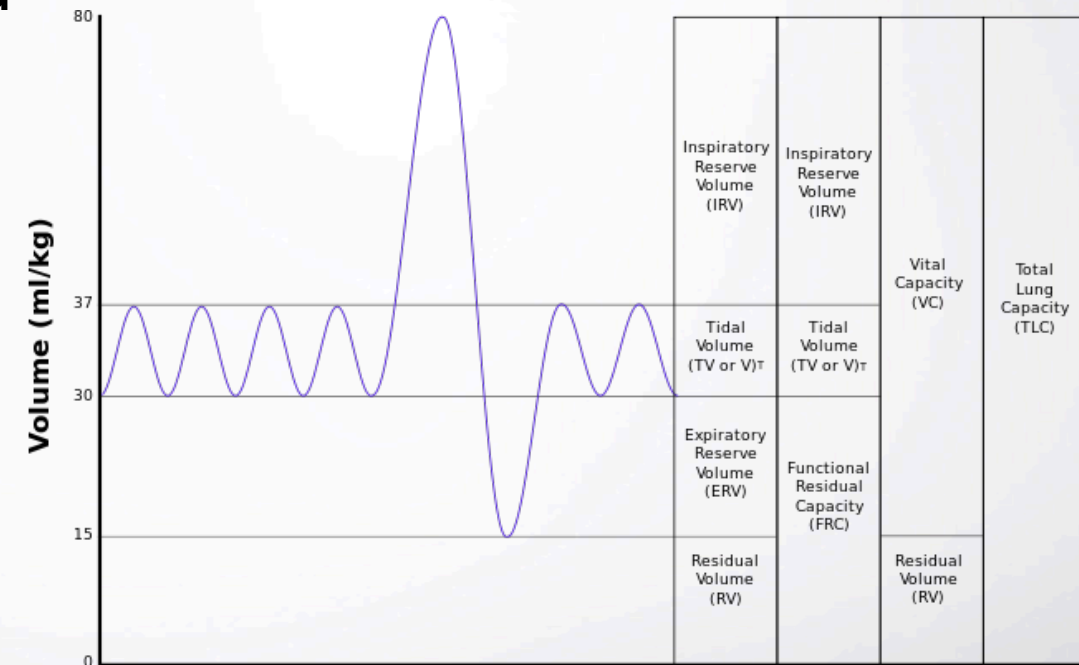
Surgical Management

- Interventions
- **Surgical Issues**
- Conclusions



Physiologic Considerations in Obesity

- Functional residual capacity decreased
- Expiratory reserve volume decreased
- Total lung capacity decreased
- Systemic blood pressure increased
- Left ventricular pressure increased
- Right ventricular pressure increased



Preoperative Anesthesia

- 77% prevalence of OSA
 - 131/170 patients
 - Independent of BMI
- Routine screening polysomnography
- 10% change in body weight, 30% change in the apnea-hypopnea index (sleep apnea severity)

O'Keefe. Obes Surg 2004; 14:23-6.

Intubation and Obesity

- Difficult intubation rate
 - BMI >35 15.5 %
 - Lean <30 2.2 %

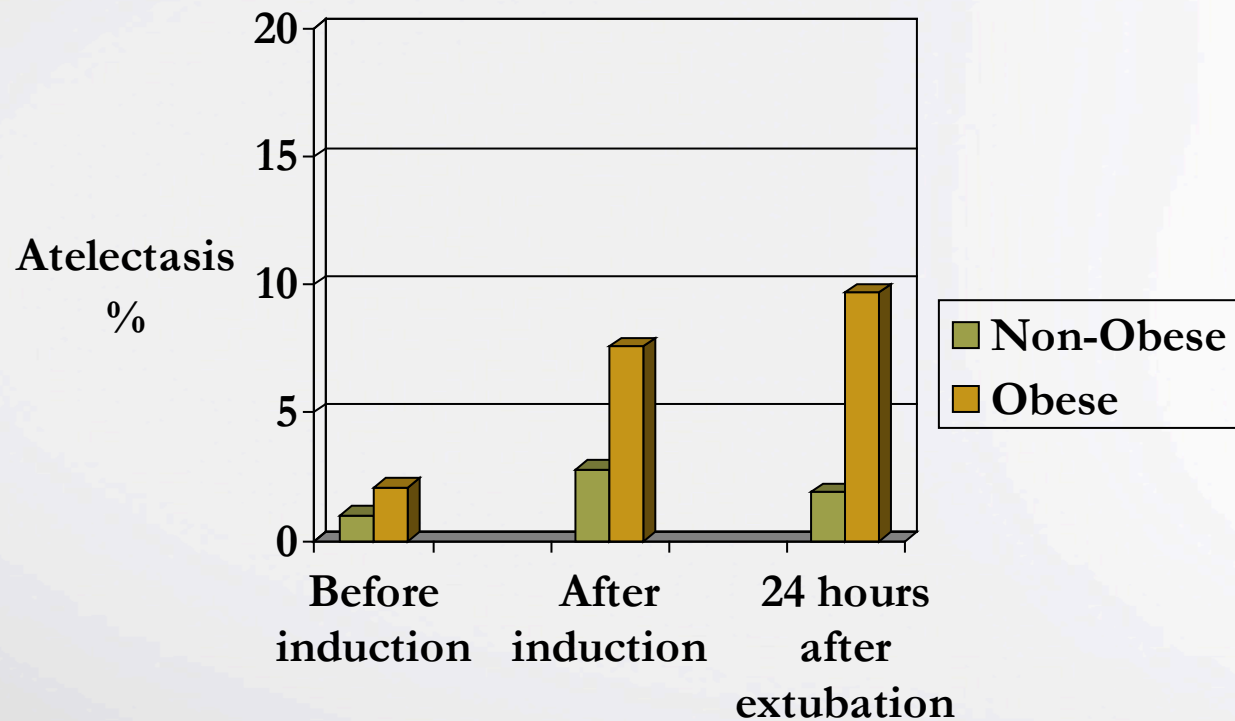
Juvin. Anesth Analg 2003;97:595-600

Ezri et al Can J Anesth 2003;50:179-83

Hiremath. BJA 1998;80:606-11



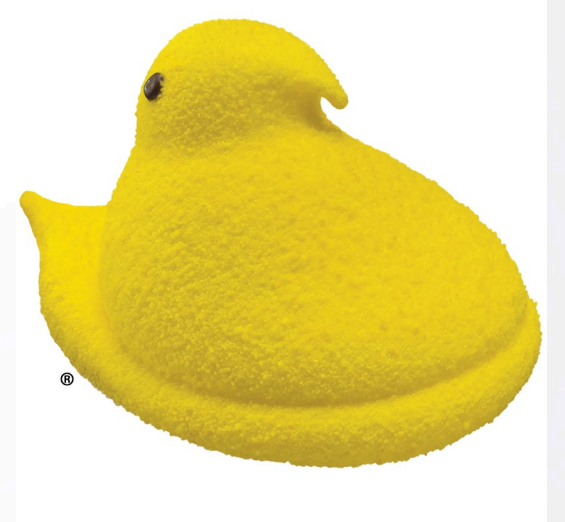
Atelectasis and Obesity



Eichenberger. Anesth Analg
2002;95:1788-92

Anesthesia Interventions

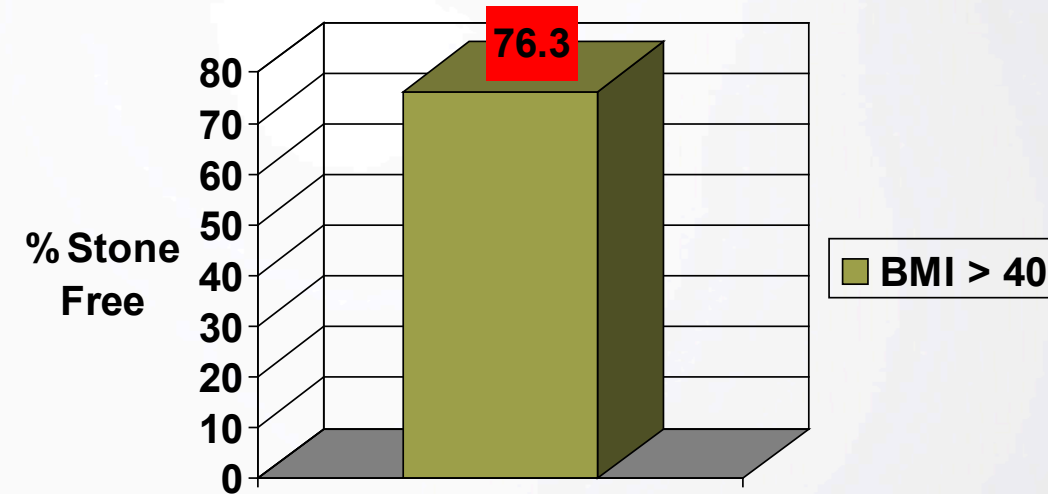
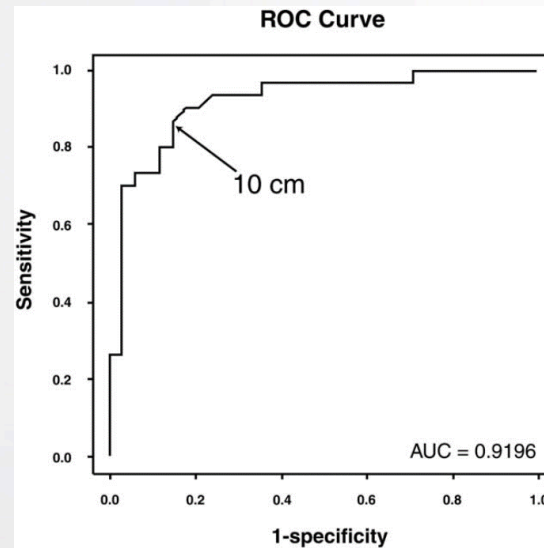
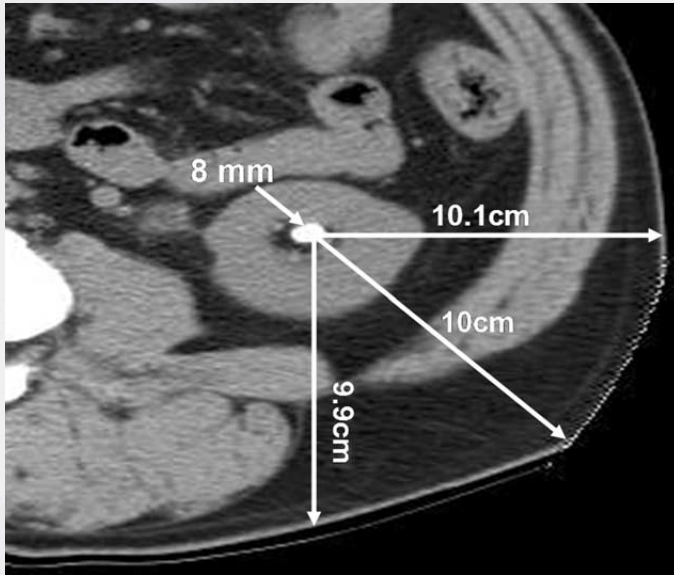
- Pre-induction with PEEP
 - Reduction of atelectasis: 10% controls vs 1.7% PEEP group
 - Increased PaO₂: 315 mm Hg controls vs 457 Hg PEEP group
- Awake intubation



Anesthesia Analgesia 2004;98:1491-5
Journal of Endourology, 23:1599, 2009.

Coussa. Anesth Analg 2004;98:1491-5

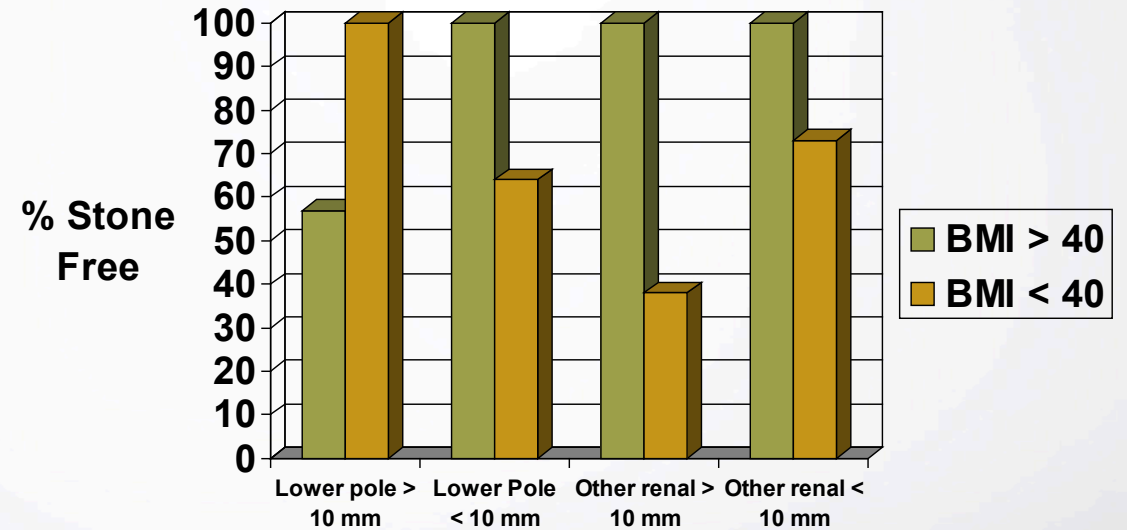
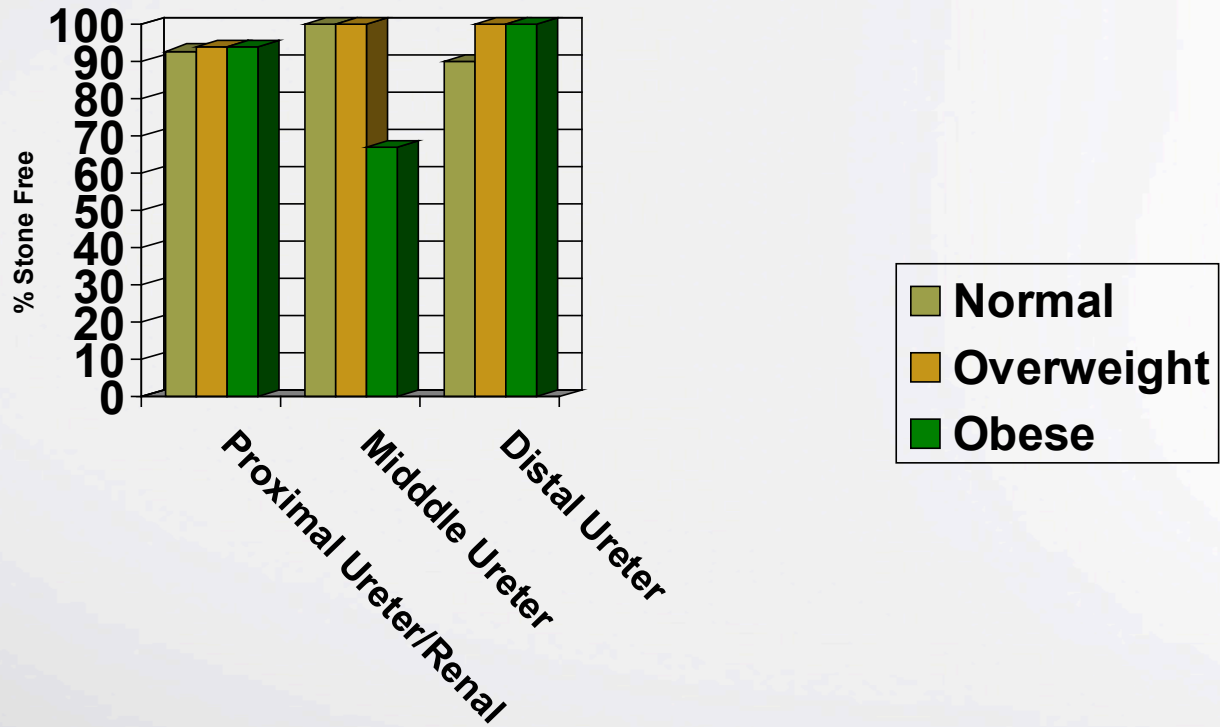
Surgical Issues: Shock Wave Lithotripsy



Journal of Urology, 150:30, 1993
Int. Braz. J of Urol. 31:105,2005

Urology, 66:941, 2005.

Surgical Issues: Ureteroscopy



Urology, 60:393, 2002.

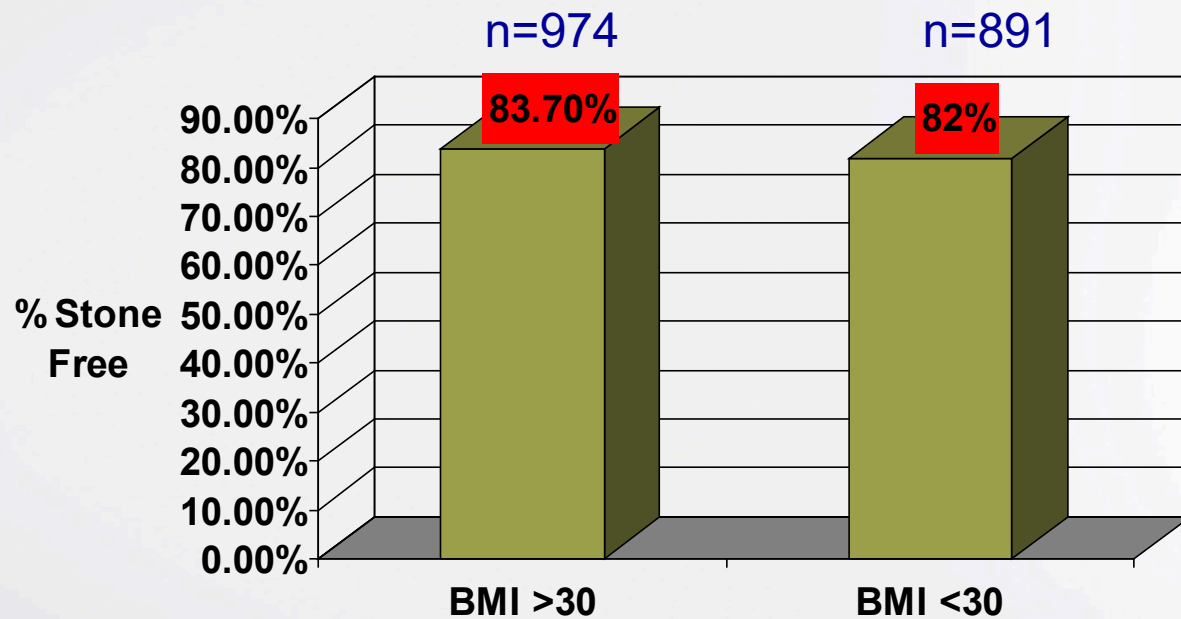
Int. Braz. J. of Urol. 35,36,2009

Surgical Issues: Ureteroscopic Challenges

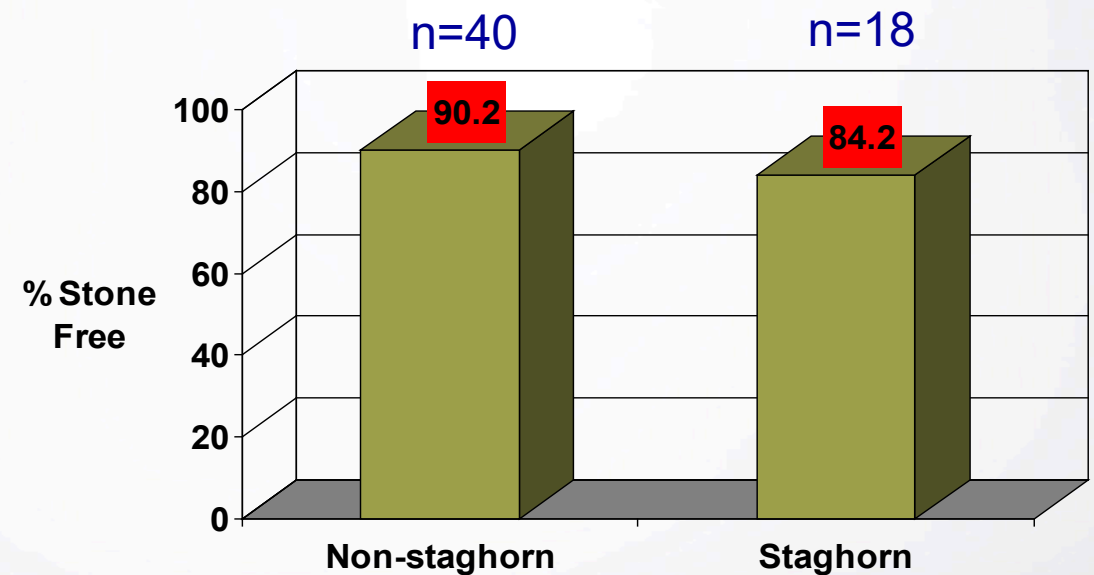
- Anesthesia
 - ↓ Vital capacity
 - ↑ Intra-abdominal pressure
 - ↑ Cardiac output
- Positioning
 - Increased risk of DVT and compartment syndrome
- Fluoroscopic Imaging



Surgical Issues: Percutaneous Nephrostolithotomy



6 Series from 1988-2008



Pearle et. al. Journal of Urology, 160:669,1998

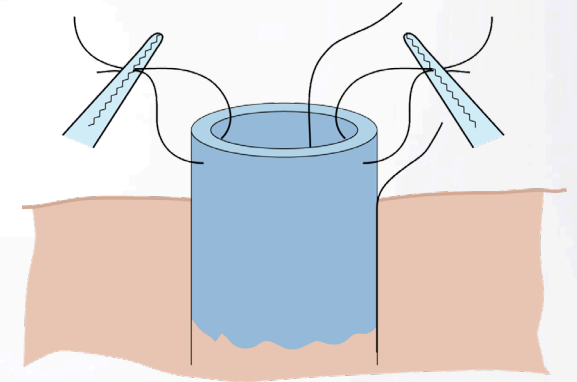
Surgical Issues: Prone Position

- ↑ oxygenation than supine
- ↑ pulmonary compliance than supine
- ↑ functional residual capacity than supine

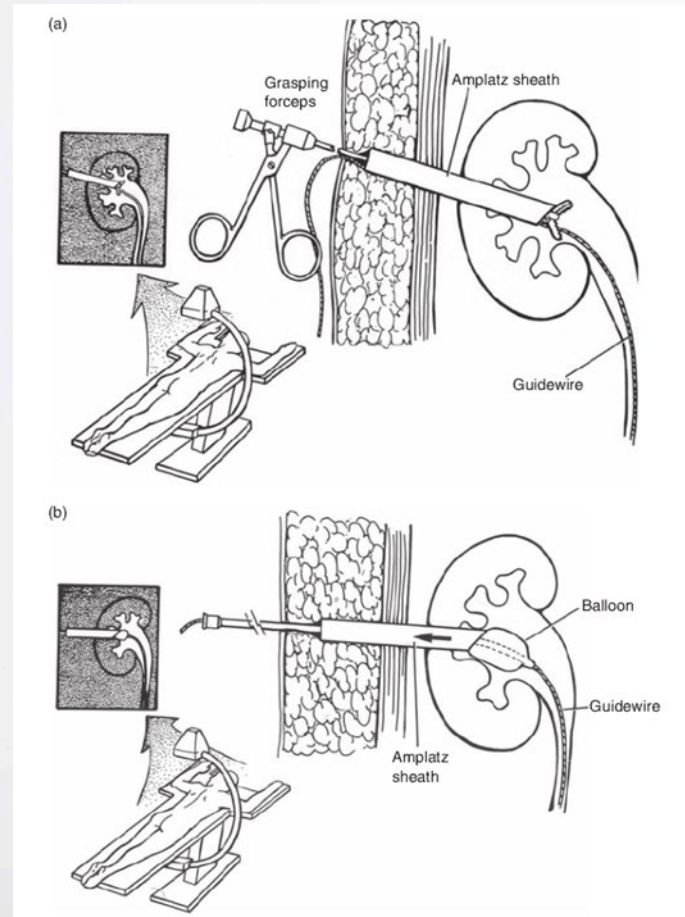


Technical Tips for Obese Patient

- Draping
- Secure sheath
- Extra long access needle
- Extra Long sheaths, nephroscope and rigid grasping devices.



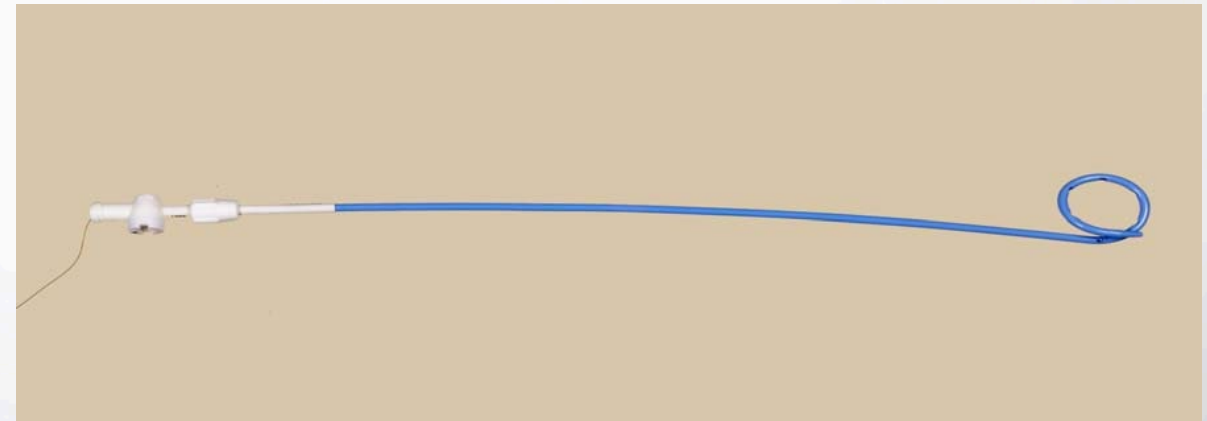
Technical Tips for Obese Patients





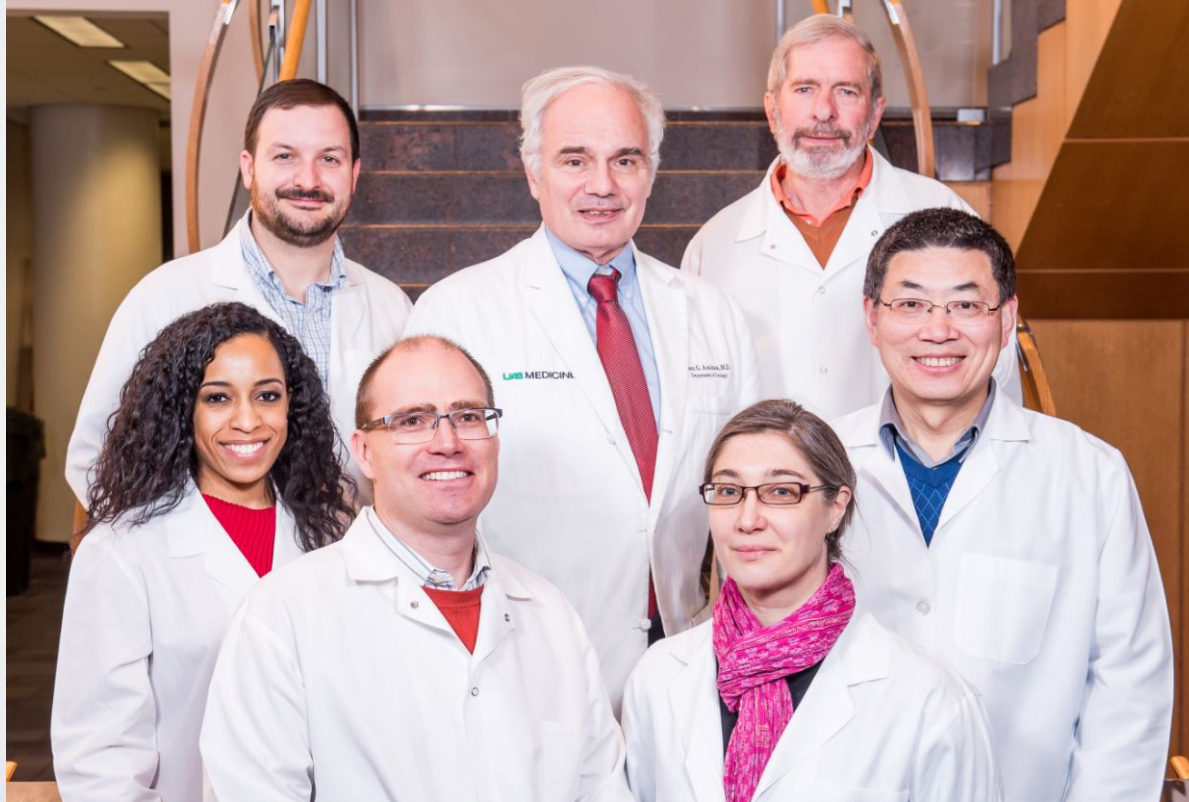
Technical Tips for Obese Patient

- Nephrostomy Tube
 - Success with tubeless PCNL has been reported
 - Frequent problems with tube displacement
 - Avoid securing tubes at skin level
 - Double J stent
 - Angiographic catheter
 - Circle-nephrostomy tube



Urology, 63:1036, 2004.

Thanks



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- UAB KSRL + Dr. Crivelli
- UTSW

