

# The Association between Diet During Pregnancy and Infant Birth Weight in white Europeans and South Asians

CHILD, FAMILY, and START cohorts and FFQs, and  
dietary patterns using PCA

# Infant Birth Weight

- Birth weight is an indicator of health
- Low birth weight (<2500g) and SGA (<10%ile) infants are at increased risk of obesity, diabetes, and CVD.
- Approximately 40% hereditary and 60% environmental
- Independent risk factors include:
  - Sociodemographic: SES, education, ethnicity, & marital status.
  - Medical: Hypertension, diabetes, weight, infections, and infectious diseases
  - Pregnancy events: birth parity, weight gain, prenatal care
  - Environment: Stress, nutrition, coffee/stimulants, smoking, alcohol

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# Infant Birth Weight

- Developed nations present comparable percentages of incidence of LBW
- Prevalence of LBW differs (and persists) by ethnicity within developed nations
  - W. Euro (<6%) vs S. Asian (>9%) in UK
  - W. Euro (3517g (22)) vs S. Asian (3282 (22)) in Canada

# NutriGen Cohort

Variable	Overall	White European	South Asian	P-Value*
Number	3,892	2,845	1,047	
<b>Maternal</b>				
Age (years)	31.4 (4.6)	31.8 (4.7)	30.4 (3.9)	< 0.001
Height (cm)	165 (7.3)	166 (7.3)	162 (6.4)	<0.001
Pre-Pregnancy BMI (kg/m <sup>2</sup> )	24.9 (6.0)	25.4 (6.6)	23.8 (4.4)	<0.001
Gestational Weight Gain (kg)	14.7 (6.8)	15.0 (6.1)	14.0 (8.1)	<0.001
Parity (n)	0.7 (0.8)	0.7 (0.9)	0.8 (0.8)	<0.01
Gestational Diabetes Status (%)	4.9 %	1.3 %	14.7 %	<0.001
Smoking During Pregnancy (%)	<1%	<1%	0	>0.05
Household Income > \$50k (%)	78.9 %	88.5 %	49.2 %	<0.001
<b>Infant (Birth)</b>				
Sex (% Male)	48.6 %	48.1 %	50.1 %	>0.05
Gestational Age (weeks)	39.4 (1.5)	39.5 (1.5)	39.1 (1.5)	<0.001
Days after birth of infants weight and length were measured	1.0 (4.6)	0.5 (1.7)	2.5 (8.2)	<0.001
Birth weight (g)	3381 (514)	3442.7 (507.3)	3214.8 (498.3)	<0.001
Birth length (cm)	51.0 (3.0)	50.9 (3.1)	51.1 (2.7)	>0.05

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# Ethnicity and Diet

- Dietary intake is closely tied to ethnicity
  - foods, cooking methods, and eating habits

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Does diet associate with infant low birth weight in the NutriGen Alliance cohort and does the association differ in white European and South Asians?



# NutriGen FFQ and Dietary Analysis

- In each cohort, pregnant women completed FFQs
- FFQs are used to determine the food and beverages, and their quantities, consumed by an individual over a given time;
- FFQs were harmonized between the cohorts

	How often? <i>Write in ONE column only</i>				Average Serving	Your Serving Size		
	Per Day	Per Week	Per Month	Per Year or Never		Less Than Average (small)	Average (medium)	More Than Average (large)
<b>VEGETABLES, PEAS AND BEANS cont.</b>								
48. CUCUMBER	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	1/2 cup or 125 ml	<input type="text" value="s"/>	<input type="text" value="M"/>	<input type="text" value="L"/>

# Maternal Diet Patterns

## ① 36 Food Groups

- Meats
- Meat Dishes
- Organ Meats
- Processed Meats
- Poultry & Waterfowl
- Eggs
- Fish & Seafood

- Fats
- Fried Foods
- Full-Fat Dairy
- Low-Fat Dairy
- Fermented Dairy

- Refined Grains
- Pasta
- Pizza
- French Fries

- Leafy Greens
- Cruciferous Vegetables
- Starchy Vegetables
- Vegetable Medley
- Other Vegetables
- Fresh Seasonings
- Legumes
- Tofu
- Fruits
- Non-Meat Dishes
- Asian Noodles and Rice

- Snacks
- Sweets
- Condiments
- Sweet Drinks
- Artificial Sweet

- Whole Grains
- Nuts and Seeds

- Tea
- Coffee

## ② Principal Component Analysis with varimax rotation

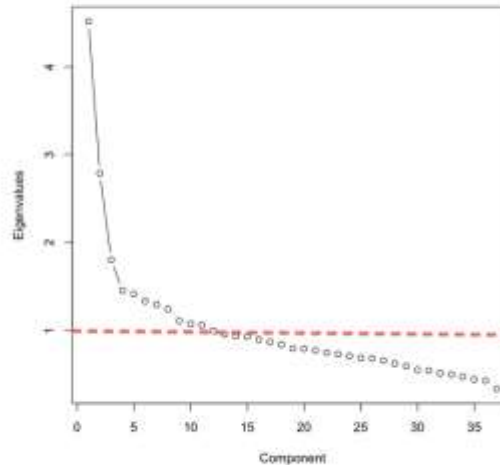


Figure 3. Scree Plot - Components above the bend or 'break' that present an eigenvalue  $\geq 1.0$  were retained

## ③ Loading Scores

	PC1	PC2	PC3	h2	u2	com
Fats	0.25	0.54	-0.07	0.357	0.64	1.4
Full.Fat.Dairy	0.03	0.20	0.11	0.052	0.95	1.6
Low.Fat.Dairy	0.38	0.42	-0.28	0.402	0.60	2.8
Fermented.Dairy	0.60	0.03	0.02	0.365	0.63	1.0
Meat	-0.42	0.47	0.24	0.452	0.55	2.5
Eggs	0.01	0.03	0.32	0.105	0.89	1.0
Organ.Meats	-0.03	0.03	0.11	0.014	0.99	1.2
Fish..Seafood	-0.12	0.07	0.50	0.265	0.74	1.1
Processed.Meats	-0.26	0.57	0.09	0.402	0.60	1.5
Meat..Dishes	-0.25	0.06	0.47	0.289	0.71	1.6
Poultry	-0.33	0.26	0.31	0.266	0.73	2.9
Fried.Foods	-0.23	0.02	0.16	0.081	0.92	1.8
Leafy.Greens	0.02	-0.05	0.33	0.115	0.88	1.1
Cruciferous.Vegetables	0.20	0.14	0.49	0.297	0.70	1.5
Legumes	0.63	-0.17	0.21	0.469	0.53	1.4
Fresh.Seasonings	0.73	-0.21	-0.02	0.578	0.42	1.2
Starchy.Vegetables	0.01	0.45	0.21	0.248	0.75	1.4
Vegetable.Medley	0.41	0.02	0.47	0.393	0.61	2.0
Other.Vegetables	0.70	-0.03	0.32	0.591	0.41	1.4
Tofu	0.14	-0.08	0.17	0.055	0.95	2.4
Fruits	0.14	0.07	0.50	0.276	0.72	1.2
Whole.Grains	0.73	0.16	-0.18	0.584	0.42	1.2
Refined.Grains	-0.14	0.19	0.32	0.158	0.84	2.1
Pasta	-0.18	0.54	0.11	0.335	0.67	1.3
Pizza	-0.23	0.29	0.16	0.161	0.84	2.5
French.Fries	-0.16	0.44	0.08	0.223	0.78	1.3
Non.Fried.Non.Meat.Dishes	0.66	-0.05	0.11	0.454	0.55	1.1
Stir.Fried.Noodles.Rice	0.06	-0.05	0.43	0.192	0.81	1.1
Snacks	0.00	0.43	0.10	0.198	0.80	1.1
Nuts.and.Seeds	-0.14	0.14	0.41	0.206	0.79	1.5
Sweets	0.20	0.46	0.10	0.261	0.74	1.5
Condiments	-0.33	0.47	0.43	0.515	0.49	2.8
Tea	0.58	0.05	-0.17	0.372	0.63	1.2
Coffee	-0.12	0.31	0.02	0.109	0.89	1.3
Sweet.Drinks	0.14	0.57	-0.21	0.388	0.61	1.4
Artificial.Sweet	0.00	0.22	-0.07	0.053	0.95	1.2

# PCA Diets

## Three diet patterns:

### 1. Plant-based:

- Aversion to meat and tendency towards legumes, vegetables, and whole grains

### 2. Western

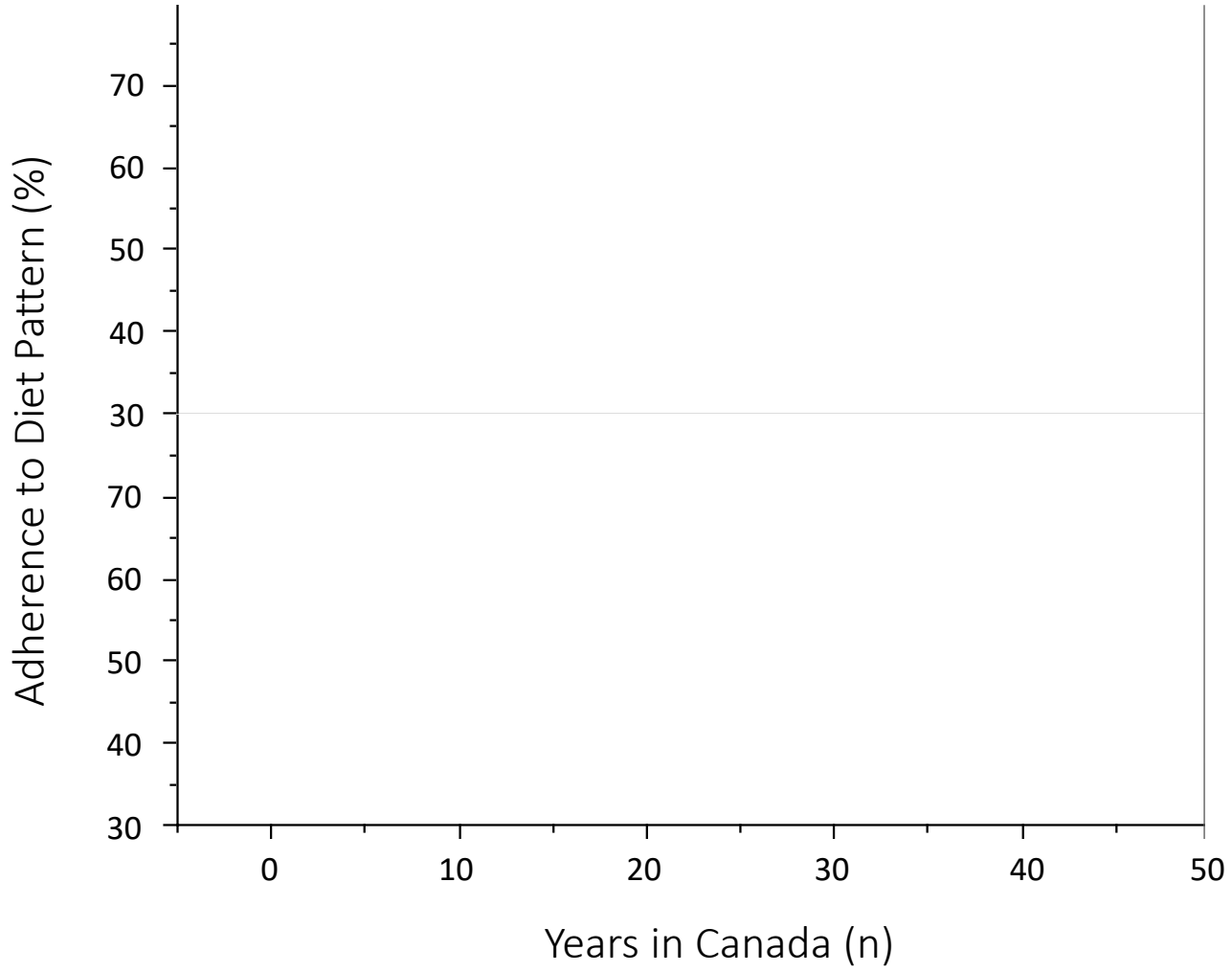
- Fats, meats, processed meats, starchy vegetables, French fries, snacks, and sweets

### 3. Polo-pescetarian

- Eggs, fish, poultry, vegetables, refined grains, nuts & seeds

Food Group	Plant-based	Western	Polo-pescetarian
Fats	.	0.54	.
Full Fat Dairy	.	.	.
Low Fat Dairy	0.38	0.42	.
Fermented Dairy	0.60	.	.
Meat	(-0.42)	0.47	.
Eggs	.	.	0.32
Organ Meats	.	.	.
Fish and Seafood	.	.	0.50
Processed Meats	.	0.57	.
Meat Dishes	.	.	0.47
Poultry and Waterfowl	(-0.33)	.	0.31
Fried Foods	.	.	.
Leafy Greens	.	.	0.33
Cruciferous Vegetables	.	.	0.49
Legumes	0.63	.	.
Fresh Seasonings	0.73	.	.
Starchy Vegetables	.	0.45	.
Vegetable Medley	0.41	.	0.47
Other Vegetables	0.70	.	0.32
Tofu	.	.	.
Fruits	.	.	0.50
Whole Grains	0.73	.	.
Refined Grains	.	.	0.32
Pasta	.	0.54	.
Pizza	.	.	.
French Fries	.	0.44	.
Non-Meat Dishes	0.66	.	.
Stir-Fried Dishes	.	.	0.43
Snacks	.	0.43	.
Nuts and Seeds	.	.	0.41
Sweets	.	0.46	.
Condiments	(-0.33)	0.47	0.43
Tea	0.58	.	.
Coffee	.	0.31	.
Sweet Drinks	.	0.57	.
Artificial Sweeteners	.	.	.
Eigenvalue	4.37	3.18	2.73
Cumulative Variation <sup>a</sup>	0.12	0.21	0.29

# Ethnicity and Dietary Habits

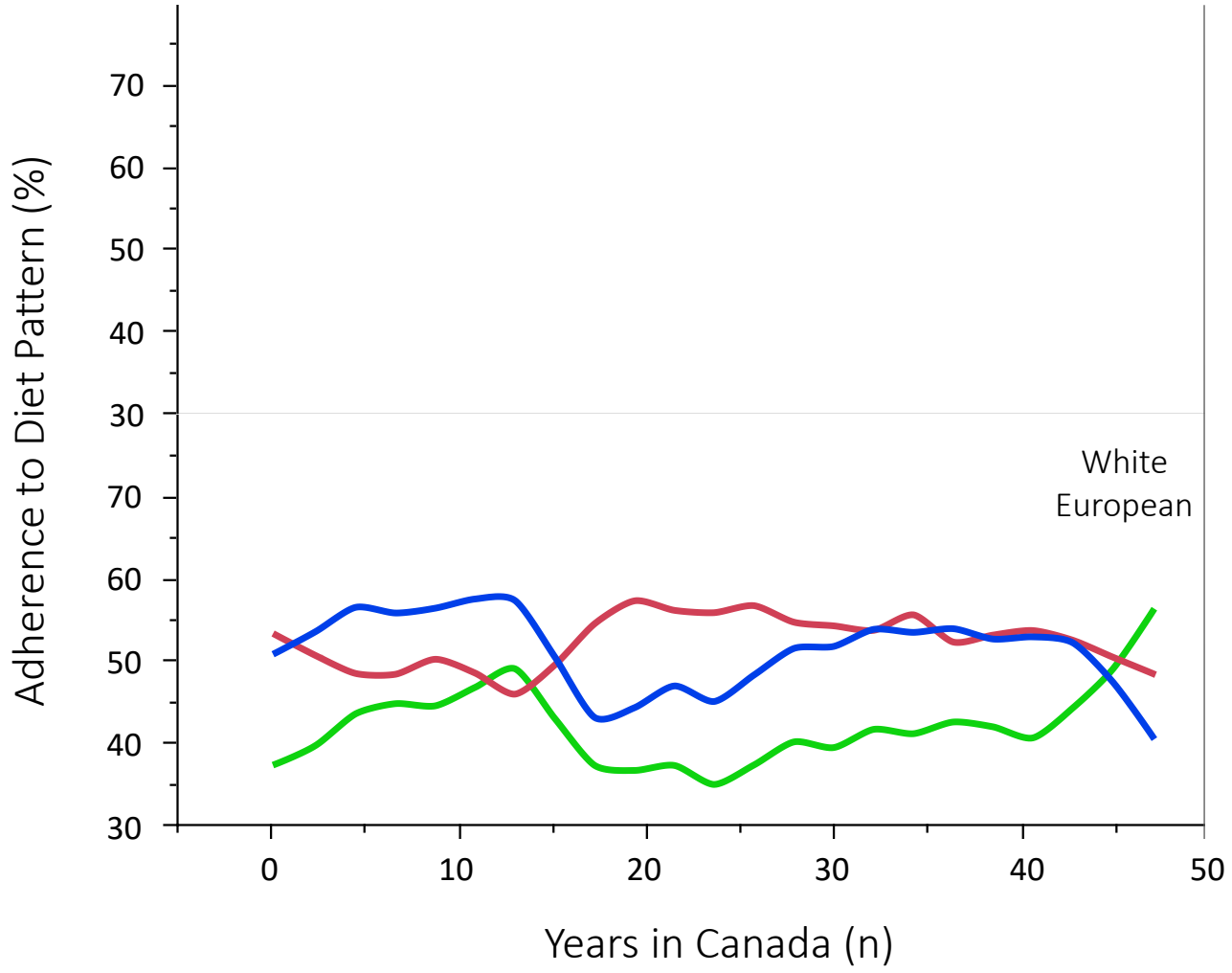


Plant-Based (%) Adherence

Western (%) Adherence

Polo-Pescetarian (%) Adherence

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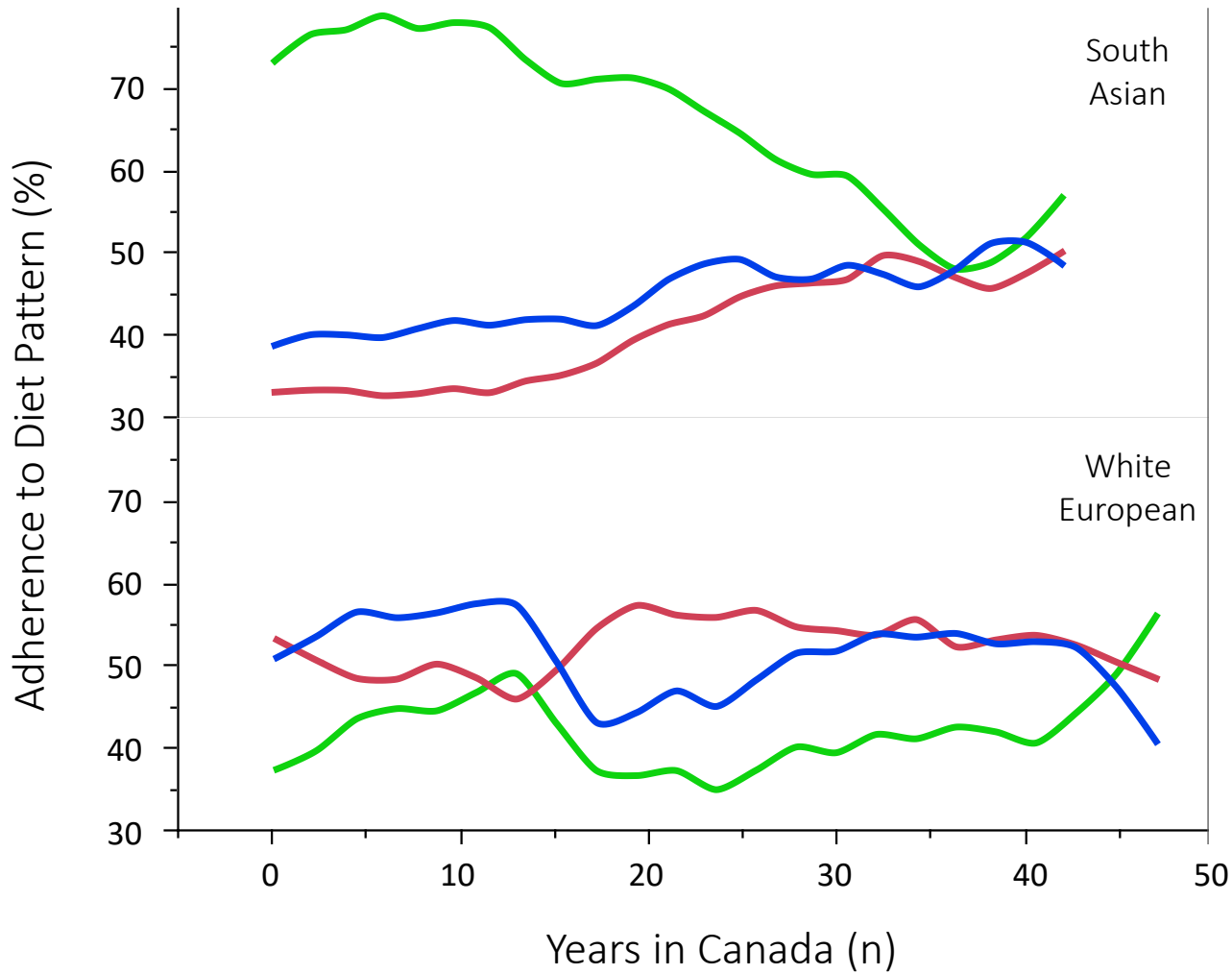


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# Covariates of birthweight

## 1. Potential covariates:

- Maternal age, pre-pregnancy weight, final pregnancy weight, gestational weight gain, height, smoking status, ethnicity, household income, education, gestational diabetes, hypertension, and years in Canada
- Infant birth order, sex, and gestational age

## 2. Univariate regression ( $P < 0.1$ )

## 3. Forward step-wise regression ( $P < 0.05$ ), with ethnicity

- Maternal ethnicity, final weight, height, and years in Canada, and infant parity, gestational age, sex, and birth length
  - Explained 50% of the variance ( $r^2$ ) of infant birth weight.

# Multi-Variable Regression of Infant Birth weight

Parameter	Estimate	P-value
Intercept	-6343.43	<0.001
Final Pregnancy Weight (kgs)	4.82	<0.001
Maternal Height (cms)	4.59	<0.001
Years in Canada (yrs)	2.26	< 0.05
Birth Parity (n)	47.02	<0.001
Gestational Age at Birth (kgs)	132.72	<0.001
Birth Length (cms)	66.55	<0.001
Sex <sup>b</sup>	-101.43	<0.001
Age of Birth Measurements (days)	4.94	<0.01
Ethnicity <sup>a</sup>	-76.57	<0.05
Plant-based Diet <sup>c</sup>	-12.01	ns
Western Diet <sup>c</sup>	-11.14	ns
Polo-pescetarian Diet <sup>c</sup>	-11.24	ns
Ethnicity <sup>a</sup> *Plant-based Diet <sup>c</sup>	50.61	<0.05
Ethnicity <sup>a</sup> *Western Diet <sup>c</sup>	15.41	ns
Ethnicity <sup>a</sup> *Polo-pescetarian <sup>c</sup> Diet	4.82	ns

<sup>a</sup> White European = 0 (reference); South Asian = 1; <sup>b</sup> Male = 0, Female = 1; <sup>c</sup> PCA score.



# Multi-Variable Regression of Infant Birth weight

Parameter	Estimate	P-value
<u>INTERPRETATION</u>		
W European	(3400)	= 3,400 g
Ethnicity <sup>a</sup>	-76.57	<0.05
Plant-based Diet <sup>c</sup>	-12.01	ns
Western Diet <sup>c</sup>	-11.14	ns
Polo-pescetarian Diet <sup>c</sup>	-11.24	ns
Ethnicity <sup>a</sup> *Plant-based Diet <sup>c</sup>	50.61	<0.05
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# Multi-Variable Regression of Infant Birth weight

Parameter	Estimate	P-value
<u>INTERPRETATION</u>		
W European (3400)		= 3,400 g
W European + Plant-Based (3400)		= 3,400 g
Ethnicity <sup>a</sup>	-76.57	<0.05
Plant-based Diet <sup>c</sup>	-12.01	ns
Western Diet <sup>c</sup>	-11.14	ns
Polo-pescetarian Diet <sup>c</sup>	-11.24	ns
Ethnicity <sup>a</sup> *Plant-based Diet <sup>c</sup>	50.61	<0.05
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Parameter	Estimate	P-value
<u>INTERPRETATION</u>		
W European (3400)		= 3,400 g
W European + Plant-Based (3400)		= 3,400 g
S Asian (3400 – 76.57)		= 3,323 g
Ethnicity <sup>a</sup>	-76.57	<0.05
Plant-based Diet <sup>c</sup>	-12.01	ns
Western Diet <sup>c</sup>	-11.14	ns
Polo-pescetarian Diet <sup>c</sup>	-11.24	ns
Ethnicity <sup>a</sup> *Plant-based Diet <sup>c</sup>	50.61	<0.05
Ethnicity <sup>a</sup> *Western Diet <sup>c</sup>	15.41	ns
Ethnicity <sup>a</sup> *Polo-pescetarian <sup>c</sup> Diet	4.82	ns

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W European + Plant-Based (3400)		= 3,400 g
S Asian (3400 - 76.57)		= 3,323 g
S Asian + Plant-Based (3400 - 76.57 + 50.61)		= 3,374 g
Ethnicity <sup>a</sup>	-76.57	<0.05
Plant-based Diet <sup>c</sup>	-12.01	ns
Western Diet <sup>c</sup>	-11.14	ns
Polo-pescetarian Diet <sup>c</sup>	-11.24	ns
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# Multi-Variable Logistic Regression of SGA

Parameter	Estimate	OR (95% CI)	P-value
Intercept	11.76	—	<0.001
Age of Mother (yrs)	0.055	1.06 (1.02 to 1.10)	<0.01
Pre-pregnancy BMI (kgs/m <sup>2</sup> )	-0.054	0.95 (0.92 to 0.98)	<0.001
Mother's Height (cms)	-0.059	0.94 (0.92 to 0.97)	<0.001
Birth Parity (n)	-0.604	0.55 (0.42 to 0.69)	<0.001
Household Income (>50k)	-0.604	0.55 (0.37 to 0.82)	<0.01
Years in Canada (yrs)	-0.015	0.99 (0.96 to 1.01)	ns
Gestational Age at Birth (kgs)	0.287	1.33 (1.19 to 1.50)	<0.001
Birth Length (cms)	-0.313	0.73 (0.68 to 0.78)	<0.001
Sex <sup>b</sup>	0.629	1.88 (1.36 to 2.60)	<0.001
Age of Birth Measurements (days)	-0.022	0.98 (0.92 to 1.01)	ns
Ethnicity <sup>a</sup>	-0.201	0.82 (0.43 to 1.53)	ns

## Small for gestational age (SGA)

- Infants born in the 10%ile for birthweight for their gestational age
- Can be subgroup-specific (i.e., ethnicity)
- Ethnic-specific cutoffs may associate more strongly with future health complication than generalized cutoffs

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Age of Birth Measurements (days)	-0.022	0.98 (0.92 to 1.01)	ns
Ethnicity <sup>a</sup>	-0.201	0.82 (0.43 to 1.53)	ns
Plant-based Diet <sup>c</sup>	-0.043	0.96 (0.74 to 1.23)	ns
Western Diet <sup>c</sup>	0.095	1.1 (0.83 to 1.46)	ns
Polo-pescetarian Diet <sup>c</sup>	-0.071	0.93 (0.74 to 1.16)	ns
Ethnicity <sup>a</sup> *Plant-based Diet <sup>c</sup>	-0.658	—	<0.01
Ethnicity <sup>a</sup> *Western Diet <sup>c</sup>	-0.593	—	ns
Ethnicity <sup>a</sup> *Polo-pescetarian <sup>c</sup> Diet	-0.071	—	ns

# Ethnicity and Diet vs SGA

Infants born to South Asian mothers are at no greater risk of SGA (OR = 0.66; 95% CI: 0.38 to 1.13), compared to white European infants

Infants born to high plant-based diet consumers are at no greater risk of SGA (OR = 0.87; 95% CI: 0.70 to 1.07), compared to white European infants

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## White Europeans

Plant-Based Diet	SGA		Overall
	SGA	Non-SGA	
High Adherence	114	451	872
Low Adherence	125	1859	1677
Overall	239	2310	2549

## South Asians

Plant-Based Diet	SGA		Overall
	SGA	Non-SGA	
High Adherence	27	249	276
Low Adherence	72	608	680
Overall	99	857	956



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Increased adherence to the plant-based diet by white European mothers, increases their infant's risk of SGA, while for South Asian mothers it reduces their infant's risk

Take home message

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- PCA can be used to identify common diet patterns in an ethnically diverse cohort

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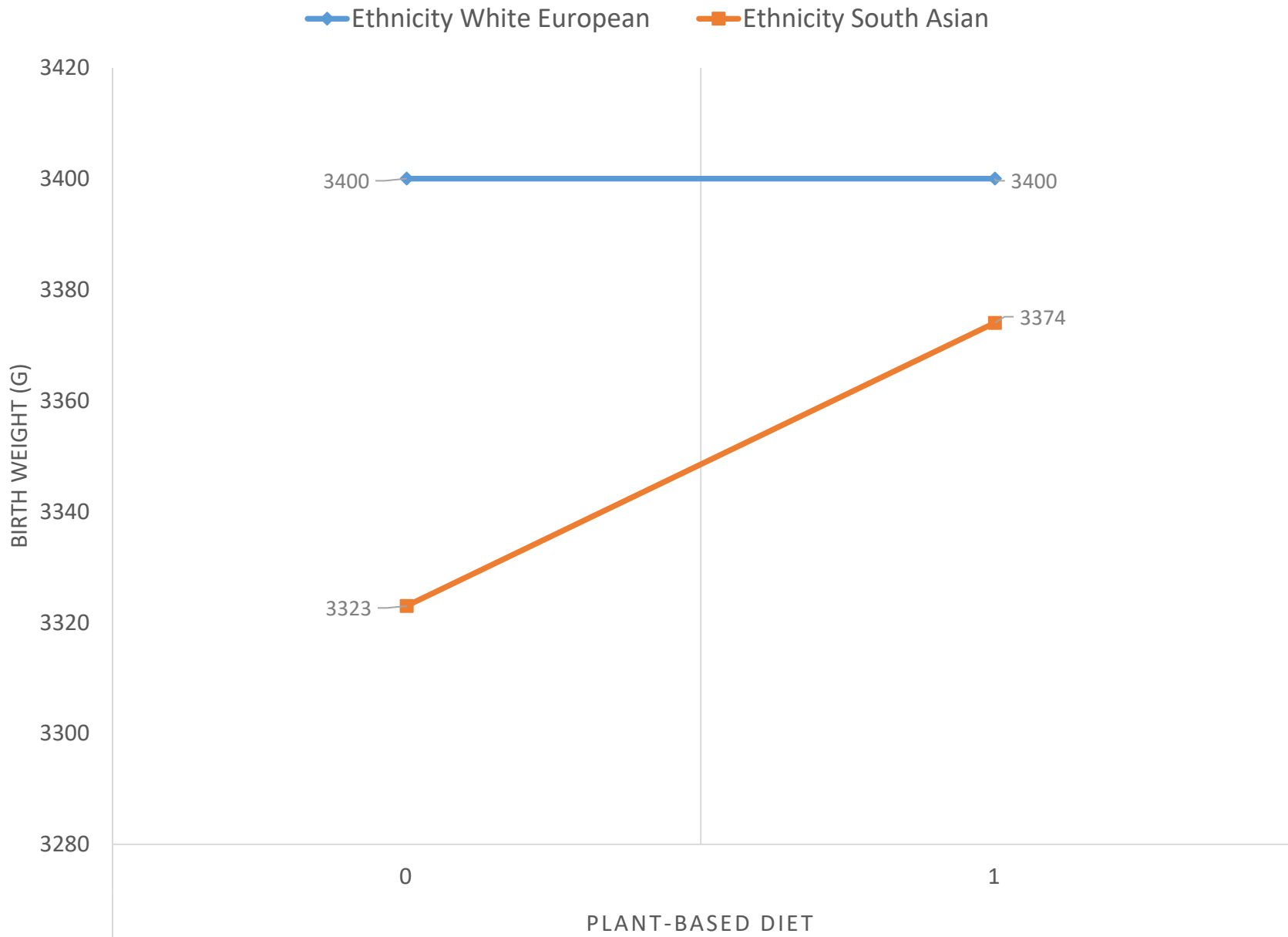
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- It's effect is modified by ethnicity







# Caloric Range

