DECOMPOSING ETHNIC DIFFERENCES IN BODY MASS INDEX AND OBESITY RATES AMONG NEW ZEALAND PRE-SCHOOLERS

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Disclaimer

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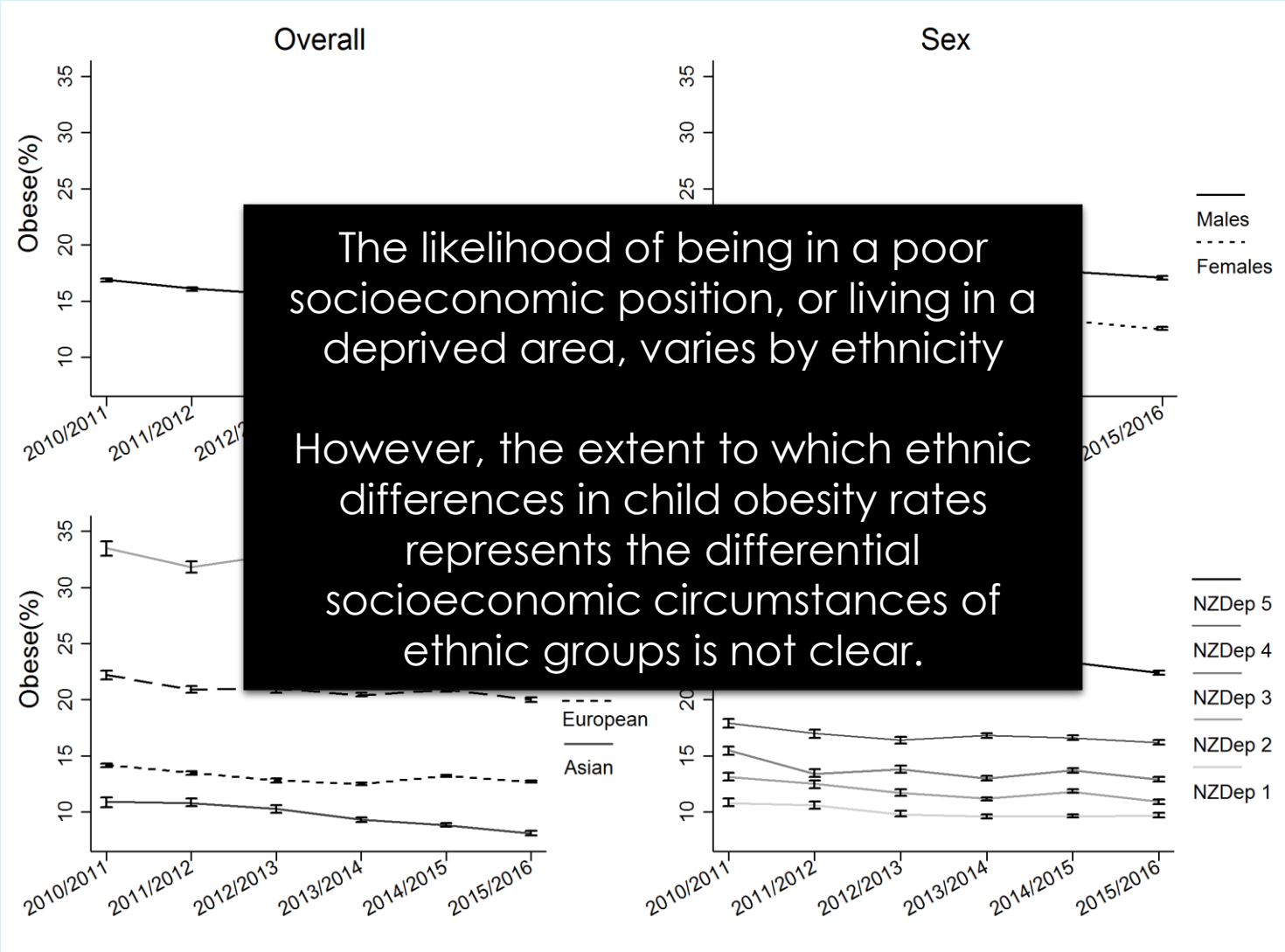
Background

- large and persistent ethnic and socioeconomic differentials in obesity rates
- Recent evidence from New Zealand confirms large disparities in obesity by ethnic group and deprivation at 4 years of age with no evidence of change in these disparities over time
- The extent to which ethnic disparities in child obesity rates represent differential socioeconomic circumstances of ethnic groups is not clear.



Background

Evidence from the US

- Ethnic differences in child obesity can be fully accounted for by socioeconomic characteristics and neighbourhood deprivation
  - Rossen LM, Talih M. Social determinants of disparities in weight among US children and adolescents. *Annals of epidemiology* 2014; **24**(10)**:** 705-713.
  - Rossen LM. Neighbourhood economic deprivation explains racial/ethnic disparities in overweight and obesity among children and adolescents in the USA. *Journal of Epidemiology and Community Health* 2014; **68**(2)**:** 123-129.

Evidence from the UK

- Differences in obesity rates between some ethnic groups remain even when accounting for a much broader range of covariates (including cultural factors, nutrition, bed times and maternal body mass index (BMI)) in addition to socioeconomic characteristics,
  - Zilanawala A, Davis-Kean P, Nazroo J, Sacker A, Simonton S, Kelly Y. Race/ethnic disparities in early childhood BMI, obesity and overweight in the United Kingdom and United States. *International Journal of Obesity (2005)* 2015; **39**(3)**:** 520-529.

Background – NZ context

- Reid & Robinson (2000) the health status of Māori needs to be considered alongside colonial history.
  - Sovereignty, land and other resources were taken from Māori
  - subsequent marginalization through the instatement of new social systems based on European norms and values.
- Higher prevalence of disease and lower life expectancy among Māori linked to an over-representation among lower SES groups and loss of traditional extended family structures, knowledge and practises, such as, food gathering.
- Evidence suggests that institutional racism is sustaining the inequities Māori experience in health.
  - Māori have lower levels of access to health services, receive a poorer quality and slower service, and are less likely to receive appropriate levels of care.
- There are similar findings for Pacific peoples in New Zealand, whereby Pacific communities also have high levels of unmet need.

Background – NZ context

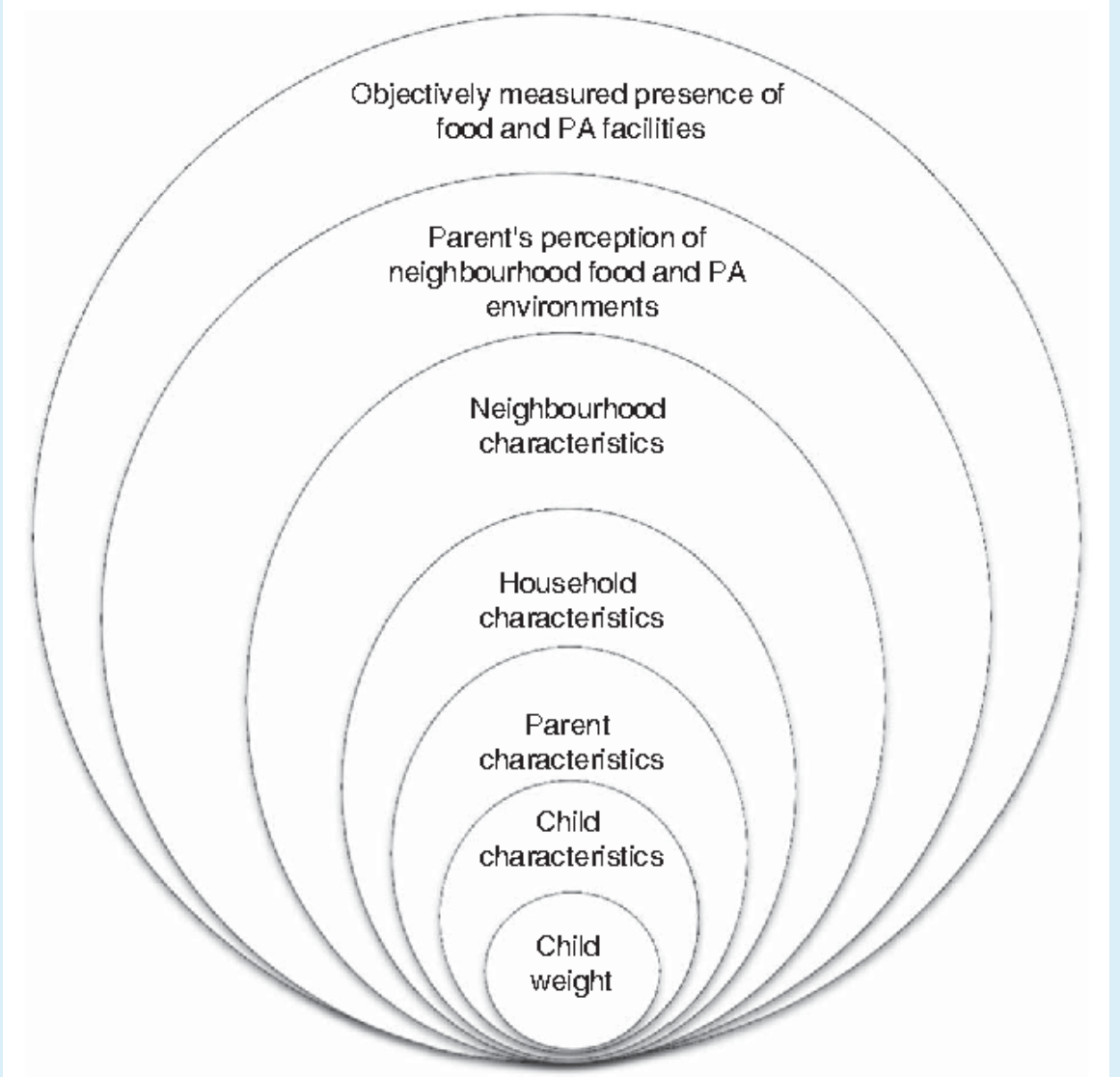
The disentangling of socioeconomic circumstance and ethnicity is complex

- Focussing on a small number of socioeconomic measures such as income and education, can mask underlying disparities in material resources and accumulated wealth.
- Access to resources and services may not be equivalent for a given level of education or income.
- There are differential expectations of how economic resources are shared within families.
  - In a study of Pacific families and debt, focus groups with Samoan and Tongan community leaders in South Auckland highlighted the greater value of collective responsibility including: supporting family, donating to church and community events, as key contributors to Pacific families financial strain. Language comprehension was also raised as a key issue contributing to Pacific families debt (Families Commission, 2012).
- Neighbourhood characteristics are important for understanding determinants of, and implementing initiatives to, reduce obesity and disparities in obesity rates.

Aim

- To determine the extent to which ethnic differences in BMI and obesity can be explained by other sociodemographic characteristics taking account of individual, family, and area level characteristics.

- Steps we took:
- 1) descriptive analysis – unadjusted relationships between all of the covariates and the outcomes (ZBMI and Obesity), and all of the covariates and the exposure (ethnicity)
- 2)Sequentially adjusted multiple regression models
- 3) Quantile Regression models
- **<u>4) Oaxaca decomposition models</u>**

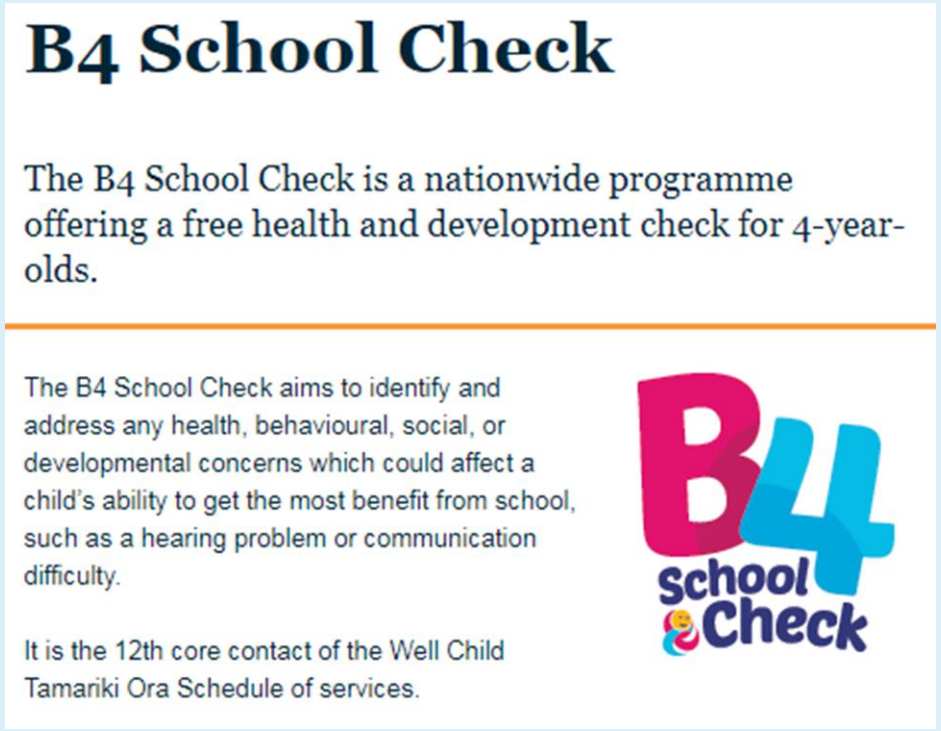


Ohri-Vachaspati, Punam, et al. "The relative contribution of layers of the Social Ecological Model to childhood obesity." *Public health nutrition* 18.11 (2015): 2055-2066.

Data

The B4 School Check data is integrated into the IDI

- Established September 2008 (we use 2010/2011 to 2015/2016)
- Eligible children are those who are enrolled with a PHO on their 4th birthday- target is 90% of eligible children
- coverage between 72-92%



B4 School Check

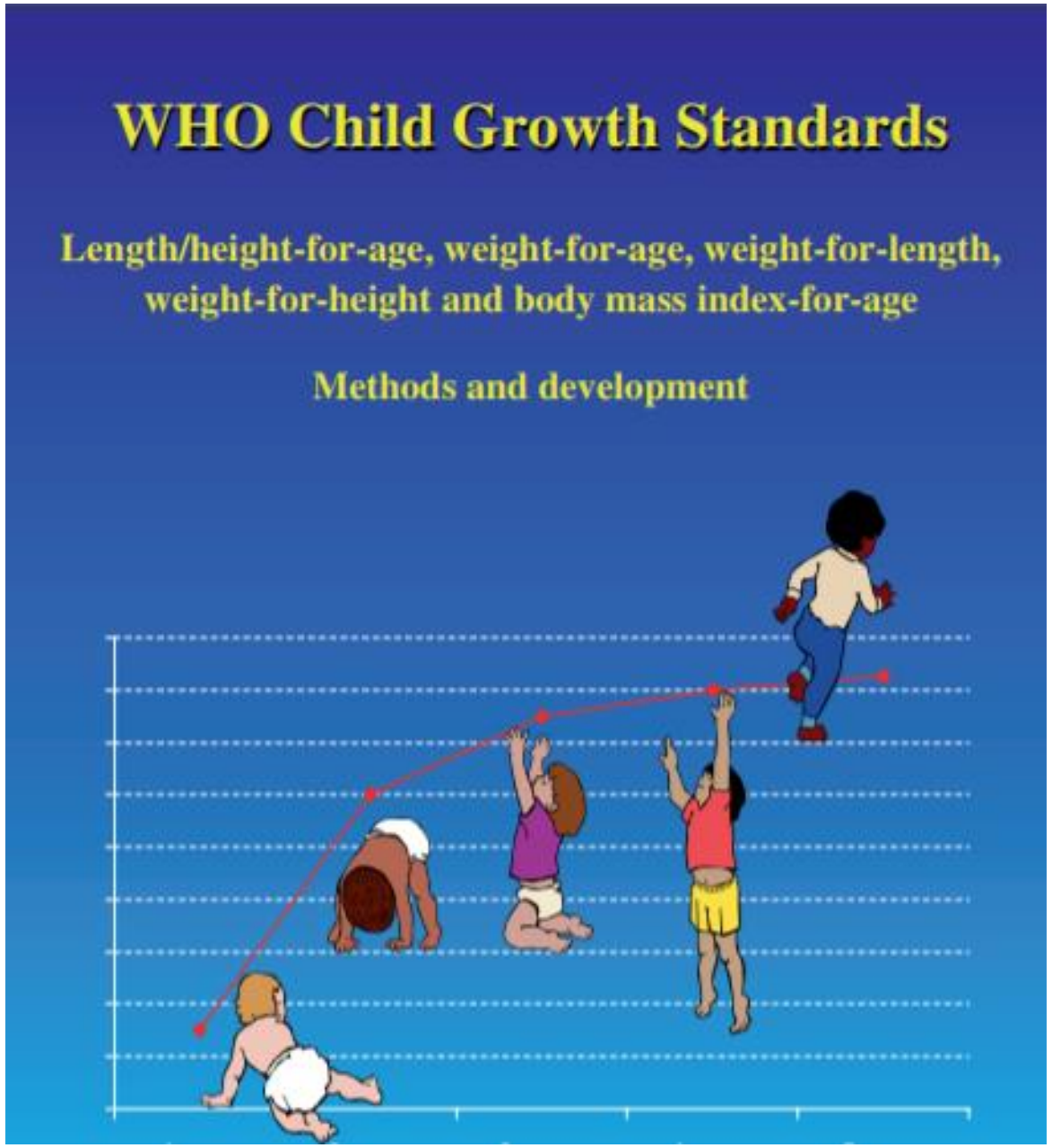
The B4 School Check is a nationwide programme offering a free health and development check for 4-year-olds.

The B4 School Check aims to identify and address any health, behavioural, social, or developmental concerns which could affect a child's ability to get the most benefit from school, such as a hearing problem or communication difficulty.

It is the 12th core contact of the Well Child Tamariki Ora Schedule of services.

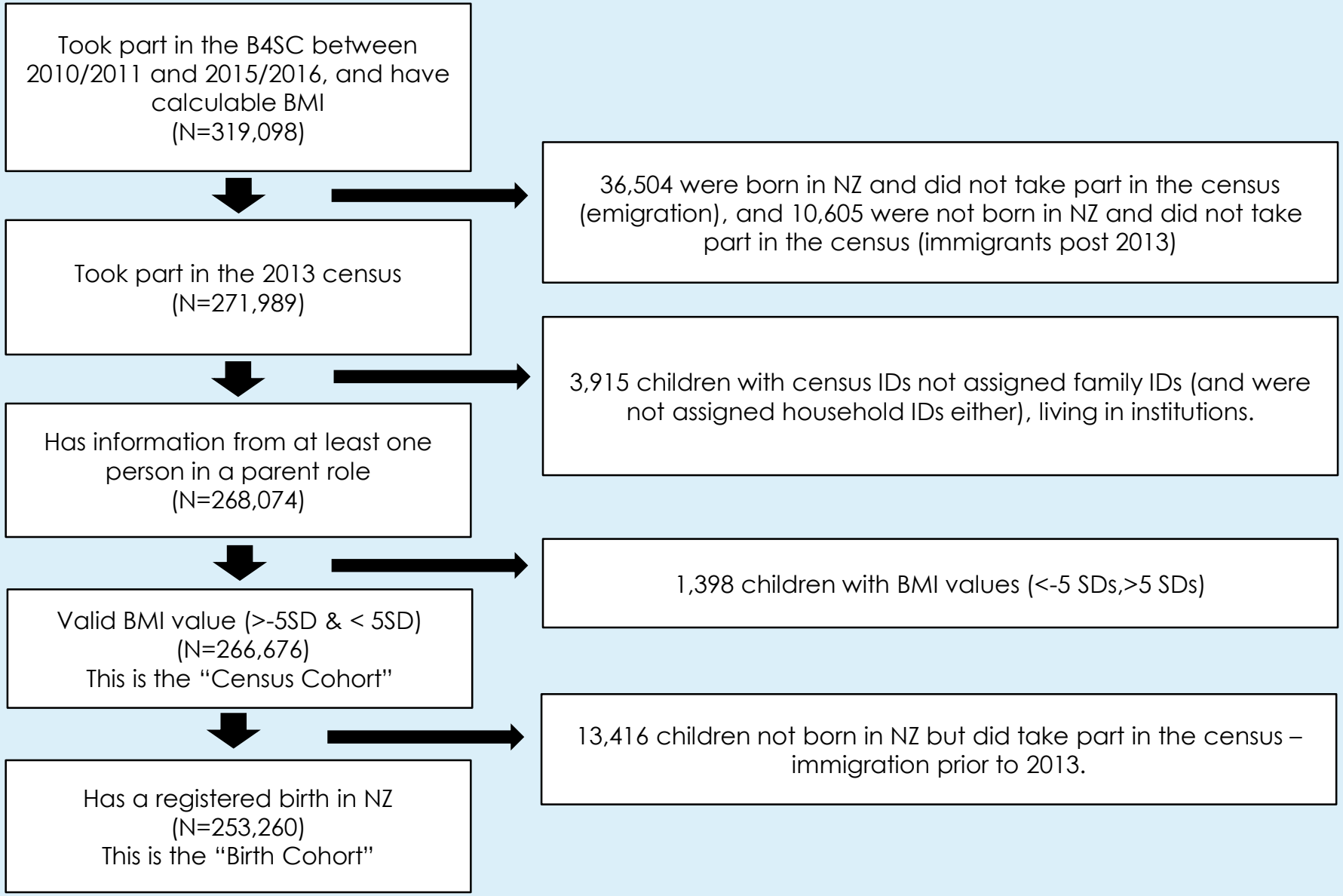
B4 School Check

http://www.health.govt.nz/our-work/life-stages/child-health/b4-school-check



Data Preparation & measures

- Restricted data to:
  - those ages 48-60 months
  - Fiscal years 2010/2011 – 2015/2016
- Linked to other data
  - Census, Birth records, Source ranked ethnicity table, Address notification
- WHO Anthro package used to calculate BMI Z-scores (age and sex adjusted)
  - Obesity: ≥ 95th percentile

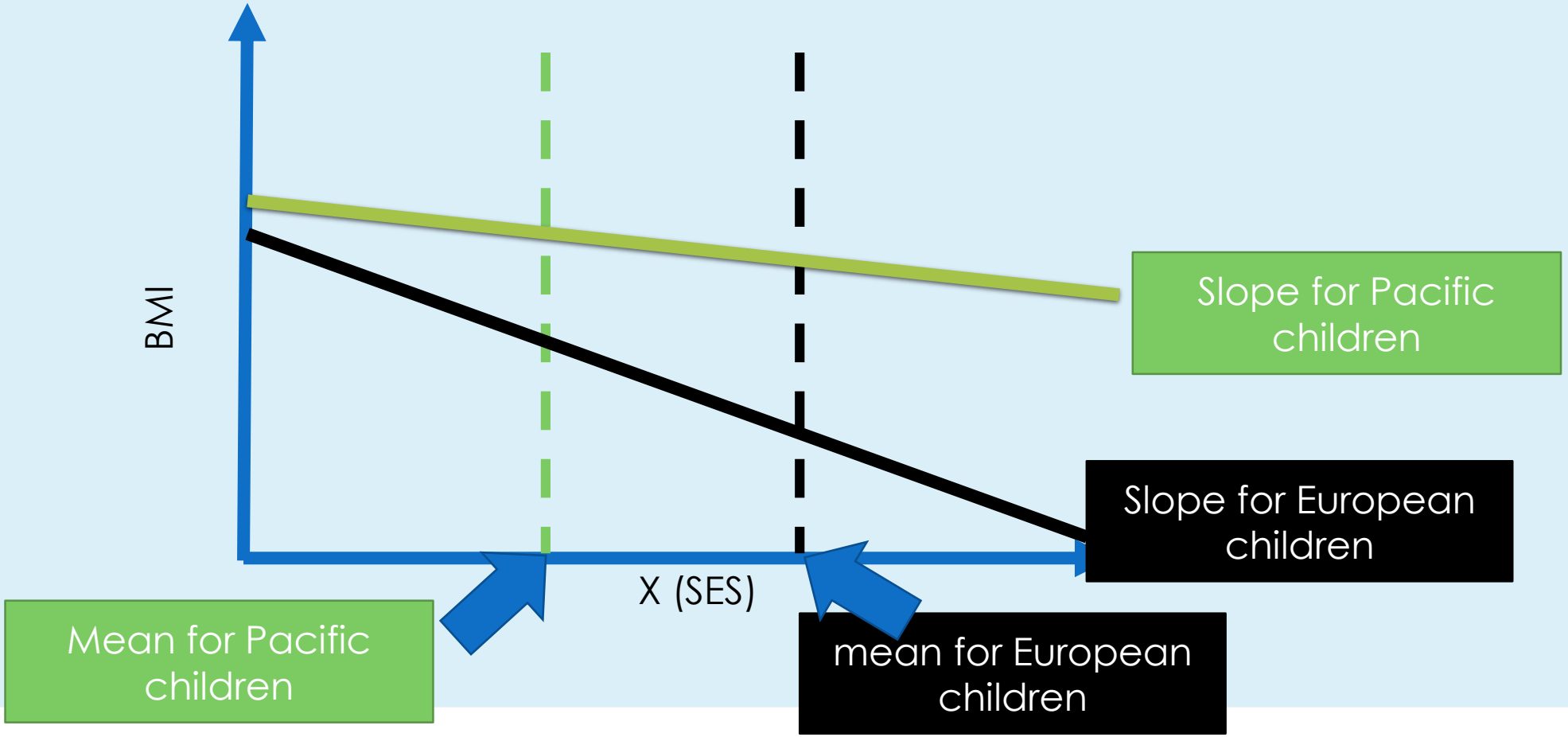

Took part in the B4SC between 2010/2011 and 2015/2016, and have calculable BMI (N=319,098)
36,504 were born in NZ and did not take part in the census (emigration), and 10,605 were not born in NZ and did not take part in the census (immigrants post 2013)
Took part in the 2013 census (N=271,989)
3,915 children with census IDs not assigned family IDs (and were not assigned household IDs either), living in institutions.
Has information from at least one person in a parent role (N=268,074)
1,398 children with BMI values (<-5 SDs,>5 SDs)
Valid BMI value (>-5SD & < 5SD) (N=266,676) This is the "Census Cohort"
13,416 children not born in NZ but did take part in the census – immigration prior to 2013.
Has a registered birth in NZ (N=253,260) This is the "Birth Cohort"

Descriptive

	Column %	Mean BMI z-score (95% CI)	Obesity % (95% CI)
Ethnicity			
European/Other	55.1	0.57 (0.56;0.57)	11.41 (11.24;11.58)
Māori	24.9	0.87 (0.86;0.88)	20.41 (20.10;20.73)
Pacific	8.5	1.24 (1.22;1.26)	33.11 (32.49;33.75)
Asian	10.4	0.23 (0.22;0.24)	8.65 (8.32;9.00)
MELAA	1.2	0.57 (0.53;0.61)	13.61 (12.42;14.88)

OAXACA-BLINDER

Oaxaca-Blinder technical



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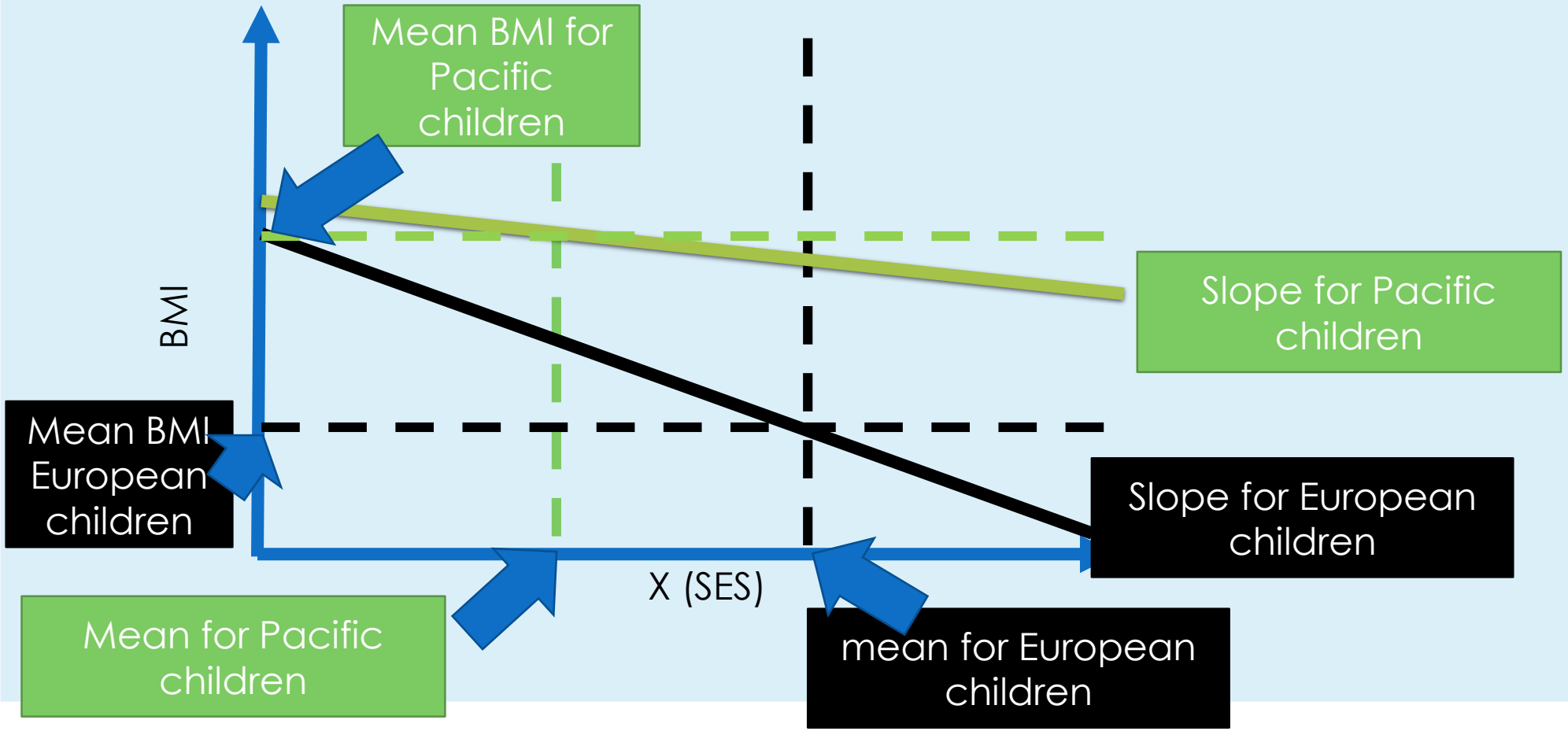

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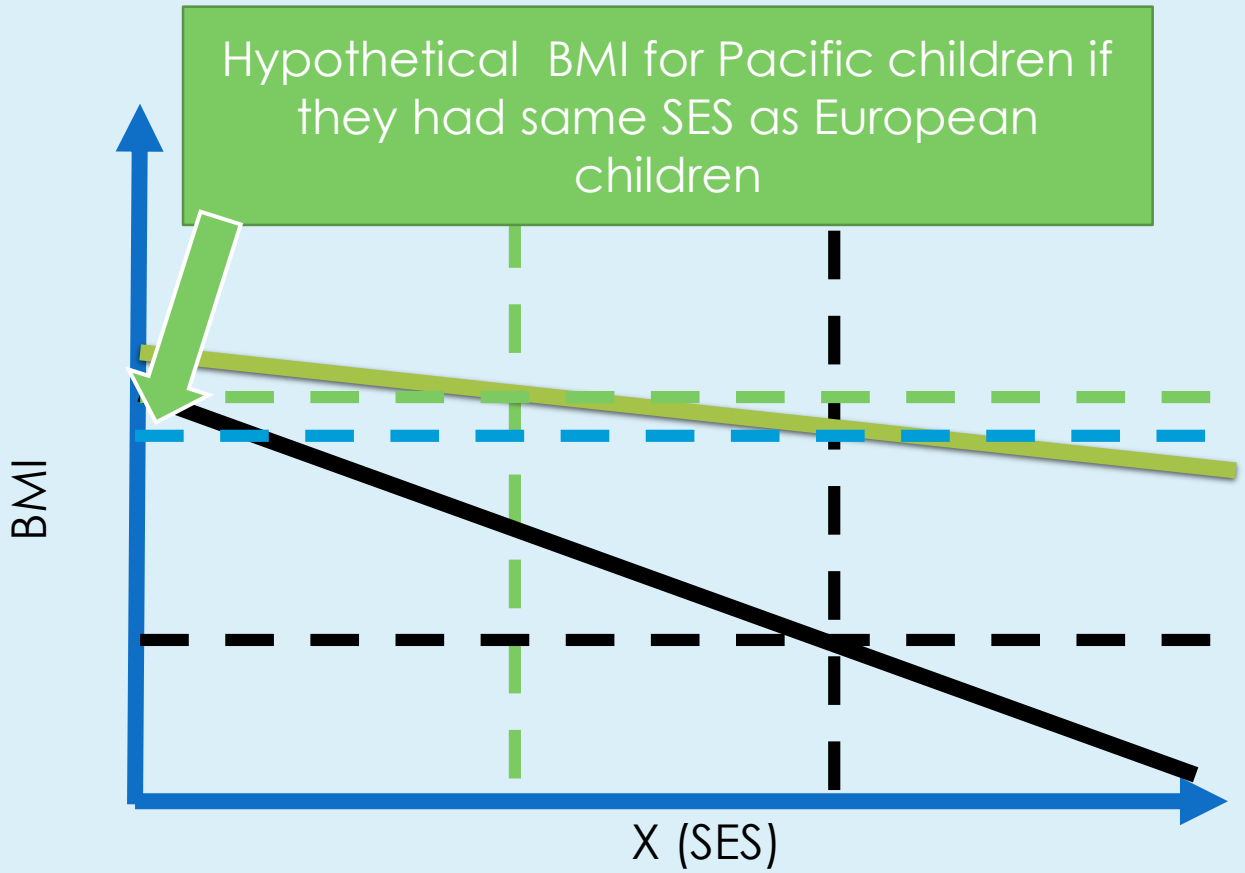


Oaxa er technical

- Simplified (hopefully
  it works
  - Two groups
    - Individual models:
      - mean BMI group 1=Intercept+Betas*mean covariate values
      - mean BMI group 2=Intercept+Betas* covariate values
      - Error term assumed to be nor distributed with mean 0 (star regression assumption)

The strength of the association between the covariate and the outcome – often referred to as the "slope"

Example: Covariates are things like: age (mean age=25), family socioeconomic position (mean SEP=1.5)

BMI=23+0.05*age+ -0.5*SEP
Mean BMI=23.5

The mean value of covariates

Oaxaca – Blinder technical

- Simplified explanation of how it works
  - Two groups
    - Individual models:
      - mean BMI group 1=Intercept+Betas*mean covariate v
      - mean BMI group 2=Intercept+Betas*mean covariate v
      - Often used when group 1 is advantaged (not in pover disadvantaged (in poverty, OR Black, OR Female)
      - Error term assumed to be normally distributed with me
    - Differences between group 1 and group 2 may arise from **covariates**, or differences in the **strength of the relationshi** (the Betas).

Original example: mean age=25, mean SEP=1.5: BMI=23+0.05*age+ -0.5*SEP
Mean BMI=23.5

Different means same Betas: **mean age=23**, **mean SEP=0.5**:
BMI=23+0.05*age+ -0.5*SEP
Mean BMI=23.9

Same means different Betas: mean age=25, mean SEP=1.5:
BMI=23+**0.10***age+ **-0.2***SEP
Mean BMI=25.2

Oaxaca – Blinder technical

- Simplified explanation of how it works
  - Two groups
    - Individual models:
      - mean BMI group 1=Intercept+Betas*mean covariate values
      - mean BMI group 2=Intercept+Betas*mean covariate values
      - Error term assumed to be normally distributed with mean 0 (standard linear regression assumption)
    - Differences between group 1 and group 2 may arise from 2 sources: differences in the **mean values of the covariates**, or differences in the **strength of the relationship** between those covariates and the outcome (the Betas).
    - The Oaxaca blinder decomposes overall differences between group 1 and 2 into these two components. Mathematically done by creating a hypothetical term which contains the mean covariate values of group 1 and the Beta values of group 2.
    - This tells us → if group 2 had exactly the same covariate values as group 1 – how much of the difference would remain.

Oaxaca-Blinder summary

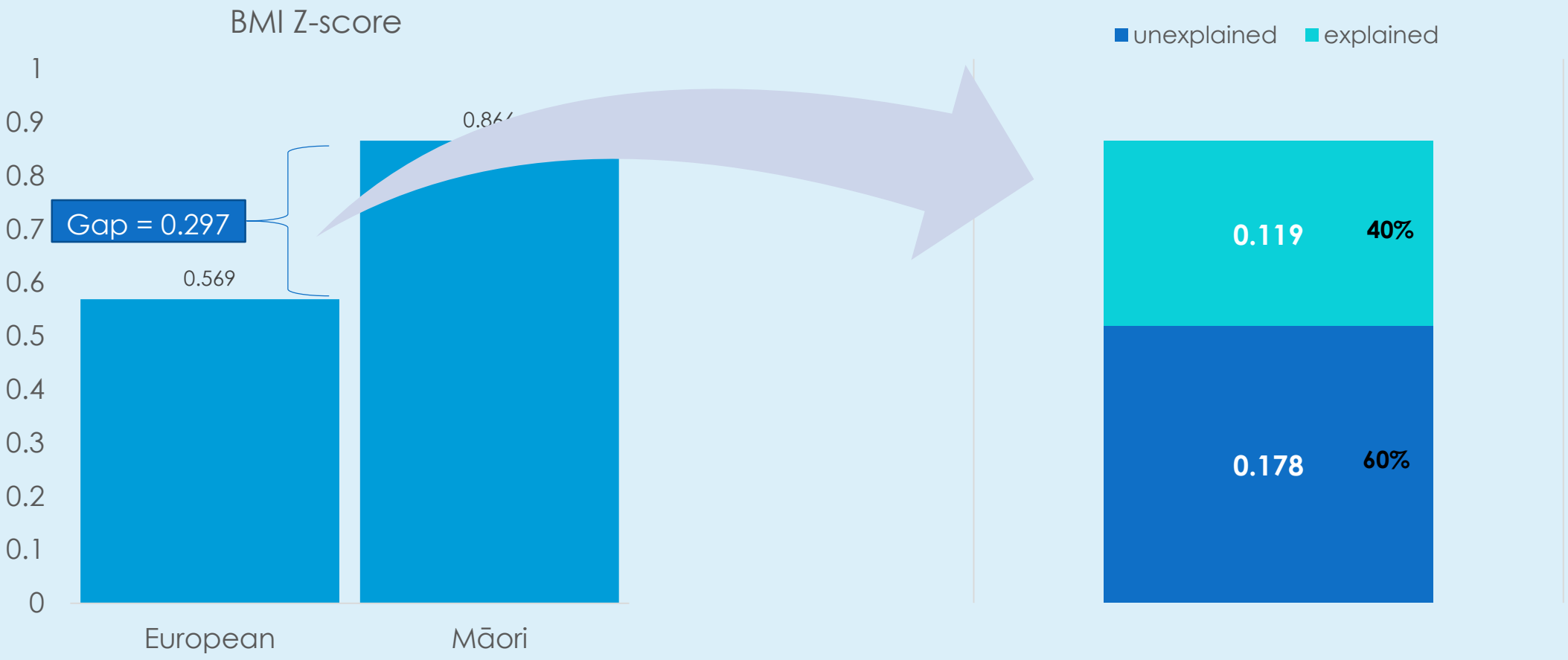
- Partitions the gap in an outcome of interest between two groups into an **EXPLAINED** and an **UNEXPLAINED** portion.
  - EXPLAINED = difference attributable to group differences in levels of the predictor variables.
  - UNEXPLAINED = difference in the relationship between the covariates and the outcome in the two groups. This would exist even if both groups had exactly the same levels on all covariates.
- Ethnic differences in ZBMI/obesity arise from both differences in mean levels on the covariates (x values), and differences in the relationship between covariates and ZBMI/Obesity (β).
- the explained represents the amount to which differences between say Māori and European children in BMI/Obesity would shrink in a hypothetical world where Māori now have the same mean levels on the measured variables as Europeans.


DETOUR
ENDS

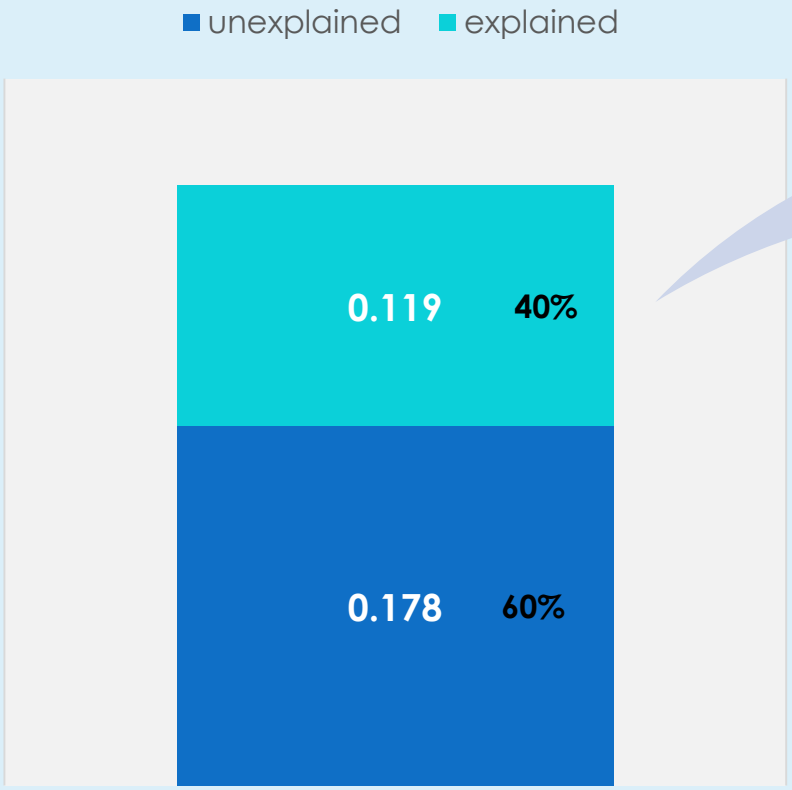
Covariates

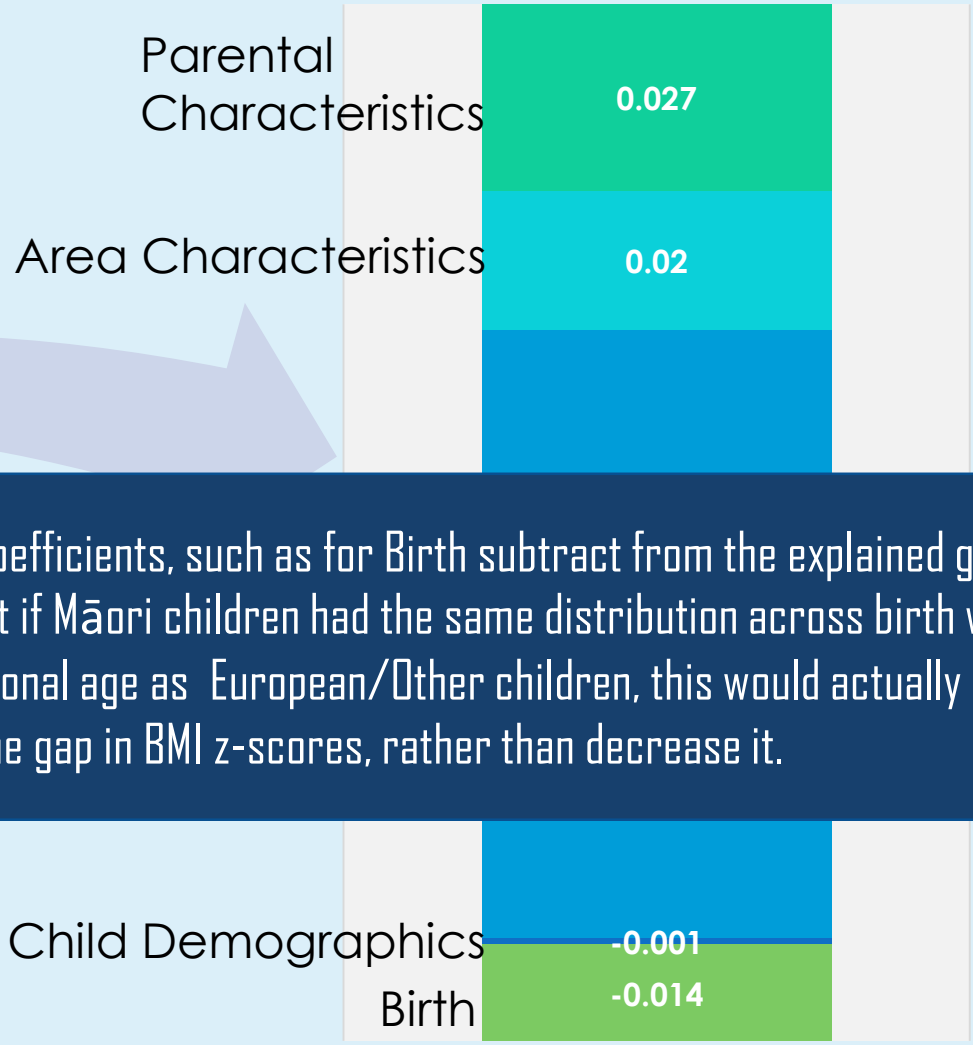
1) child demographics	sex age in months at time of B4 School Check
2) family structure, mobility and socioeconomic characteristics	Family structure: Single parent status, number of dependent children. Family SES: the number of sources of income support, grouped family income, employment status of parents, occupation of parents, and parental education. Mobility: total number of different addresses lived at from birth to fourth birthday
3) area characteristics	Area deprivation urban or rural location region of residence at time of B4 School Check
4) parental characteristics	Age at the time of B4 School Check, Immigration status religious beliefs languages spoken
5) birth	Birth Weight Gestational age

Oaxaca-Blinder Results: Māori



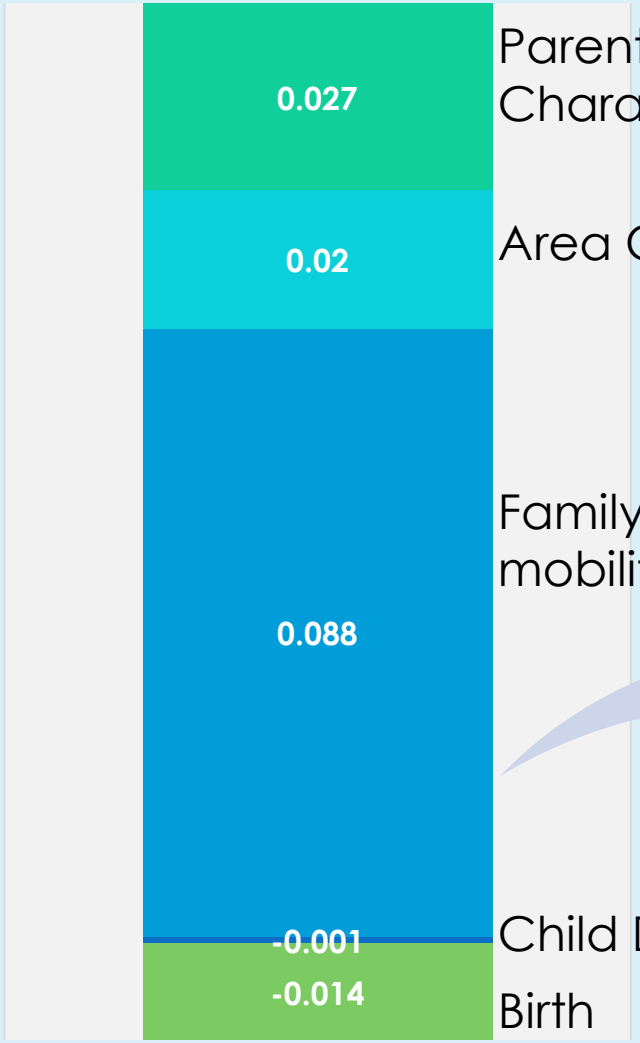
Oaxaca-Blinder Results





Negative coefficients, such as for Birth subtract from the explained gap. This implies that if Māori children had the same distribution across birth weight and gestational age as European/Other children, this would actually increase the gap in BMI z-scores, rather than decrease it.

Oaxaca-Blinder Results



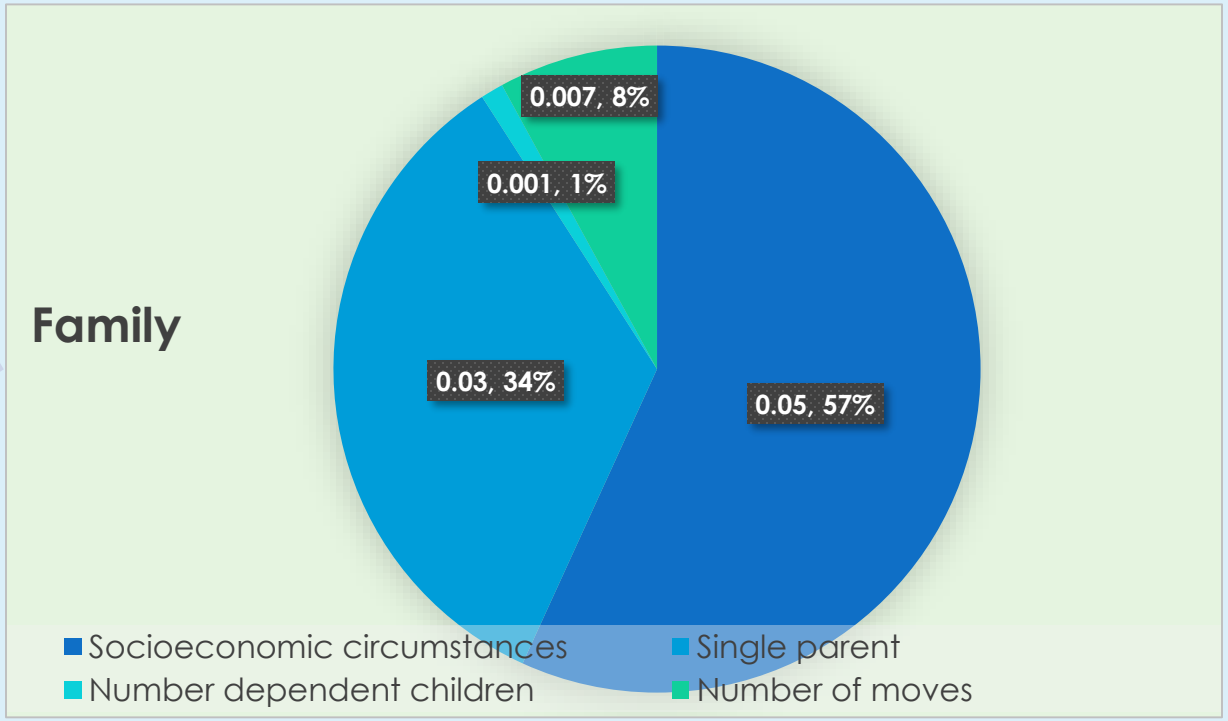
Parental Characteristics

Area Characteristics

Family structure, mobility and SES

Child Demographics

Birth



Of the 0.297 difference in BMI Z-score between Māori and European children, 0.119 can be explained through the difference in the covariates – this is 40% of the difference.

	BMI z-score Mean (95% CI)	Obesity proportion (95% CI)
Value for European/Other	0.569 (0.564;0.574)	0.114 (0.112;0.116)
Value for Māori	0.866 (0.858;0.875)	0.204 (0.201;0.207)
Total Predicted gap	0.297 (0.288;0.307)	0.090 (0.086;0.094)
Explained gap	0.119 (0.113;0.126)	0.045 (0.042;0.047)
Unexplained gap	0.178 (0.167;0.189)	0.045 (0.041;0.049)
Total Explained %	40.0%	50.0%

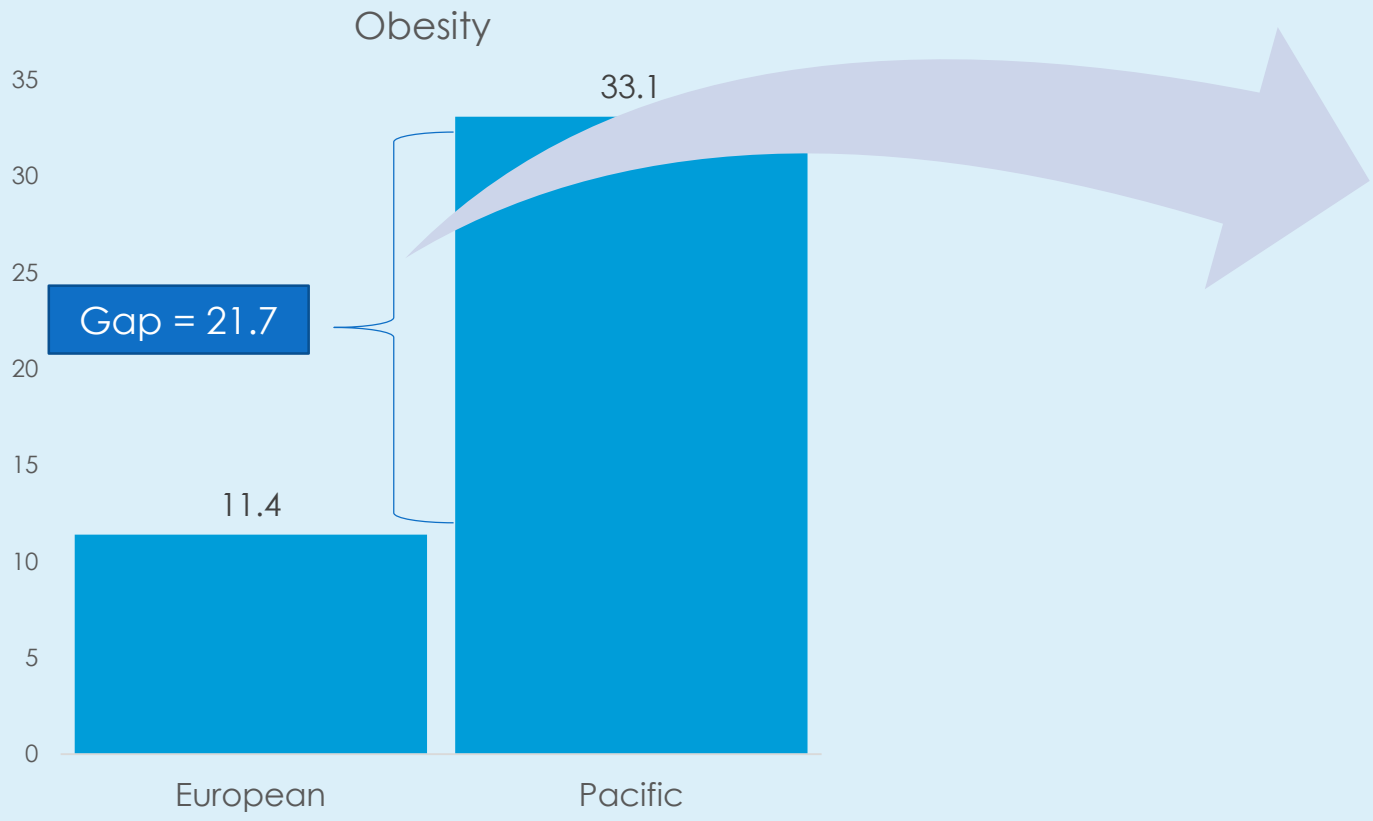
Summary of Results

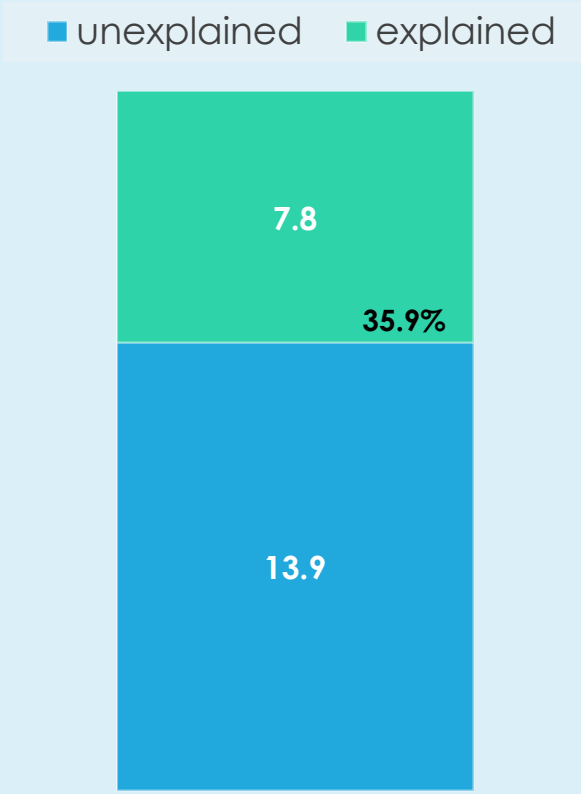
- The main contributor to the explained portion was family structure, mobility and socioeconomic characteristics which accounted for around three quarters of the explained gap.
  - Within family contributors, family socioeconomic circumstances (0.050) had the largest impact (accounting for 42% of the explained gap).
- If Māori children had the same values on the covariates as European/Other children for family structure, mobility and socioeconomic characteristics (0.088) area deprivation (0.037) and parental characteristics (0.027) then we could reduce the gap in mean BMI z-scores by 0.152 (explaining 51.2% of the total predicted gap).

Oaxaca Blinder Results

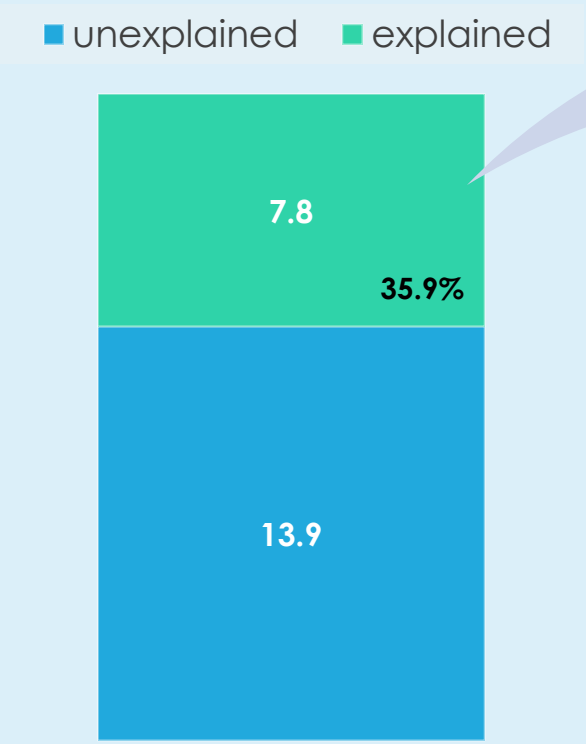
	BMI z-score Mean (95% CI)	Obesity proportion (95% CI)
Value for European/Other	0.569	0.114
	(0.564;0.574)	(0.112;0.116)
Value for Pacific	1.239	0.331
	(1.224;1.255)	(0.325;0.337)
Total Predicted gap	0.671	0.217
	(0.654;0.687)	(0.210;0.224)
Explained gap	0.108	0.078
	(0.095;0.122)	(0.072;0.085)
Unexplained gap	0.562	0.139
	(0.542;0.583)	(0.130;0.147)
Total Explained %	16.1%	35.9%

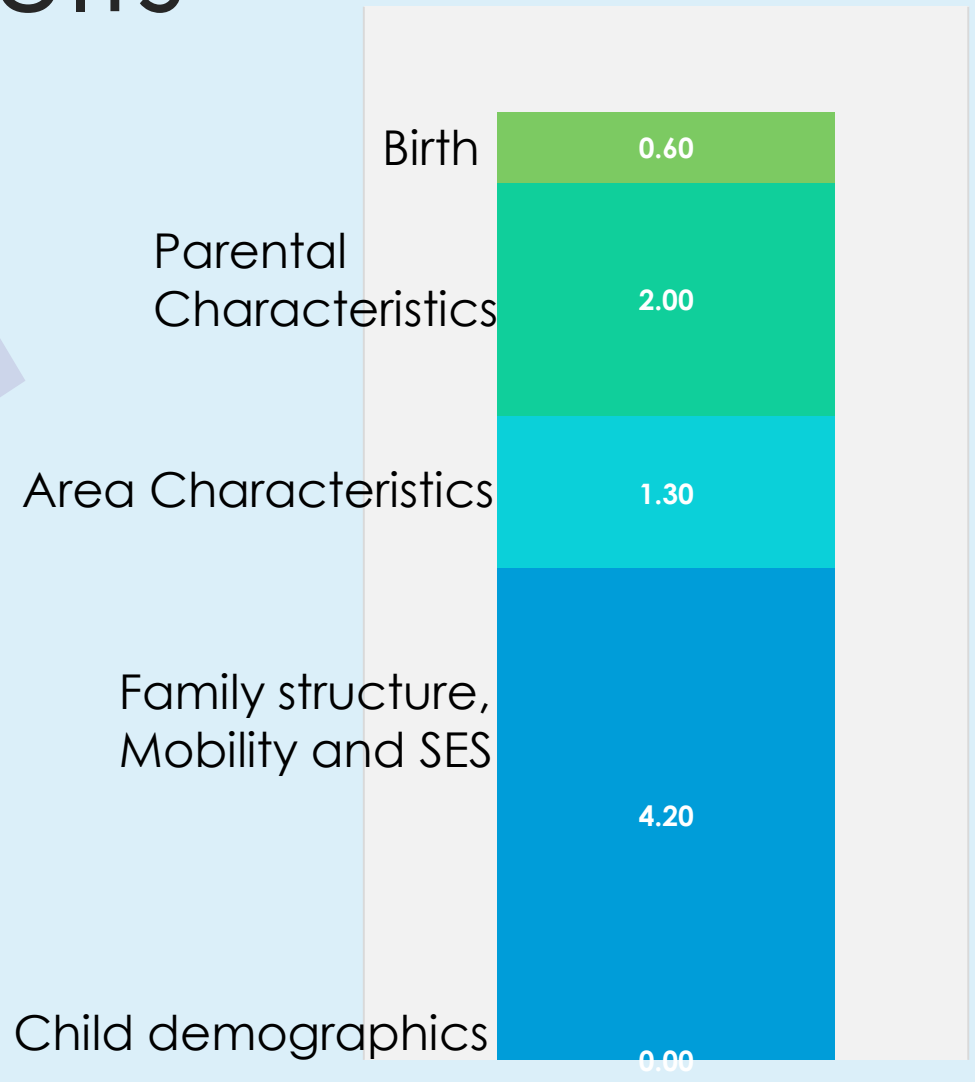
Oaxaca-Blinder Results





Oaxaca-Blinder Results





Discussion

- Overall, differences in family socioeconomic position as well as area level deprivation explained a large percentage of the differences in BMI and obesity rates for Māori children compared to European/Other children. These factors were also important for understanding differences in obesity rates between Pacific and European/Other children.
- How does this relate to previous literature?
  - Rossen & Talih (2014) used propensity score methods to investigate the extent to which differences between ethnic groups were attributable to factors such as household income, caregiver education, marital status, area level crime rates and deprivation. They found that differences between non-Hispanic white, non-Hispanic black and Mexican-American adolescent obesity rates were no longer statistically significant after accounting for these characteristics.
  - Powell et al (2012) were able to explain a substantial percentage of the gap in BMI between Hispanic (78% males 62% females) and Black (63% males and 44% females) adolescents compared to White adolescents using a Oaxaca-Blinder decomposition.

Discussion

- In our study, we were not able to fully account for ethnic differences in obesity rates and explained a smaller percentage of the gap between ethnic groups in our Oaxaca-Blinder decompositions.
- Could the difference be due to range of covariates accounted for?
  - Powell et al. (2012) included some area level contextual measures (including the price of fast food in the area, price of food at home, and the number of fast food restaurants per capita), while Rossen and Talih (2014) included a measure of racial segregation at the county level.
- Could the difference be due to the age of the children?
  - We studied children aged 4 years, whereas Powell et al (2012) and Rossen & Talih (2014) focused on adolescents.
  - **BUT** a comparative study of 5-year-olds in the UK and the US by Zilanawala et al (2015) found that ethnic differences in the US were completely attenuated after accounting for familial socioeconomic status, whereas in the UK ethnic differences persisted even after further adjustment for nutrition, cultural factors, bed times and maternal BMI
- Could the differences be due to country level differences from variable ethnic compositions, histories, policies and practises?

Discussion

There is still a lot "unexplained" – how do we explain this?

- **Omitted variables:** There were a number of variables related to child BMI and obesity that could not be accounted for and which might vary among ethnicities, such as frequency and importance placed on family meals, physical activity levels, and parental BMI.

- **Measurement error:** Systematic differences in what a variable actually measures across ethnic groups.
  - Measurement error in the outcome? Different BMI standards may be required for different ethnicities - there is some evidence that the relationship between body fat percentage and BMI differs across ethnic groups, with Pacific children having lower levels of body fat for a given BMI.
  - Measurement error among covariates? E.g. within a category of income, European children may have higher income values than Pacific children, meaning we are not comparing like with like.

- **Discrimination:** Differences in the treatment of children and their families based on their ethnicity could influence obesity rates

Limitations

- **The data used were not collected for research purposes:** While we were able to add depth to our data though linkage to census records, the census only happens every 5 years and does not collect all information pertinent to obesity.

- **Lack of precision:** Census records can be taken up to 2 years and 8 months prior to the B4SC examination, and up to 2 years 3 months after. As a result, the more a variable changed over time, the greater the extent of measurement error included in our estimates. More precise estimates of the covariates would likely improve our ability to explain differences among ethnic groups.

- **Doesn't capture everyone:** Immigrants were excluded to include birth information. Not everybody gets a B4 School Check. Children not participating in the B4SC are more likely to be Māori or Pacific and are at a greater risk of being obese – also likely to have differential distribution across important covariates.

QUESTIONS?

Covariates

Who are the parents

- Using self-reported roles in the family nucleus from the census data caregivers were identified as:
  - 1) the parent;
  - 2) a grandparent in a parent role; or
  - 3) another person in a parent role.
- We categorised anybody in a "parent role" with female gender as the primary caregiver and anybody in a "parent role" with a male gender as the secondary caregiver.
- Single parents who were males (n=5,154) were classified as the primary caregiver.
- There were 348 children with same-sex female parents, and 60 children with same sex male parents, where one partner was classified as the primary and secondary caregiver.
- In 97% of cases, the person listed as the primary caregiver was a female identifying as the parent (rather than someone else in the parenting role

	Column %	Mean BMI z-score	Obesity %
Child demographics			
sex			
Male	51.2	0.75 (0.74;0.76)	17.52(17.32;17.74)
Female	48.8	0.58 (0.57;0.58)	12.83 (12.64;13.01)
age in months (mean (SD))[¥]	52.10(3.38)	Pearson r=0.008	OR=1.00 (1.00;1.00)
Family Structure, mobility and Socioeconomic			
family structure			
2 parent family	79.2	0.61 (0.61;0.61)	13.68(13.53;13.83)
1 parent family	20.8	0.87(0.86;0.88)	21.10(20.79;21.49)
number of dependent children			
1 dependent child	21.2	0.66 (0.65;0.67)	15.69(15.39;16.00)
2 dependent children	44.1	0.61 (0.60;0.61)	13.67(13.47;13.87)
3 dependent children	22.6	0.69 (0.68;0.70)	15.36(15.06;15.66)
4 dependent children	7.6	0.80 (0.78;0.81)	18.55(18.01;19.11)
5+	4.2	0.91 (0.89;0.94)	22.40(21.62;23.21)
unknown	0.3	0.81 (0.73;0.90)	19.32(16.46;22.55)
Socioeconomic characteristics			
sources of income support			
no income support	56.6	0.58 (0.57;0.59)	12.89(12.72;13.07)
one source	38.0	0.76 (0.76;0.77)	17.94(17.70;18.18)
two sources	3.9	0.83 (0.81;0.85)	20.01(19.24;20.82)
three or more sources	0.5	0.85 (0.79;0.90)	19.04(16.98;21.28)
missing/unknown	1.0	0.91 (0.87;0.95)	23.81(22.22;25.47)
grouped family income			
20,000 or less	8.9	0.87 (0.86;0.89)	21.62(21.09;22.16)
20,001 ; 30,000	7.3	0.82 (0.80;0.83)	19.98(19.41;20.57)
30,001;50,000	14.0	0.72 (0.71;0.73)	17.45(17.06;17.85)
50,001;70,000	16.3	0.66 (0.65;0.67)	14.94(14.60;15.28)
70,001;100,000	20.3	0.60 (0.59;0.61)	13.26(12.97;13.56)
100,001 or more	24.8	0.52 (0.51;0.53)	10.52(10.29;10.77)
not stated	8.4	0.81 (0.80;0.83)	19.92(19.39;20.46)
highest parental education			
No formal qualifications	10.1	0.91 (0.89;0.92)	22.80(22.46;23.15)
Level 1,2,3 certificate	30.4	0.76 (0.75;0.77)	18.21(17.86;18.57)
Level 4,5,6 certificate/diploma	21.4	0.66 (0.65;0.66)	14.74(14.38;15.10)
Undergraduate degree	23.7	0.52 (0.51;0.53)	10.76(10.39;11.13)
postgraduate degree	11.9	0.46 (0.45;0.47)	9.10(8.73;9.47)
missing	2.4	0.92 (0.89;0.95)	24.16(23.82;24.50)
Primary caregiver			
employment status			
employed full time	27.4	0.66 (0.65;0.67)	15.28(15.01;15.55)
employed part time	26.9	0.60 (0.59;0.60)	12.51(12.26;12.76)
unemployed	6.4	0.87 (0.86;0.89)	21.70(21.07;22.34)
not in labour force	38.8	0.68 (0.67;0.68)	15.92(15.69;16.15)
unknown	0.6	0.88 (0.82;0.93)	22.24(20.14;24.48)
occupation			
managers	8.1	0.59 (0.58;0.60)	12.36(11.92;12.82)
professionals	17.1	0.56 (0.55;0.57)	11.76(11.46;12.07)
technicians and trades workers	2.6	0.64 (0.62;0.67)	14.65(13.82;15.52)
community and personals service	5.2	0.72 (0.70;0.74)	16.20(15.58;16.84)
clerical and administrative workers	10.4	0.61 (0.60;0.62)	13.60(13.19;14.02)
sales workers	4.5	0.66 (0.64;0.68)	15.73(15.07;16.41)
machine operators and drivers	0.6	0.84 (0.79;0.90)	20.47(18.55;22.53)
labourers	3.6	0.79 (0.77;0.82)	19.33(18.54;20.16)
residual categories	47.8	0.71 (0.70;0.71)	16.82(16.61;17.03)
Secondary caregiver (in 2 parent households n=197,943)			
Employment status			
employed full time	86.0	0.59 (0.59;0.60)	12.96(12.80;13.12)
employed part time	3.9	0.65 (0.63;0.68)	15.54(14.74;16.37)
unemployed	2.5	0.86 (0.83;0.89)	21.94(20.81;23.12)
not in labour force	6.2	0.74 (0.72;0.76)	18.76(18.08;19.46)
unknown	1.4	0.85 (0.81;0.89)	21.47(19.96;23.06)
Occupation			
managers	24.0	0.53 (0.52;0.54)	10.80(10.52;11.08)
professionals	18.2	0.48 (0.47;0.49)	9.63(9.33;9.94)
technicians and trades workers	16.3	0.61 (0.60;0.62)	13.67(13.30;14.05)
community and personals service	4.0	0.65 (0.63;0.67)	14.00(13.26;14.78)
clerical and administrative workers	3.8	0.59 (0.56;0.61)	13.93(13.17;14.73)
sales workers	4.4	0.55 (0.53;0.57)	12.04(11.37;12.74)
machine operators and drivers	7.2	0.79 (0.77;0.81)	19.42(18.78;20.08)
labourers	8.7	0.79 (0.77;0.80)	18.85(18.28;19.45)
residual categories	13.4	0.75 (0.74;0.77)	18.90(18.43;19.38)
Mobility			
number of times moved			
0	37.9	0.61 (0.61;0.62)	13.73(13.51;13.95)
1	26.3	0.63 (0.63;0.64)	14.53(14.26;14.80)
2	15.6	0.70 (0.69;0.71)	16.30(15.94;16.66)
3	9.1	0.75 (0.74;0.76)	17.73(17.25;18.23)
4	5.1	0.76 (0.74;0.78)	17.90(17.25;18.57)
5+	5.3	0.85 (0.83;0.86)	19.67(19.01;20.35)
missing/unknown	0.6	0.60 (0.55;0.65)	13.58(11.99;15.35)
Area characteristics			
Area level deprivation			
NZIMD Decile 1 (least deprived)	9.2	0.51 (0.49;0.52)	9.50(9.13;9.89)
Decile 2	9.2	0.53 (0.52;0.54)	10.74(10.35;11.15)
Decile 3	8.7	0.55 (0.54;0.57)	11.30(10.89;11.73)
Decile 4	9.3	0.57 (0.55;0.58)	11.79(11.38;12.21)
Decile 5	9.4	0.57 (0.56;0.58)	12.49(12.07;12.91)
Decile 6	9.7	0.61 (0.60;0.62)	13.82(13.40;14.26)
Decile 7	10.0	0.66 (0.65;0.67)	15.06(14.63;15.51)
Decile 8	10.3	0.72 (0.71;0.74)	17.47(17.01;17.94)
Decile 9	11.2	0.81 (0.80;0.82)	20.29(19.83;20.76)
Decile 10 (most deprived)	13.0	0.96 (0.95;0.97)	24.60(24.14;25.07)
Urban/rural			
Urban	86.1	0.67 (0.66;0.67)	15.47 (15.32;15.63)
Rural	13.8	0.66 (0.65;0.67)	13.72 (13.4;14.2)
Region of residence			
Northland	3.6	0.83 (0.81;0.85)	17.60(16.83;18.40)
Auckland	32.2	0.60 (0.59;0.60)	15.45(15.21;15.70)
Waikato	10.8	0.64 (0.62;0.65)	15.14(14.72;15.56)
Bay of Plenty	6.5	0.67 (0.66;0.69)	14.40(13.87;14.95)
Gisborne	1.2	0.78 (0.74;0.82)	19.00(17.66;20.41)
Hawke's Bay	4.1	0.58 (0.56;0.60)	14.84(14.17;15.53)
Taranaki	2.9	0.72 (0.70;0.74)	14.76(13.98;15.59)
Manawatu-Wanganui	5.5	0.82 (0.80;0.84)	18.16(17.53;18.81)
Wellington	10.6	0.68 (0.67;0.69)	14.21(13.80;14.63)
Tasman	1.0	0.64 (0.60;0.68)	12.55(11.29;13.93)
Nelson	1.0	0.61 (0.57;0.64)	11.56(10.37;12.87)
Marlborough	1.0	0.74 (0.71;0.78)	15.34(13.99;16.80)
West Coast	0.7	0.76 (0.72;0.81)	15.17(13.58;16.91)
Canterbury	12.3	0.65 (0.64;0.67)	13.97(13.59;14.36)
Otago	4.0	0.76 (0.74;0.78)	14.97(14.29;15.68)
Southland	2.6	0.86 (0.84;0.88)	17.77(16.86;18.71)
parental characteristics			
Parental immigrant status			
Primary caregiver			
age (years) mean(SD)[¥]	34.17 (6.45)	Pearson r=0.04	OR=0.98 (0.98;0.98)
Born in NZ			
Yes	73.3	0.71 (0.70;0.71)	15.58 (15.22;15.94)
no	25.7	0.54 (0.53;0.54)	14.06 (13.70;14.42)
missing	1.0	0.77 (0.73;0.82)	19.92 (18.41;21.45)
Religious beliefs			
No Religion	47.0	0.64 (0.64;0.65)	13.80 (13.61;14.00)
Christian	42.5	0.73 (0.73;0.74)	17.07 (16.85;17.30)
Other religion	5.3	0.23 (0.21;0.25)	10.31(9.80;10.84)
Unclear/not stated	5.1	0.73 (0.71;0.75)	17.96(17.30;18.63)
Languages spoken			
English only	74.8	0.66 (0.65;0.66)	14.21(14.06;14.37)
English and other (not Māori)	17.3	0.60 (0.59;0.61)	16.45(16.10;16.80)
English and Māori	4.9	0.98 (0.96;1.00)	24.13(23.39;24.89)
doesn't speak English	1.8	0.65 (0.62;0.69)	17.69(16.60;18.84)
missing	1.2	0.83 (0.80;0.87)	21.04(19.65;22.50)
Secondary caregiver (in 2 parent households n=197,943)			
Born in NZ			
Yes	70.3	0.63 (0.63;0.64)	13.26 (12.90;13.63)
no	28.2	0.56 (0.55;0.57)	14.86 (14.50;15.22)
missing	1.3	0.72 (0.68;0.77)	17.14 (15.58;18.70)
Religious beliefs			
No Religion	48.8	0.58 (0.58;0.59)	12.05(11.84;12.25)
Christian	37.6	0.70 (0.69;0.70)	16.00(15.74;16.27)
Other religion	5.5	0.20 (0.18;0.22)	10.19(9.64;10.78)
Unclear/not stated	8.0	0.69 (0.67;0.70)	16.16(15.59;16.74)
Birth weight and gestational age			
Birth weight			
1500g	0.8	0.12 (0.08;0.17)	7.55 (6.48;8.78)
1500-2499g	4.8	0.34 (0.32;0.35)	10.12 (9.59;10.67)
2500g-3999g	78.8	0.62 (0.62;0.62)	13.97 (13.82;14.12)
≥4000g	15.7	1.02 (1.01;1.03)	23.55 (23.13;23.97)
Gestational age			
very preterm (<32 weeks)	1.0	0.31 (0.27;0.35)	10.44 (9.31;11.68)
preterm (32-36 weeks)	6.1	0.56 (0.54;0.58)	13.71 (13.18;14.27)
term (37-41 weeks)	92.5	0.68 (0.68;0.68)	15.37 (15.23;15.52)
post term (≥42 weeks)	0.4	0.75 (0.68;0.83)	17.41 (15.09;19.99)

Birthweight and gestation

	European	Māori	Pacific	Asian	MELAA
very low	0.73	0.95	0.85	0.86	0.91
low	4.41	5.37	3.67	6.17	4.23
average	77.60	79.34	74.08	86.73	84.69
high	17.25	14.34	21.39	6.24	10.17

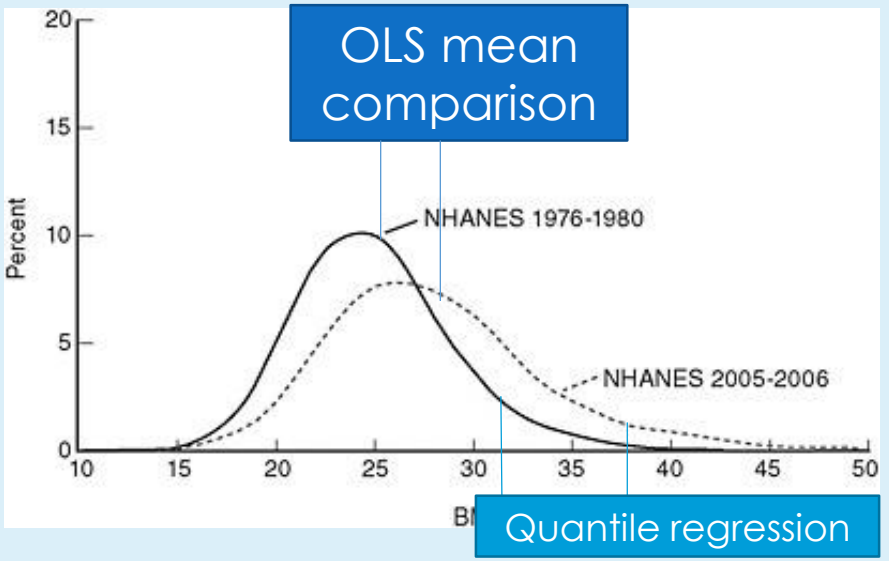
	European	Māori	Pacific	Asian	MELAA
very preterm	0.93	1.18	1.15	0.94	1.01
preterm	11.82	12.14	10.98	12.72	11.96
term	86.95	86.24	87.22	86.02	86.53
long term	0.29	0.43	0.66	0.32	0.50

		unadjusted	adjusted[a]
Q25			
	Māori	0.230	0.143
		(0.213;0.247)	(0.133;0.152)
	Pasifika	0.530	0.441
		(0.512;0.548)	(0.423;0.459)
	Asian	-0.430	-0.241
		(-0.454;-0.406)	(-0.266;-0.216)
	MELAA	-0.090	-0.000
		(-0.133;-0.047)	(-0.059;0.059)
	Constant[b]	-0.030	
		(-0.040;-0.020)	
Q50			
	Māori	0.280	0.165
		(0.268;0.292)	(0.153;0.176)
	Pasifika	0.640	0.500
		(0.622;0.658)	(0.484;0.515)
	Asian	-0.340	-0.220
		(-0.359;-0.321)	(-0.248;-0.192)
	MELAA	-0.030	0.027
		(-0.068;0.008)	(-0.024;0.078)
	Constant	0.550	
		(0.546;0.554)	
Q75			
	Māori	0.340	0.194
		(0.324;0.356)	(0.181;0.207)
	Pasifika	0.790	0.580
		(0.766;0.814)	(0.556;0.603)
	Asian	-0.260	-0.207
		(-0.280;-0.240)	(-0.235;-0.179)
	MELAA	0.070	0.057
		(0.029;0.111)	(-0.005;0.118)
	Constant	1.140	
		(1.130;1.150)	

[a] Adjusted for ethnicity + demographics+ family socioeconomic characteristics+ area characteristics+ parental cultural and sociodemographic characteristics + birth characteristics

[b] in unadjusted models, the constant term in the ZBMI value for Europeans at the given percentile

allows us to compare differences in the distribution of ZBMI between ethnic groups – what is the difference between the "lightest" European children and the "lightest" Asian children



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		(0.029;0.111)	(-0.005;0.118)
	Constant	1.140	
		(1.130;1.150)	

[a] Adjusted for ethnicity + demographics+ family socioeconomic characteristics+ area characteristics+ parental cultural and sociodemographic characteristics + birth characteristics

[b] in unadjusted models, the constant term in the ZBMI value for Europeans at the given percentile

Differences in ZBMI were larger at the 75th compared to the 25th percentile for Māori and Pacific children. In adjusted models a greater percentage of the difference in ZBMI scores was accounted for by covariates at the 75th compared to the 25th percentile for Māori (43% and 38% respectively) and Pacific children (27% and 17% respectively). For Asian children the opposite pattern emerged. Differences in ZBMI were larger at the 25th percentile and smaller at the 75th percentile, and a greater percentage of the difference was accounted for at the 25th compared to the 75th percentile (44% and 20% respectively).