Poverty and Cardiovascular Disease Risk in Children

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Background

- BA: Psychology, Cognitive Science (UCLA)
- PhD: Epidemiology (University of Rochester)
  - Dissertation: Risk of cardiovascular disease among people with HIV, Hepatitis C or coinfection
- Postdoc: Epidemiology (McGill)

Background

- Among adults, low socioeconomic status (SES) during childhood is associated with higher cardiovascular disease mortality
  - Even after controlling for current income and SES
- Among children, the association between childhood low SES and cardiovascular disease risk is less clear
  - Limited longitudinal data

Shrewsbury V and Wardle J. *Obesity* 2008; 16(2):275-284
Melchior M, et al. *Am J Epidemiology* 2007; 166(8): 966-974
Geyer S, et al. *J Epidemiol Community Health.* 2006;60:804-810.

Research Objectives

- Longitudinal analysis of a Quebec birth cohort:
  - Handling missing data in longitudinal studies
  - Defining overweight in youth
  - Effects of childhood poverty on nutrition
  - Childhood poverty experience and cardiovascular disease risk factors

Dataset

- Quebec Longitudinal Study of Child Development (ELDEQ) birth cohort (n=2,120)
- Eligible children identified through birth registry, randomly sampled from a multistage cluster sampling design
- Representative of singleton births in Québec (1998)

Data Collection

- Regular home interviews
  - Annual follow-up until 8 years old
  - Every two years after 8 years old
- Parental report
  - Child's health and behaviours
  - Household income
- Health measurements

Participation Rates

- Wave 1 (n=2120)
- Wave 10 (n=1334)

Descriptive Statistics

Characteristics at baseline	Wave 1 (n=2120)	Wave 10 (n=1334)
Poor household	24%	20%
Mother's an immigrant	12%	8%
≥ High school education	84%	86%
Single-parent household	8%	6%

1) Handling Missing Data

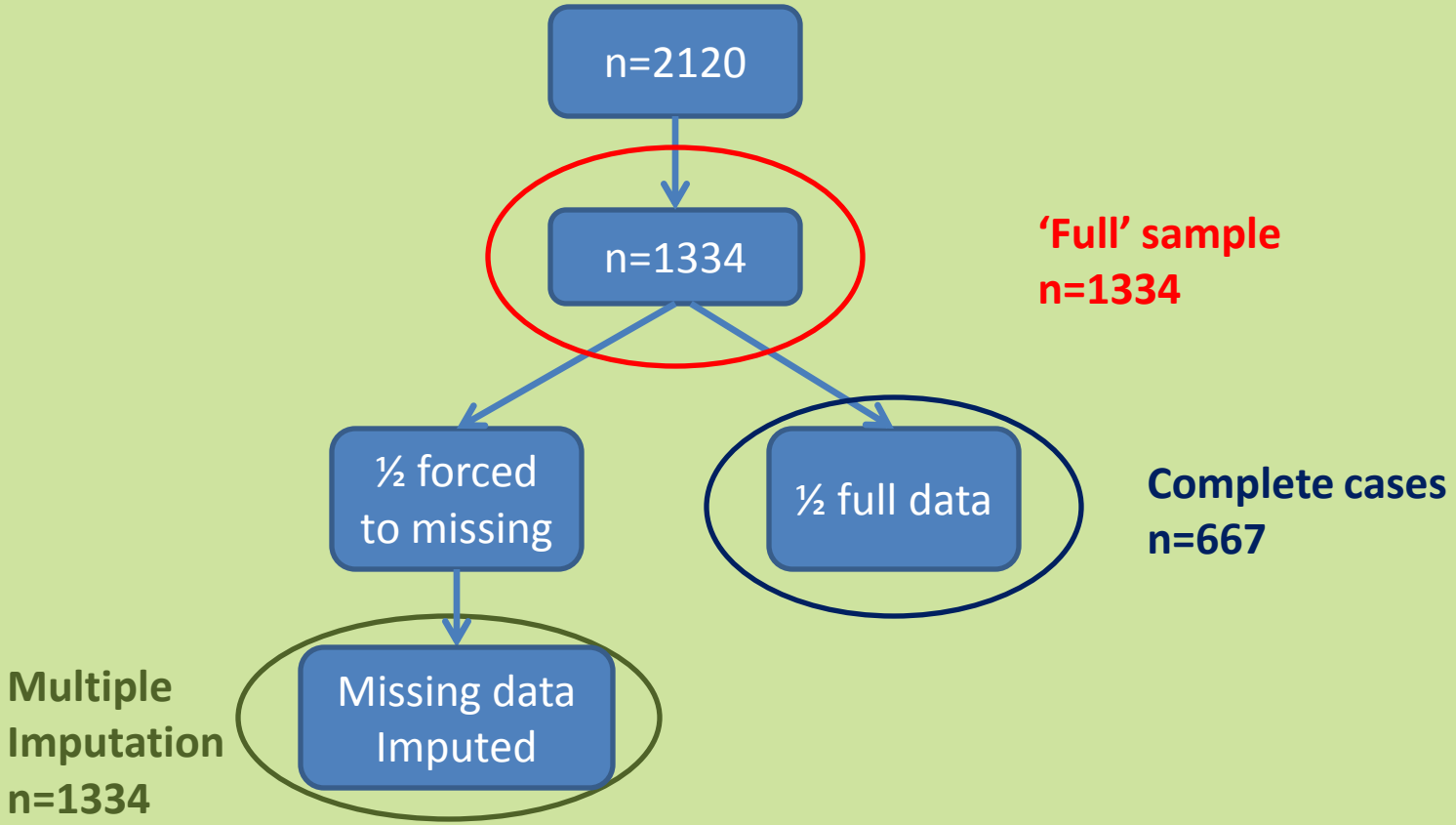
- Complete case
- Mean of the sample
- Last observation carried forward
- Imputation

Imputation

- Replaces missing values with predicted values from a regression using auxiliary variables
  - Auxiliary variables help to explain why data are missing
- Types of imputation
  - Single imputation
  - Multiple imputation

Objectives

- Compare parameter estimates of 1) imputed data or 2) complete cases to 3) 'full' sample



Analysis

- Scenario 1:
  - Data missing completely at random
- Scenario 2: Differential attrition
  - Poor households 2x more likely to be missing

Auxiliary variables

Children's variables

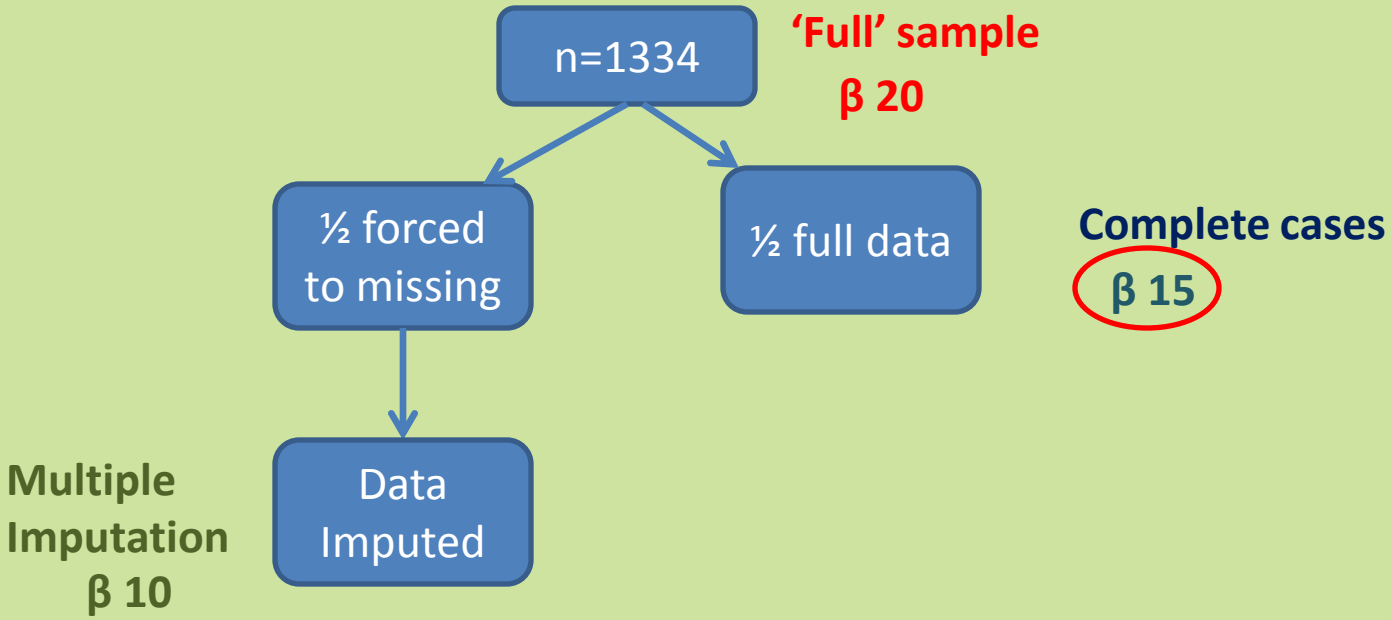
- Age (age 5 months, 5 years, 10 years)
- Sex
- Puberty (age 10)
- Whether the child is overweight or obese (age 6, 8, 10, 12)
- Physical activity (age 10)
- TV use (age 10)
- Birth weight

Parental variables

- Income level at all ages
- Parental education at least highschool (baseline)
- Maternal age
- Family type (age 5 months, 5 years, 10 years)
- Mother's immigration status
- Mother's employment status (baseline)
- Whether mother is overweight or obese

Example

- Compare parameter estimates of 1) imputed data or 2) complete cases to 3) 'full' sample



Newman DA. Organizational Research Methods 2003;6:328-62.

Results

- Data missing completely at random
  - Multiple imputation estimates were closer to the 'true' data 50% of the time
- With differential attrition
  - Multiple imputation estimates were closer to the 'true' data 75% of the time

Conclusions

- If there is differential attrition, using complete-case data will result in an analytic sample that is significantly different from the original sample
  - Incorporating data from multiple imputation may help to address this bias

Research Objectives

- Longitudinal analysis of a Quebec birth cohort:
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  - Defining overweight in youth
  - Effects of childhood poverty on nutrition
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2) Defining overweight in youth

1. In youth, BMI is compared to same-age and same-sex reference populations (*growth curves/growth charts)*
2. Numerous growth curves exist: the two most commonly used: CDC and WHO
3. No unified recommendations
   - European Obesity Task Force: WHO (0-5)
   - Canadian Pediatric Society: CDC (0-5), WHO (5-19)
   - CDC: WHO (0-2), CDC (2-19)

Background

BMI Growth Curves

	CDC	WHO
Year	2000	2006
Purpose	Represent typical growth	Represent optimal growth
Population	1963-1994 national US surveys (inc NHANES)	Brazil, Ghana, India, Norway, Oman, US
Definitions	Overweight: $\geq 85^{th}$ percentile Obese: $\geq 95^{th}$ percentile	Overweight: $\geq 85^{th}$ percentile Obese: $\geq 97.7^{th}$ percentile

Background: WHO vs CDC

Comparison of prevalence estimates

				Overweight		Obese	
1st author	Age	Data	N	WHO	CDC	WHO	CDC
Mei	0-5	NHANES 99-04	3920	8.5-13%	9.6%		
Shields	2-17	CCHS 2004	~10K	35%	28%	13%	12%
Khasnut-dinova	14-17	Russia	1066	10%	9%	5%	3%

Scenario

BMI
15.7

CDC algorithm

BMI percentile: 83.9

WHO algorithm

BMI percentile: 85.7

CDC: Normal weight, no action

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WHO: Overweight, Lipid profile

Objectives and Methods

- Assess how well BMI percentiles based on the CDC and the WHO growth curves predict cardiometabolic risk factors: ROC curves
- Assess how different definitions of overweight and obesity affect the prediction of cardiometabolic risk: Sensitivity/specificity

CMAJ RESEARCH

Association between different growth curve definitions of overweight and obesity and cardiometabolic risk in children

Lisa Kakinami PhD, Mélanie Henderson MD, Edgard E. Delvin PhD, Emile Levy MD PhD, Jennifer O'Loughlin PhD, Marie Lambert MD, Gilles Paradis MD

Methods: Dataset

1999 Québec Child and Adolescent Health and Social Survey (QCAHS)

- Multistage, stratified, cluster sampling
- Representative of 9, 13, 16 y.o. youth in and out of school in Québec (n=2,466)
- Outcomes assessed: lipids, glucose, insulin, blood pressure

Paradis G et al. Can J Cardiol 2003; 19(5):523-531.

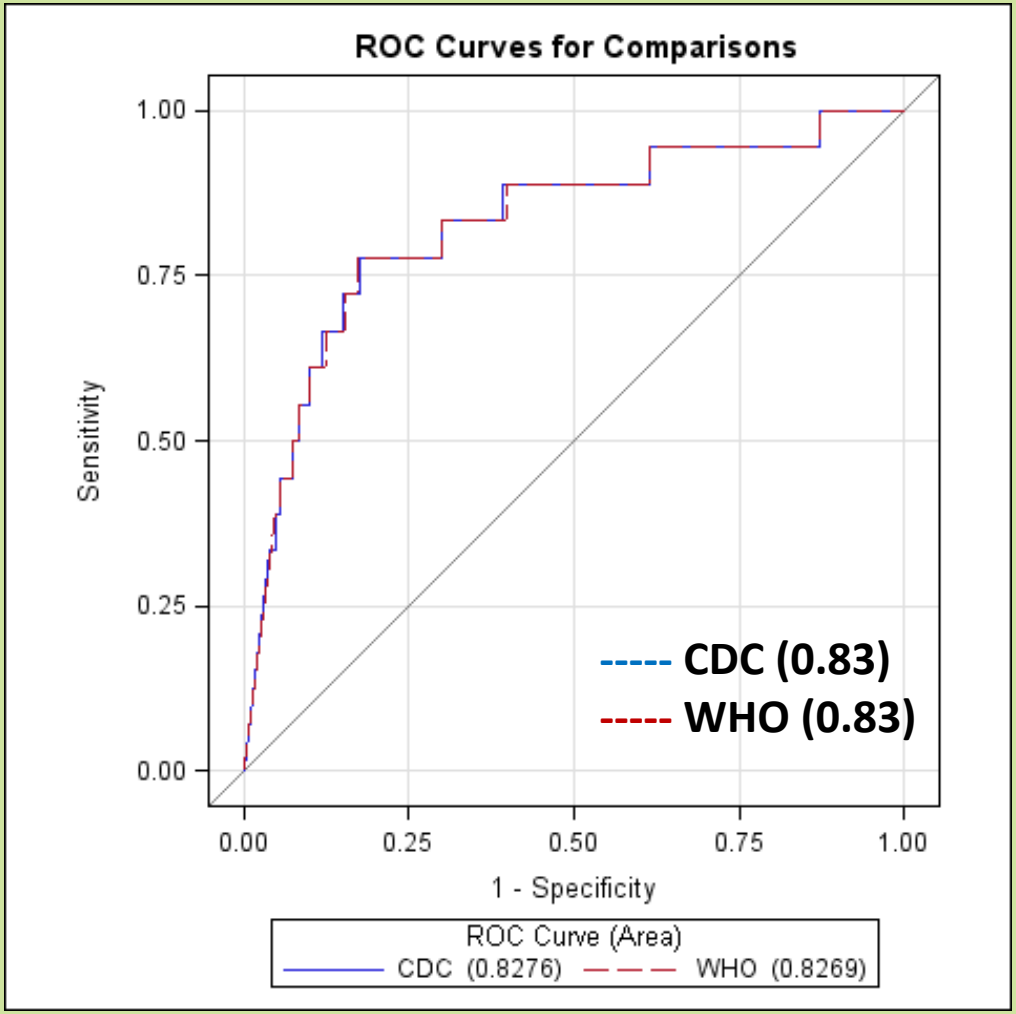
Results

Compare BMI categorization

	Girls		Boys	
	CDC	WHO	CDC	WHO
BMI percentiles, mean (SD)	51.2 (30.8)	54.8 (31.8)	53.3 (31.0)	56.6 (32.5)
Underweight	8%	6%	6%	5%
Normal BMI	72%	69%	70%	66%
Overweight	12%	15%	15%	17%
Obese	9%	9%	9%	11%

Results

ROC curves: Triglycerides (girls)



Results

Specificity for predicting CVD RF

	CDC: Overweight	WHO: Overweight	CDC: Obese	WHO: Obese
HDL-cholesterol < 1.0 mmol/L				
Boys	78.2	73.4	91.3	90.5
Girls	80	75.9	93	93
Triglycerides ≥ 1.7 mmol/L				
Boys	79	74.2	91.3	90.7
Girls	79.7	75.7	92.6	92.6
Insulin ≥ 38 mmol/L (9yo)				
Boys	85.7	80.5	97.4	95.2
Girls	88.3	83.7	97.3	97.3

Results

Sensitivity for predicting CVD RF

	CDC: Overweight	WHO: Overweight	CDC: Obese	WHO: Obese
HDL-cholesterol < 1.0 mmol/L				
Boys	33.5	37.3	19.6	17.7
Girls	40.2	42.3	18.6	19.6
Triglycerides ≥ 1.7 mmol/L				
Boys	79.1	81.2	43.7	39.6
Girls	44.6	47.7	16.9	18.5
Insulin ≥ 38 mmol/L (9yo)				
Boys	60.3	64.7	29.4	32.3
Girls	42.2	50	23.5	23.5

Conclusions

1. ROC curves nearly identical between CDC and WHO in predicting cardiometabolic risk factors
2. Marginal sensitivity/specificity differences between growth curves

Research Objectives

- Longitudinal analysis of a Quebec birth cohort:
  - Handling missing data in longitudinal studies
  - Defining overweight in youth
  - Effects of childhood poverty on nutrition
  - Childhood poverty experience and cardiovascular disease risk factors

3) Childhood poverty & nutrition

- Majority of children fail to meet Canada's food guide recommendations on daily servings of major food groups
- Low SES associated with poorer diet quality among adolescents in cross-sectional studies
  - Association weaker in early adolescence
  - Association weakest with income

Hanson MD, Chen E. *J Behav Med.* Jun 2007;30(3):263-285.
Pearson N, et al. *Public Health Nutr.* Feb 2009;12(2):267-283.
Hare-Bruun H, et al. *J Nutr.* May 2011;141(5):928-934.

Objectives

- Determine association between poverty and nutrition
  - Does the association vary across different ages (age 6, 8, 10, 12)?

Dataset

- Quebec Longitudinal Study of Child Development (ELDEQ) birth cohort (n=2,120)
- Eligible children identified through birth registry, randomly sampled from a multistage cluster sampling design
- Representative of singleton births in Québec (1998)

Poverty

- Parental report of past year's household income
  - Measured: 5, 17, 29, 41, 61, 74, 86, 98, 122, 145 months

- Compared to the low-income thresholds by Statistics Canada (adjusted for household size and geographic region)

Nutritional Behaviours

- Parental report: “In the past week, how many times has child eaten food X…”
  - None, 1-2/week, 3-4/w, 5-6/w, 1/day, 2/day, 3/day, 4/day
- Categories:
  - Milk, cheese (excluding milk desserts)
  - Fruit (excluding fruit drinks)
  - Vegetables

Analysis

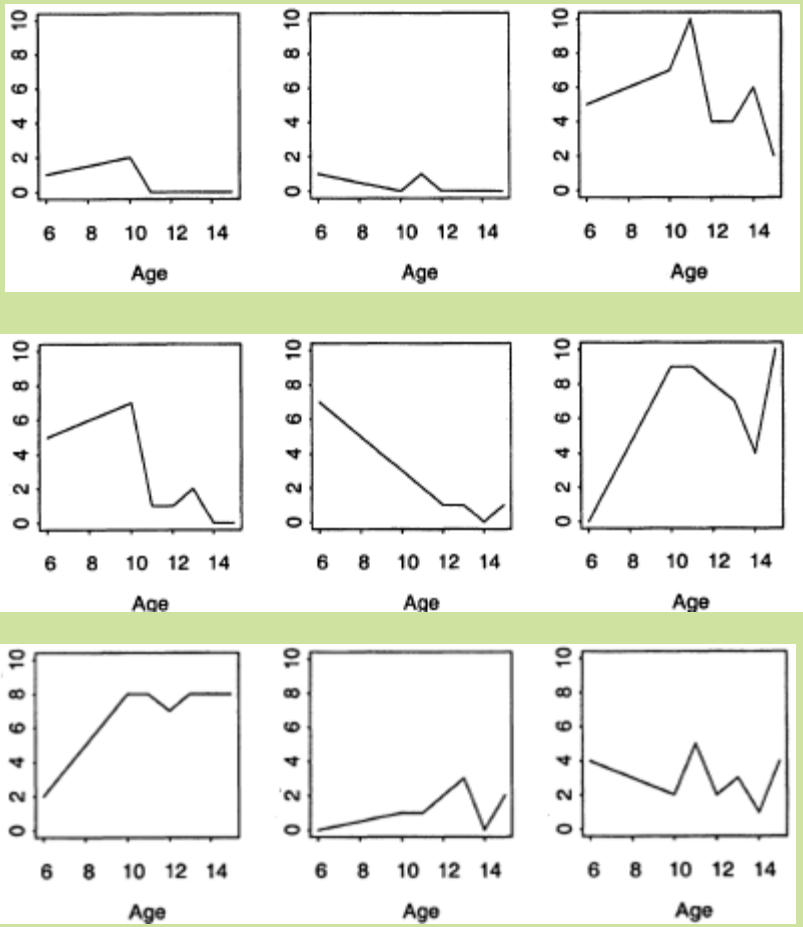
Main Predictors:

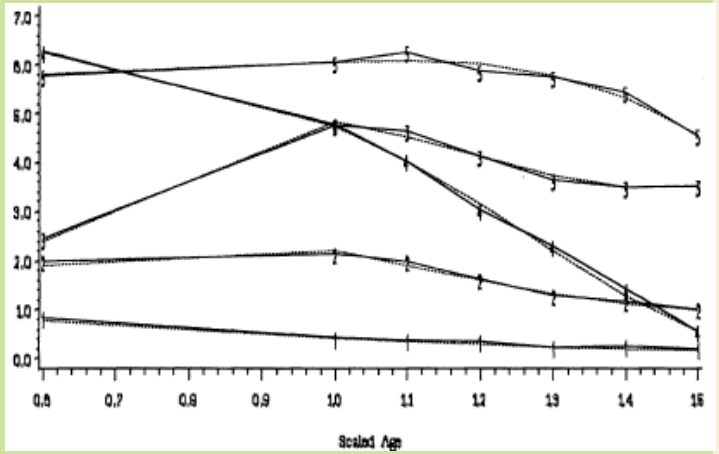
- Longitudinal analysis:
  - Trajectory membership by Latent Class Growth Analysis

Outcomes:

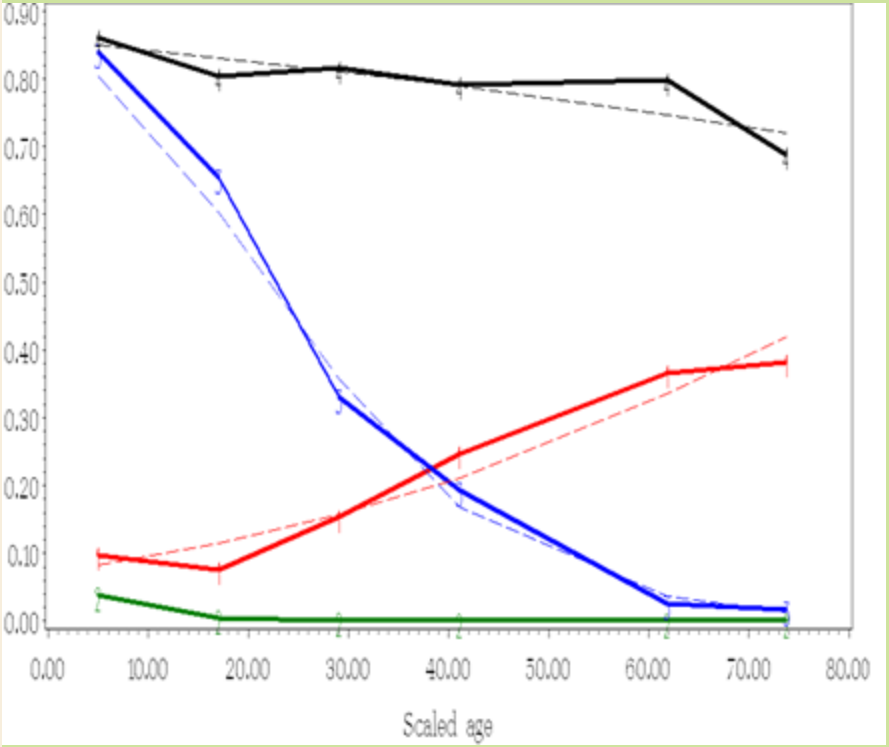
- Logistic regression:
  - ≥ 2 servings of dairy per day
  - ≥ 2 servings of fruits per day
  - ≥ 2 servings of veggies per day
- Covariates
  - Sex, child's weight status (overweight or obese), parental education, family status

Latent Class Growth Analysis





Final Trajectories



Trajectory group	
Consistently not in poverty	67%
Decreasing risk for poverty	7%
Increasing risk for poverty	10%
Consistently poor	16%

Study Population Characteristics

	Age 6	Age 8	Age 10	Age 12
Anthropometric characteristics				
BMI percentile, mean (SD)	52.1 (30.1)	51.2 (29.4)	60.7 (27.8)	62.1 (27.8)
BMI overweight or obese	17%	17%	25%	29%
Nutritional characteristics				
≥ 2 servings of milk/cheese/day	73%	71%	50%	50%
≥ 2 servings of fruits/day	33%	47%	42%	39%
≥ 2 servings of veggies/day	38%	44%	44%	42%

Nutrition Behaviours

	≥ 2 /day (6 years)	≥ 2 /day (8 years)	≥ 2 /day (10 years)	≥ 2 /day (12 years)
	OR (CI)	OR (CI)	OR (CI)	OR (CI)
Consistently poor	**0.51 (0.4-0.7)*** **	**0.51 (0.3-0.7)** **	**0.42 (0.3-0.6)*** **	**0.50 (0.3-0.7)** **
Increasing risk	**0.68 (0.5-1.0)***	0.76 (0.5-1.2)	0.70 (0.5-1.0)	**0.70 (0.5-0.9)***
Decreasing risk	0.70 (0.4-1.1)	0.72 (0.5-1.0)	0.73 (0.5-1.1)	0.81 (0.6-1.2)
Not poor	Reference	Reference	Reference	Reference
Consistently poor	**0.72 (0.5-1.0)***	**0.53 (0.3-0.8)** **	**0.46 (0.3-0.7)*** **	**0.47 (0.3-0.7)** **
Increasing risk	0.82 (0.6-1.2)	0.76 (0.5-1.1)	**0.56 (0.4-0.8)** **	0.74 (0.5-1.0)
Decreasing risk	0.70 (0.4-1.1)	0.78 (0.5-1.1)	0.84 (0.5-1.3)	**0.65 (0.4-0.9)***
Not poor	Reference	Reference	Reference	Reference
Consistently poor	**0.50 (0.3-0.7)*** **	**0.39 (0.2-0.6)*** **	**0.35 (0.2-0.5)*** **	**0.40 (0.3-0.6)*** **
Increasing risk	**0.65 (0.5-0.9)***	0.82 (0.5-1.2)	**0.56 (0.4-0.8)** **	**0.67 (0.5-0.9)** **
Decreasing risk	**0.57 (0.4-0.9)***	**0.61 (0.4-0.8)** **	0.72 (0.5-1.0)	**0.57 (0.4-0.8)** **
Not poor	Reference	Reference	Reference	Reference

* p<0.05, ** p<0.01, *** p<0.0001

Discussion

- Children from households that were consistently in poverty were:
  - 50% less likely to consume 2 dairy/day
  - 50% less likely to consume 2 fruits/day
  - 50-60% less likely to consume 2 veggies/day
- Children at increasing or decreasing risk for poverty were:
  - ~25% less likely to consume 2 dairy/fruits/veggies a day

Research Objectives

- Longitudinal analysis of a Quebec birth cohort:
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  - Defining overweight in youth
  - Effects of childhood poverty on nutrition
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4) Childhood poverty and CVD risk factors

- Lifecourse models of health
  - Timing: exposure during a critical period
  - Accumulation: effects of low SES are additive
  - Mobility: Changes are detrimental
- Gaps: Cross-sectional, proxies, limited data among children

Wells NM, Evans GW, Beavis A, et al. 2010. AJPH 100 (12): 2507-2512
Chen E, et al. Pediatrics. 2007 Aug;120(2):e297-303.

Objectives

- To better understand the relationship between lifecourse models of poverty on health during childhood
  - Do the timing, accumulation, or mobility lifecourse models predict cardiovascular disease risk factors among youth?

Methods

- Quebec Longitudinal Study of Child Development (ELDEQ) birth cohort (n=2,120)
- Parental report of past year's household income
  - Measured: 5, 17, 29, 41, 61, 74, 86, 98, 122, 145 months
- Compared to the low-income thresholds by Statistics Canada (adjusted for household size and geographic region)

Data Collection:

Health component (2008)

- Added to the regular interview to specifically assess health
- Home visit by a nurse
  - Blood pressure
  - Blood sample

Analysis

Main predictor: Poverty

- Timing
  - 0-2 years of age
  - 3-5 years of age
  - 6-9 years of age
- Accumulation
- Mobility
  - Any: Increasing or decreasing likelihood of poverty
  - Increasing likelihood of poverty

Outcomes:

- Total cholesterol (TC)
- HDL cholesterol
- LDL cholesterol
- Triglycerides (TG)
- Glucose
- Insulin
- Systolic blood pressure (SBP)
- Diastolic blood pressure (DBP)

Statistical Analysis

- Comparison of models: structural approach (Mishra et al.)
  - Saturated model includes all main effects, and possible interactions
  - Compares each life course model to the saturated model
- Adjusted for: sex, pubertal status, parental education, mother's age, family status, child's weight status, child's physical activity levels, and family history

Mishra G, et al. Int J Epidemiol 2009; 38(2): 528-537.

Results (unadjusted)

	HDL β	TG β	Insulin β	SBP β
Timing:				
Exposure age 0-2	**-0.05 (0.02)***	**0.10 (0.03)****	**7.59 (2.21)****	1.20 (0.7)
Exposure age 3-6	-0.06 (0.03)	**0.11 (0.03)****	**6.87 (2.13)****	**1.65 (0.8)***
Exposure age 7-9	-0.05 (0.03)	**0.08 (0.03)****	**4.70 (2.17)***	**1.73 (0.8)***
Accumulation	**-0.02 (0.01)***	**0.04 (0.01)****	**2.95 (0.86)****	**0.70 (0.3)***
Mobility				
Any mobility	-0.01 (0.03)	-0.01 (0.04)	-2.98 (2.99)	0.83 (1.0)
Increasing risk	-0.02 (0.03)	-0.001 (0.04)	-2.55 (2.57)	0.43 (1.0)

* $p<0.05$, ** $p<0.01$, *** $p<0.0001$

Results (adjusted)

	Triglycerides β	Insulin β
Timing:		
Exposure age 0-2	**0.09****	**5.48***
Exposure age 3-6	**0.10****	**4.53***
Exposure age 7-9	**0.07***	2.15
Accumulation	**0.04****	**1.97***
Mobility		
Any mobility	-0.02	-3.47
Increasing risk	-0.01	-3.13

* p<0.05, ** p<0.01, *** p<0.0001

Adjusted for: sex, pubertal status, whether at least one parent had at least a high-school education, mother's age, whether the household was a single-parent household, whether the child was overweight or obese, average number of days the child exercised at least 15 minutes at a time in an average week, and family history of either hypercholesterolemia or diabetes

Results

Model Comparisons

Triglycerides

Model	F-stat	P-value
Timing		
0-2 years	2.6	0.01
3-5 years	2.4	0.02
6-9 years	5.0	<0.0001
Accumulation	1.8	0.08
Mobility		
Any	7.4	<0.0001
↑ risk	7.4	<0.0001

Insulin

Model	F-stat	P-value
Timing		
0-2 years	1.9	0.07
3-5 years	3.2	<0.01
6-9 years	4.8	<0.0001
Accumulation	2.7	<0.01
Mobility		
Any	6.8	<0.0001
↑ risk	7.0	<0.0001

Discussion

- Exposure according to the timing models and accumulation models are both significantly associated with elevated triglycerides and insulin among 10-year old youth
  - Model comparisons indicate accumulation of poverty has the largest effect on *triglycerides*, while there may be a critical period of exposure for *insulin*

Strengths and Limitations

- Birth cohort with 10+ years of follow-up
- Considerable study attrition
  - Multiple imputation
    - Bias from complete case greater than multiple imputation even up to 75% missing data (Newman 2003; Davey et al 2001.)
- Parental report

Davey A, et al. Correcting for selective nonresponse in the National Longitudinal Survey of Youth using Multiple Imputation. 2001;36(3):500-19.
Newman DA. Longitudinal modeling with randomly and systematically missing data: A simulation of ad hoc, maximum likelihood, and multiple imputation techniques. 2003;6:328-62.

Strengths and Limitations

- Food frequency questionnaire
- Conservative definitions of Canada's Food Guide recommendations
  - Excludes fruit juice, vegetable juice, and yogurt
  - $\geq$ 2 servings rather than age-specific cut-offs

Davey A, et al. Correcting for selective nonresponse in the National Longitudinal Survey of Youth using Multiple Imputation. 2001;36(3):500-19.
Newman DA. Longitudinal modeling with randomly and systematically missing data: A simulation of ad hoc, maximum likelihood, and multiple imputation techniques. 2003;6:328-62.

Future Directions

- Methodological questions
  - BMI changes
  - Imputation methods
- Socio-familial determinants of cardiovascular disease risk factors
  - Body image
  - Weight loss strategies

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QUESTIONS?

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