Serum Metabolomic Profile of the Dietary Approaches to Stop Hypertension (DASH) Dietary Pattern

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Serum untargeted metabolomic profile of the Dietary Approaches to Stop Hypertension (DASH) dietary pattern

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Background

- Diet is a modifiable risk factor for cardiometabolic diseases

- The usual methods for assessing dietary intake are prone to a high amount of measurement error

- Biomarkers are less susceptible to some sources of error, but there are few available biomarkers of dietary intake
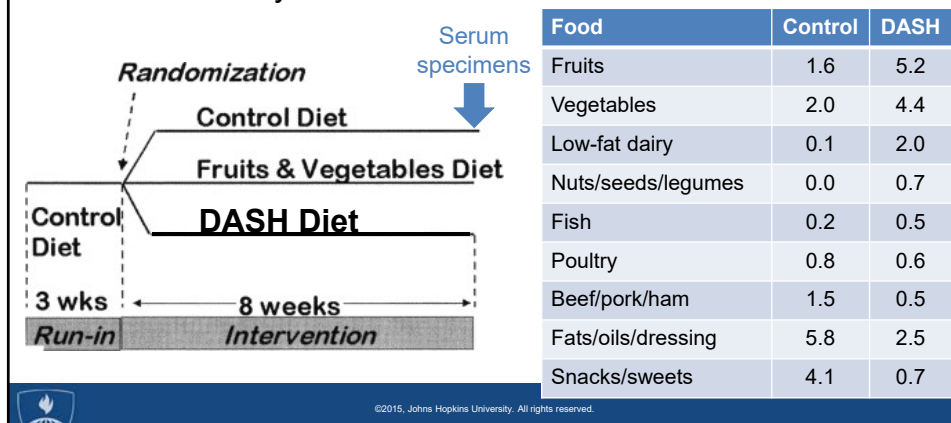 - ➢ Single nutrients vs. dietary pattern

Study Objective

- To identify individual metabolites and an overall metabolomic pattern associated with the DASH dietary pattern

DASH Dietary Pattern

- The DASH diet is a dietary pattern that is rich in fruits, vegetables, and low-fat dairy products; moderate in fish, poultry, nuts, and beans; and low in sugar-sweetened beverages, sweets, fats, and red meat
- This dietary pattern is recommended by the AHA and U.S. Dietary Guidelines for Americans
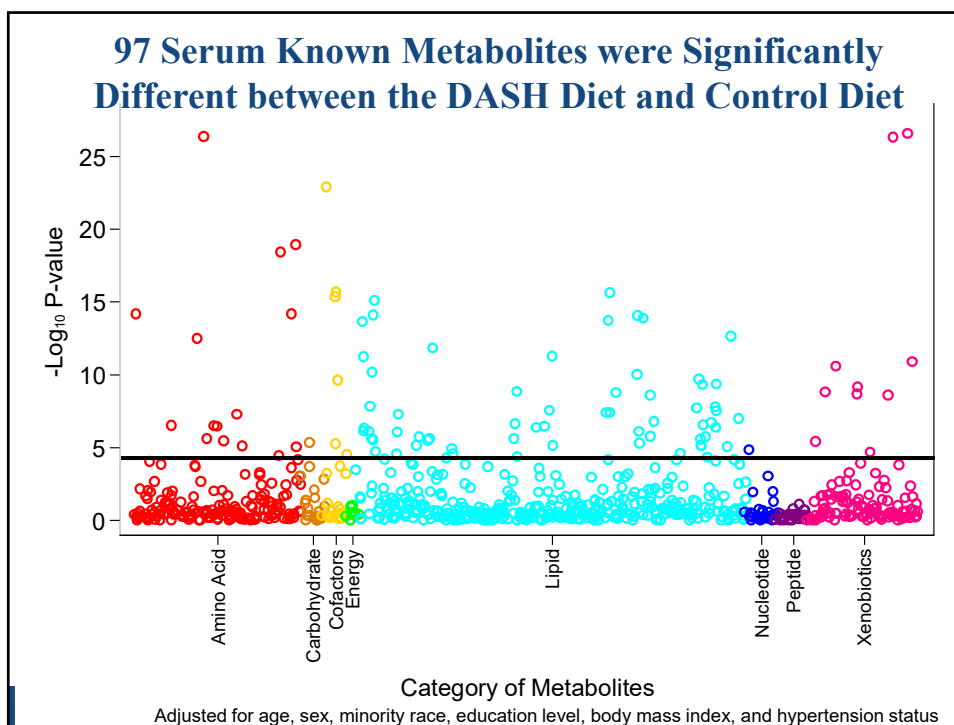
Serum specimens

Randomization

Control Diet

Fruits & Vegetables Diet

DASH Diet

Control Diet

3 wks — 8 weeks

Run-in | Intervention

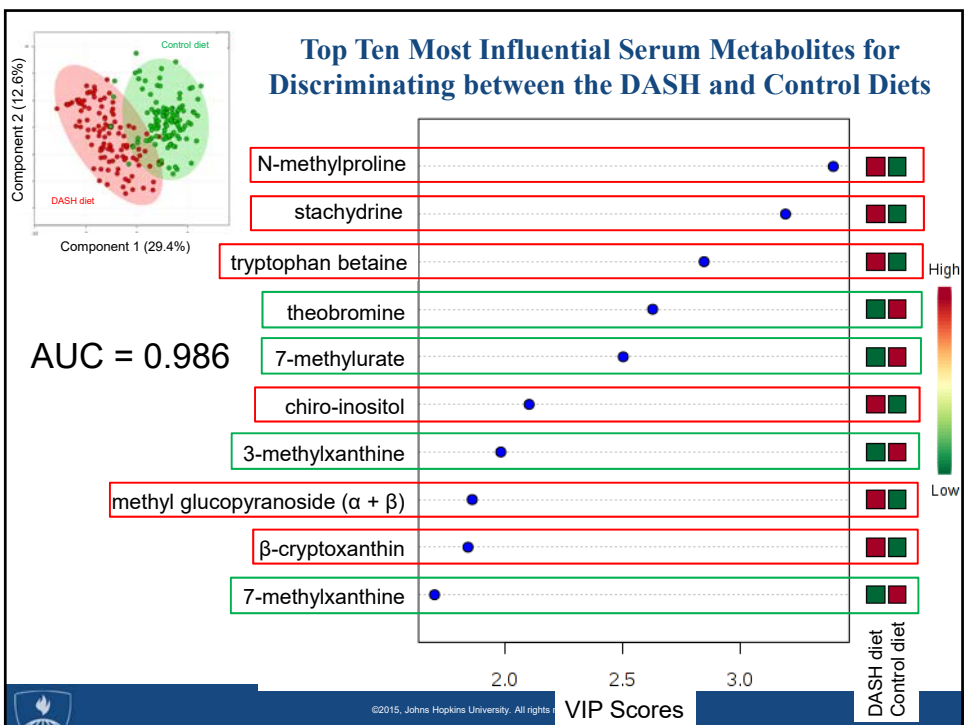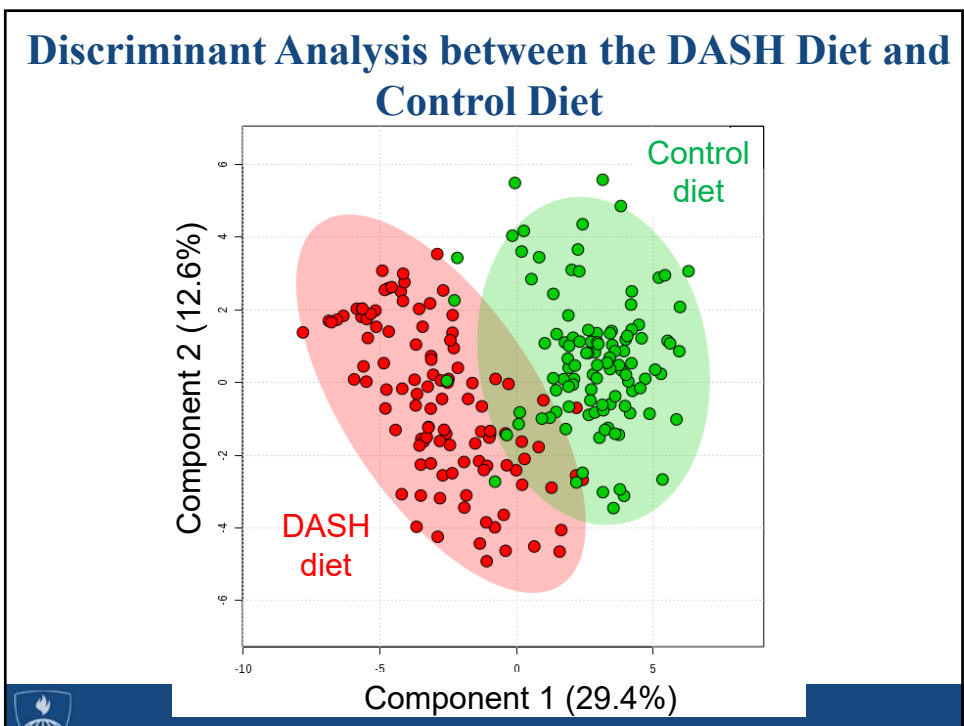| Food	Control	DASH
Fruits	1.6	5.2
Vegetables	2.0	4.4
Low-fat dairy	0.1	2.0
Nuts/seeds/legumes	0.0	0.7
Fish	0.2	0.5
Poultry	0.8	0.6
Beef/pork/ham	1.5	0.5
Fats/oils/dressing	5.8	2.5
Snacks/sweets	4.1	0.7

Methods

- Data and stored serum specimens from NHLBI BioLINCC repository

- Serum specimens collected at the end of eight weeks on the DASH or control diet (N=218)

- Global, untargeted metabolomic profiling performed using UPLC-MS/MS (Metabolon)

- Multivariable linear regression adjusted for age, sex, race, education, BMI, and hypertension

- Bonferroni correction

- Partial least squares-discriminant analysis (PLS-DA)

97 Serum Known Metabolites were Significantly Different between the DASH Diet and Control Diet

Discriminant Analysis between the DASH Diet and Control Diet

Top Ten Most Influential Serum Metabolites for Discriminating between the DASH and Control Diets

AUC = 0.986

Interpretation of Findings

Metabolite	Summary
Chiro-inositol	✓ Component of structural lipids of cell membranes ✓ Phytic acid found in fruits, beans, grains, nuts, and seeds
N-methylproline	✓ Citrus fruit and juice
Stachydrine	✓ Citrus fruits
Tryptophan betaine	✓ Lentils and legumes
Glucopyranoside	✓ Cereals and cereal products ✓ Total fruit intake
β-cryptoxanthin	✓ Provitamin A carotenoid ✓ Fruits and vegetables: red peppers, corn, citrus
Theobromine	✓ Chocolate ✓ Lower diet quality score
7-methylxanthine 3-methylxanthine 7-methylurate	✓ Caffeine and theobromine ✓ Desserts

Conclusion

- In this feeding trial, an untargeted metabolomic platform identified a broad array of serum metabolites that differed between the DASH and control dietary patterns after adjusting for participant characteristics and accounting for multiple comparisons.

- This newly identified panel of metabolites may be used to objectively assess adherence to the DASH dietary pattern.

- Further research is necessary to validate these findings in an independent population.

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Questions?

Thank You!

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Millions at a Time

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	Control Diet	DASH Diet
Energy intake, kcal	2,084.7	2,094.4
Carbohydrate, % of energy	49.8%	58.2%
Protein, % of energy	14.1%	18.2%
Fat, % of energy	36.8%	27.3%
SFA, % of energy	14.4%	7.4%
MUFA, % of energy	12.6%	10.5%
PUFA, % of energy	7.1%	7.6%
Sodium, mg	2,922.5	2,880.9
Calcium, mg	446.0	1,220.1
Magnesium, mg	169.2	464.7
Potassium, mg	1,742.8	4,589.1
Phosphorus, mg	939.7	1,481.1
Fiber, g/1,000 kcal	5.1	14.3
Cholesterol, mg/1,000 kcal	118.0	67.1

	Control Diet	DASH Diet
Vitamin A, IU	6,192.3	14,020.0
Thiamin (B1), mg	1.8	1.5
Riboflavin (B2), mg	1.5	1.9
Niacin (B3), mg	23.1	22.6
Pantothenic acid (B5), mg	3.0	4.7
Vitamin B6, mg	1.4	2.5
Vitamin B12, µg	2.9	4.2
Vitamin C, mg	132.8	266.2
Vitamin E	7.6	12.7
Folate, µg	168.2	390.3
Iron, mg	15.6	20.2
Zinc, mg	7.6	10.4
Caffeine, mg	2.3	0.0

	Control Diet (n=108)	DASH Diet (n=110)	Total (N=218)
Age category			
18-30 years	14.8% (16)	9.1% (10)	11.9% (26)
31-55 years	63.0% (68)	75.5% (83)	69.3% (151)
56+ years	22.2% (24)	15.5% (17)	18.8% (41)
Female sex	42.6% (46)	52.7% (58)	47.7% (104)
Minority race	54.6% (59)	60.9% (67)	57.8% (126)
Household income[†]			
<$29,999	34.9% (37)	30.9% (34)	32.9% (71)
$30,000-$59,999	43.4% (46)	47.3% (52)	45.4% (98)
≥$60,000	21.7% (23)	21.8% (24)	21.8% (47)
Employment status[‡]			
Full-time	76.6% (82)	80.0% (88)	78.3% (170)
Part-time	7.5% (8)	5.5% (6)	6.5% (14)
Retired	7.5% (8)	3.6% (4)	5.5% (12)
Other	8.4% (9)	10.9% (12)	9.7% (21)

	Control Diet (n=108)	DASH Diet (n=110)	Total (N=218)
Education level			
HS graduate or less	19.4% (21)	10.9% (12)	15.1% (33)
Some college	31.5% (34)	40.9% (45)	36.2% (79)
College graduate	25.0% (27)	31.8% (35)	28.4% (62)
Post-graduate work/degree	24.1% (26)	16.4% (18)	20.2% (44)
Current smoker[§]	26.8% (11)	15.6% (7)	20.9% (18)
Weight, kilograms	82.4 (15.0)	82.6 (14.7)	82.5 (14.8)
BMI, kg/m^2	28.0 (3.9)	28.3 (3.9)	28.2 (3.9)
SBP, mmHg	130.0 (12.5)	129.9 (11.9)	129.9 (12.2)
DBP, mmHg	85.2 (7.0)	83.7 (7.0)	84.5 (6.9)
Ever used BP medication‖	46.9% (23)	46.2% (24)	46.5% (47)
Hypertension status	26.9% (29)	24.6% (27)	25.7% (56)

	N-methylproline	stachydrine	tryptophan betaine	theobromine	7-methylurate	chiro-inositol	3-methylxanthine	methyl glucopyranoside	β-cryptoxanthin	7-methylxanthine
N-methylproline	1									
stachydrine	0.94 <0.001	1								
tryptophan betaine	0.46 <0.001	0.49 <0.001	1							
theobromine	-0.34 <0.001	-0.33 <0.001	-0.15 0.005	1						
7-methylurate	-0.28 <0.001	-0.27 <0.001	-0.17 0.002	0.77 <0.001	1					
chiro-inositol	0.67 <0.001	0.62 <0.001	0.26 <0.001	-0.21 <0.001	-0.16 0.004	1				
3-methylxanthine	-0.31 <0.001	-0.30 <0.001	-0.11 0.05	0.91 <0.001	0.81 <0.001	-0.17 0.002	1			
methyl glucopyranoside	0.71 <0.001	0.71 <0.001	0.44 <0.001	-0.28 <0.001	-0.26 <0.001	0.58 <0.001	-0.26 <0.001	1		
β-cryptoxanthin	0.55 <0.001	0.56 <0.001	0.32 <0.001	-0.28 <0.001	-0.26 <0.001	0.32 <0.001	-0.25 <0.001	0.48 <0.001	1	
7-methylxanthine	-0.28 <0.001	-0.28 <0.001	-0.11 0.04	0.90 <0.001	0.82 <0.001	-0.16 0.003	0.94 <0.001	-0.25 <0.001	-0.25 <0.001	1