The Australian Aboriginal Birth Cohort study: socio-economic status at birth and cardiovascular risk factors to 25 years of age

ABSTRACT

Objectives: Both individuals' own as well as their neighbourhood socioeconomic features have been related with cardiovascular risk factors and clinical events. However, there is no longitudinal childhood data available among Indigenous populations. Therefore, we aimed to explore the relationship of socioeconomic position at birth with prospective lipid, blood pressure and body mass index (BMI) values.

Design, setting and participants: This prospective follow-up study utilized data among 570 participants of the Aboriginal Birth Cohort Study in Northern Territory, Australia. As socioeconomic measures, the Indigenous Relative Socioeconomic Outcomes (IRSEO) index, residence area (urban/remote) and parity of the mother were evaluated at birth (1987-1990).

Main outcome measures: Body mass index (BMI), blood pressure and lipid measurements were performed at three time-points: at mean ages of 11 years (Wave-2) 18 years (Wave-3) and 25 years (Wave-4). Statistical analyses were performed with linear mixed models adjusting for sex, study wave and BMI (except for BMI analyses).

Results: Higher disadvantage (by IRSEO at birth) was associated with lower BMI, systolic blood pressure, LDL-cholesterol and HDL-cholesterol levels during the follow-up. Remote residency at birth was associated with lower BMI, lower HDL-cholesterol and higher triglyceride levels. Higher number of children in the family (at birth) was related with lower BMI.

Conclusions: These data from longitudinal lifecourse analyses provide evidence of areal / socioeconomic differences in major cardiovascular risk factors in early life among Indigenous Australians.

KEY WORDS:

Cardiovascular, indigenous, socioeconomic, lipid, blood pressure

Tweet statement: Our lifecourse analyses provide evidence of areal / socioeconomic differences in major cardiovascular risk factors in early life among Indigenous Australians.

Dot-point box:

The known: Especially in adulthood, individuals' own as well as their neighbourhood socioeconomic features have been related with cardiovascular risk factors and clinical events.

The new: These data from longitudinal lifecourse analyses provide evidence of areal / socioeconomic differences in major cardiovascular risk factors already in early life among Indigenous Australians.

The implications: These data novel information on the socioeconomic differences in cardiovascular risk factors within an Indigenous community suggesting a need for preventive efforts.

INTRODUCTION

In developed countries, the age-adjusted prevalence and mortality rates of atherosclerotic cardiovascular disease (CVD) have markedly decreased since the 1960s. The main reason has been significant improvements in cardiovascular risk factor levels, i.e. serum lipids and blood pressure. The favourable changes in these 2 main risk factors have been suggested to explain over 40% of the achieved improvement in CVD mortality(1). However, such favourable trends have not been achieved among Indigenous populations. Life expectancy for the Indigenous population in Australia remains approximately 10 years lower when compared to the non-Indigenous population(2). Importantly, the most common cause of death among Indigenous Australians is CVD(2).

Even though CVD risk and its main risk factors have improved worldwide, the socioeconomic differences have not decreased. Several reports around the world have pointed out the socioeconomic inequalities in CVD(3, 4). Both individuals' own and their neighbourhood socioeconomic features have been related with CVD risk factors and events(5-7). However, there is paucity of knowledge concerning the association between socioeconomic position and CVD risk factors over the lifecourse, especially in the early life. Moreover, there is no longitudinal childhood data available among Indigenous populations.

We have utilized lifelong risk factor data gathered from 570 participants in the Aboriginal Birth Cohort (ABC) study in Northern Territory (NT), Australia. Our aim was to explore whether socioeconomic position at birth is related with longitudinal data on body mass index (BMI), lipids and blood pressure until the mean age of 25 years**.**

METHODS

Participants

Details of the ABC have been previously published (8, 9). Of all children born to Aboriginal mothers 1987-1990 at the Royal Darwin Hospital, 686 of the possible 1238 were recruited. There were no differences in mean birth weights or sex ratios between those recruited and not recruited. Three clinical follow-ups have been conducted: Wave-2 (mean age 11 years, range 8-14 years), Wave-3 (mean age 18 years, range 16-20 years), Wave-4 (mean age 25 years, range 23-28 years). Wave-4 took place in 2014-2016 with a follow-up rate of 70.9% of living participants. Participants resided in over 40 urban and remote communities across the NT, approximately 75% in remote communities and the remainder in urban Darwin and its immediate surrounds. Remote residency included Arnhem, Vic/Daly and Tiwi regions. All procedures contributing to this work comply with the Helsinki Declaration of 1975, as revised in 2008. This study was approved by the Human Research Ethics Committee of Northern Territory Department of Health and Menzies School of Health Research, including the Aboriginal Ethical Sub-committee which has the power of veto (ABC Reference no. 2013-2022). All research was performed in accordance with the National Health and Medical Research Council guidelines (National Statement on Ethical Conduct in Human Research, 2008). Informed written consent was obtained from all participants.

Socioeconomic variables

For areal disadvantage, the Indigenous Relative Socioeconomic Outcomes (IRSEO) index was used. It is a score calculated at the Indigenous Area level based on 9 variables including 3 related to employment, 3 to education, 2 to housing and 1 to income using information derived from the

2011 Census of Population and Housing. Each area is assigned to one of 100 percentiles, 1 representing the most advantaged and 100 for the most disadvantaged.(10) Based on their reported addresses at birth, the participants were assigned an IRSEO score. The scores were categorised into four groups: least disadvantage (range 13-37), mid-high disadvantage (range 43-79), high disadvantage (range 81-89) and highest disadvantage (range 91-99). Concerning the residence at birth, families living in urban areas were classified as urban and those in remote locations as remote. Parity of the mother at the time of birth of the participant was recorded. It was put into four categories: 1, 2-3, 4-5, and ≥6 children.

Lipids, blood pressure and BMI

Venous blood samples were taken to assess lipid values, including low density lipoprotein (LDL)-cholesterol, high-density lipoprotein (HDL)-cholesterol and triglycerides, which were subsequently measured using enzymatic methods (at Wave-2: Hitachi 917 auto analyser, Roche, Switzerland; at Wave-3: colorimetric analyser, Roche Modular; and at Wave-4: colorimetric analyser, Siemens XPand Plus). LDL-cholesterol was directly measured using automated flex kit reagent cartridge. Blood pressure was obtained three times at each Wave, on the right arm, whilst sitting, and post resting using an automatic oscillatory unit (Lifesigns BP Monitor, Welch Allyn, New York, USA). A mean of these three measurements was used. Weight was measured in light clothing while barefoot to the last complete 0.1 kg with a digital scale (TBF-521; Tanita Corporation, Arlington Heights, Illinois, USA). Height was measured with a portable stadiometer to the nearest millimetre. BMI was calculated using these measures.

Statistical analyses

To describe the study participants, variables were presented as mean (standard deviation (SD)) for continuous variables and as (%) for categorical variables. Attrition analyses were performed to compare baseline characteristics between participants and non-participants of the follow-ups with t-tests for continuous and chi-square tests for categorical variables.

The main analyses examined whether socioeconomic position at birth (IRSEO, residence, mother's parity) is associated with longitudinal data on cardiovascular risk factors. To test these associations and provide point estimates with 95% confidence intervals for risk factors in different study waves according to baseline socioeconomic position, linear mixed models were used to account for the intra-subject correlation arising from the repeated measures. Models included one of socioeconomic variables at birth (IRSEO, residence or mother's parity) as the variable of interest and sex, BMI (except BMI models) and study wave as adjusted covariates. In addition, to provide least square means and their 95% confidence intervals at different waves, interaction terms between socioeconomic variable and study wave were included in the models. Age was not included in the main analyses due to its high collinearity with study wave (variance inflation factor of 30). Due to limited variability in age at each study wave, we used study wave in the models rather than continuous age. However, we performed additional sensitivity analyses with age also included in the models. To assess the influence of missing data, analyses were also performed including only those individuals participating in all follow-ups. The statistical tests were performed with SAS version 9.4 (SAS Institute, Inc, Cary, North Carolina). Statistical significance was inferred at a 2-tailed P-value <0.05.

RESULTS

The characteristics of the study participants are presented in Table 1. In Wave-4, 19% (N=75) reported living in another community for a period at some point in their life. By Wave-4, 8.7% (N=30) of those who lived in remote area in Wave-2 had moved to urban and 18.5% (N=15) of those who lived in urban area in Wave-2 had moved to remote.

Attrition analyses are shown in Supplementary Table 1. In waves 3 and 4, when compared to participants, non-participants were more often males, and at birth their IRSEOs were less disadvantaged and they were less commonly living in remote areas. In addition, in Wave-3 non-participants were older at baseline, and in Wave-4 they were more often from families having less children.

Body mass index

Disadvantage (IRSEO at birth), remoteness (residence at birth) and higher number of children were associated with lower subsequent BMI levels (Figure 1).

Blood pressure

More disadvantaged IRSEO at birth was associated with lower systolic blood pressure levels (Figure 2). No significant associations were observed for diastolic blood pressure (Supplemental Figure 1).

Lipids

IRSEO at birth was associated with LDL levels; individuals with the highest disadvantage rating (IRSEO) had the lowest mean LDL-cholesterol concentrations (Figure 3). For HDL-cholesterol, differences were observed based on IRSEO and residential status (Figure 4). Individuals with the highest disadvantage (IRSEO) or in remote communities had the lowest HDL-cholesterol levels. Residential community type was associated with triglyceride levels (Figure 5); those individuals living in remote communities had the highest triglyceride levels.

Sensitivity analyses

In analyses adjusted additionally with age, the results remained similar. When utilizing only data from those individuals participating in all follow-ups (Waves 2-4), the results remained similar except for the associations between IRSEO and LDL-cholesterol (P=0.17 for IRSEO group), and residential community and triglycerides (P=0.13 fro residence group).

DISCUSSION

The present study shows that within an Indigenous population in the Northern Territory of Australia socioeconomic situation in early life is longitudinally related with cardiovascular risk factors. The most consistent associations were observed for HDL-cholesterol levels. In assessing socioeconomic measures, IRSEO grouping based Indigenous area disadvantage seemed to provide the most accurate information.

Prior studies performed mainly among adult cohorts have consistently shown that neighborhood factors are associated with CVD and its risk factors. Concerning childhood neighborhood, a Canadian study reported that children from disadvantaged neighborhoods are more likely to develop a CVD risk factor/event during a 34-year follow-up(11). In the Cardiovascular Risk in Young Finns study, lifecourse neighborhood disadvantage was related with blood pressure and triglyceride levels in midlife(7). Our findings were not completely in line with prior studies, as we observed that blood pressure and LDL-cholesterol levels were most favourable among individuals from highest disadvantage areas. However, while interpreting the findings on LDL-cholesterol, it has to be taken into account that the existence of small dense LDL particles is common among Indigenous Australians(12), a feature we were not able to evaluate. HDL-cholesterol and triglycerides results were in accordance with prior data showing that those from least disadvantaged, accessible and urban areas had the most favourable levels. While interpreting our findings, it is essential to take into account the different methods of defining disadvantaged neighbourhoods. Among non-Indigenous cohorts the variables used have related to education level, unemployment rates and proportion of people living in own vs. rental housing compared to some of those applied in the present study, such as road distance to service centres.

Possible mechanisms for the present findings are most likely multiple. Dietary factors are important. It has been estimated that poor diet is one the main reasons for the health gap among Indigenous Australians(13). Relatively high food prices in remote communities combined with low average incomes cause food insecurity(14). In USA based studies, food insecurity has been associated with lower blood pressure and cholesterol levels(15, 16). Structural factors such as limited food storage facilities and preparation resources impact dietary choices(17). Complex food-sharing networks can affect food choices, and the consumption of traditional bush foods may also affect diet quality. However, there is sparse research data available concerning the exact dietary effects of these factors. Even a short period of low money has been shown to contribute to reduced diet quality among remote Indigenous Australians(18). Most notable differences according to money cycle (available vs low) were observed in energy intake, and energy provided by fat and carbohydrates. In addition, an association with the ratio of Na/K intake was shown. Neighbourhood disadvantage among Indigenous Australians is inversely and urban residence is directly associated with a dietary index included in the American Heart Association's ideal cardiovascular health definition(19). As we found in the present analyses, for some measures increased neighborhood disadvantage or remoteness had a favourable relationship (blood pressure, LDL-cholesterol) and for others non-favourable (HDL-cholesterol, triglycerides), the mechanisms for the associations are more complicated and include several non-dietary issues. The importance of social factors such as education, inequities of resource allocation, employment opportunities and differences in physical infrastructure must also be taken into account(20). Finally, concerning especially lipid levels in Australian Indigenous populations, genetic and inflammatory factors have been shown to have a significant role(21). In a medium-sized study (n = 155) in southeast Queensland, apolipoprotein-E4 polymorphisms were 1.8 times more prevalent in Indigenous than non-Indigenous participants and associated with high triglycerides and low HDL-cholesterol(22).

From the clinical and public health point of views, our results provide novel information on the socioeconomic and areal differences in cardiovascular risk factors within an Indigenous community. Concerning the clinical relevance, it has been estimated that each increment of 20 mmHg in systolic BP levels is related with a twofold difference in cardiovascular mortality(23). One mmol/L lower LDL-cholesterol levels have been associated with a 31% prospective reduction in coronary disease(24). Thereby, the differences of up to 3.5 mmHg in systolic blood pressure and 0.6 mmol/l in LDL-cholesterol between extreme IRSEO groups can be considered relevant. From the public health perspective these data suggest that different focus and support might be needed for preventive work according to the living area of the indigenous population. To construct useful intervention strategies for positive health changes in this population based on these findings, it is essential to take Indigenous perspectives and socioeconomic issues into account.

The strengths of the study include its childhood-onset longitudinal nature/design and well-structured follow-ups with good retention rates, particularly considering the accessibility issues in data collection in remote areas. The study population, however, is relatively small causing some limitations to the interpretation of the results. Even though the retention rates in follow-up studies were high (>75% of those in Wave-2 participated in later Waves), attrition analyses showed differences between non-participants and participants. Therefore, the findings should be interpreted with caution. Other limitations concerning overall generalizability of the study include the difficult definition of socioeconomic status, as the traditional variables were not available (income, education, occupation) and are not well-suited in the remote communities. The IRSEO scores describe the areal level socioeconomic situation or remoteness and do not necessarily reflect the individual socioeconomic status of the participants. Finally, the participants were still young adults during the latest follow-up thus prohibiting the investigation of the association between socioeconomic measures and CVD morbidity.

In summary, data from these longitudinal lifecourse analyses provide evidence of areal socioeconomic differences in major cardiovascular risk factors among Indigenous Australians. Mean BMI, blood pressure and LDL-cholesterol levels were more favourable among individuals born in highly disadvantaged and remote areas, whereas their HDL-cholesterol and triglyceride levels were least favourable.

REFERENCES

1. Capewell S, O'Flaherty M. What explains declining coronary mortality? Lessons and warnings. Heart. 2008;94:1105-8.

2. Australian Institute of Health and Welfare. The Health and Welfare of Australia's Aboriginal and Torres Strait Islander Peoples: 2015. Cat No. IHW 147. Canberra. 2015. url: https://www.aihw.gov.au/reports/indigenous-health-welfare/indigenous-health-welfare-2015/contents/table-of-contents

3. Naska A, Katsoulis M, Trichopoulos D, Trichopoulou A. The root causes of socioeconomic differentials in cancer and cardiovascular mortality in Greece. Eur J Cancer Prev. 2012;21:490-6.

4. Pujades-Rodriguez M, Timmis A, et al. Socioeconomic deprivation and the incidence of 12 cardiovascular diseases in 1.9 million women and men: implications for risk prediction and prevention. PLoS One. 2014;9:e104671.

5. Diez Roux AV, Merkin SS, Arnett D, et al. Neighborhood of residence and incidence of coronary heart disease. New Engl JMed. 2001;345:99-106.

6. Halonen JI, Stenholm S, Pentti J, et al. Childhood Psychosocial Adversity and Adult Neighborhood Disadvantage as Predictors of Cardiovascular Disease: A Cohort Study. Circulation. 2015;132:371-9.

7. Kivimaki M, Vahtera J, Tabak AG, et al. Neighbourhood socioeconomic disadvantage, risk factors, and diabetes from childhood to middle age in the Young Finns Study: a cohort study. Lancet Public Health. 2018;3:e365-e73.

8. Sayers S, Singh G, Mackerras D, et al. Australian Aboriginal Birth Cohort study: follow-up processes at 20 years. BMC Int Health Hum Rights. 2009;9:23.

9. Sayers SM, Mackerras D, Singh G, et al. An Australian Aboriginal birth cohort: a unique resource for a life course study of an Indigenous population. A study protocol. BMC Int Health Hum Rights. 2003;3:1.

10. Biddle N. Center for Aboriginal Economic Policy Research Indigenous Population Project: 2011 Census Papers. Paper 13. Socioeconomic Outcomes. Canberra. Center for Aboriginal Economic Policy Research, The Australia National University. 2013. url: http://caepr.cass.anu.edu.au/research/publications/socioeconomic-outcomes

11. Kakinami L, Serbin LA, Stack DM, et a.. Neighbourhood disadvantage and behavioural problems during childhood and the risk of cardiovascular disease risk factors and events from a prospective cohort. Prev Med Rep. 2017;8:294-300.

12. O'Neal DN, Piers LS, Iser DM, et al. Australian Aboriginal people and Torres Strait Islanders have an atherogenic lipid profile that is characterised by low HDL-cholesterol level and small LDL particles. Atherosclerosis. 2008;201:368-77.

13. Popkin BM, Adair LS, Ng SW. Global nutrition transition and the pandemic of obesity in developing countries. Nutr Rev. 2012;70:3-21.

14. Brimblecombe JK, O'Dea K. The role of energy cost in food choices for an Aboriginal population in northern Australia. Med J Aust. 2009;190:549-51.

15. Saiz AM, Jr., Aul AM, Malecki KM, et al. Food insecurity and cardiovascular health: Findings from a statewide population health survey in Wisconsin. Prev Med. 2016;93:1-6.

16. Shin JI, Bautista LE, Walsh MC, et al. Food insecurity and dyslipidemia in a representative population-based sample in the US. Prev Med. 2015;77:186-90.

17. Brimblecombe J, Maypilama E, Colles S, et al. Factors influencing food choice in an Australian Aboriginal community. Qual Health Res. 2014;24:387-400.

18. Wycherley TP, Pekarsky BA, Ferguson MM, et al. Fluctuations in money availability within an income cycle impacts diet quality of remote Indigenous Australians. Public Health Nutr. 2017;20:1431-40.

19. Sjöholm P, Pahkala K, Davison B, et al. Early life determinants of cardiovascular health in adulthood. The Australian Aboriginal Birth Cohort study. Int J Cardiol. 2018;269:304-309

20. Smith KB, Humphreys JS, Wilson MG. Addressing the health disadvantage of rural populations: how does epidemiological evidence inform rural health policies and research? Aust J Rural Health. 2008;16:56-66.

21. Lyons JG, O'Dea K, Walker KZ. Evidence for low high-density lipoprotein cholesterol levels in Australian indigenous peoples: a systematic review. BMC Public Health. 2014;14:545.

22. Shaw JT, Tate J, Kesting JB, et al. Apolipoprotein E polymorphism in indigenous Australians: allelic frequencies and relationship with dyslipidaemia. Med J Aust. 1999;170:161-4.

23. Lewington S, Clarke R, Qizilbash N, et al. Age-specific relevance of usual blood pressure to vascular mortality: a meta-analysis of individual data for one million adults in 61 prospective studies. Lancet. 2002;360:1903-13.

24. Emerging Risk Factors Collaboration, Di Angelantonio E, Sarwar N, et al. Major lipids, apolipoproteins, and risk of vascular disease. JAMA. 2009;302:1993-2000.

Figure legends:

Figure 1: Title: Socioeconomic position and body mass index. Legend: Body mass index in study Waves 2-4 according to different socioeconomic variables at birth. Least square means, their 95% confidence intervals and P-values are from linear mixed models including also data on sex and study wave.

Figure 2: Title: Socioeconomic position and systolic blood pressure. Legend: Systolic blood pressure in study Waves 2-4 according to different socioeconomic variables at birth. Least square means, their 95% confidence intervals and P-values are from linear mixed models including also data on sex, BMI and study wave.

Figure 3: Title: Socioeconomic position and LDL-cholesterol. Legend: LDL-cholesterol levels in study Waves 2-4 according to different socioeconomic variables at birth. Least square means, their 95% confidence intervals and P-values are from linear mixed models including also data on sex, BMI and study wave.

Figure 4: Title: Socioeconomic position and HDL-cholesterol. Legend: HDL-cholesterol levels in study Waves 2-4 according to different socioeconomic variables at birth. Least square means, their 95% confidence intervals and P-values are from linear mixed models including also data on sex, BMI and study wave.

Figure 5: Title: Socioeconomic position and triglycerides. Legend: Triglyceride levels in study Waves 2-4 according to different socioeconomic variables at birth. Least square means, their 95% confidence intervals and P-values are from linear mixed models including also data on sex, BMI and study wave.

Supplemental Figure 1: Title: Study area map: Legend: Geographical boundaries used, communities included, population estimates and index of relative socioeconomic advantage and disadvantage of Northern Territory shires/regions.

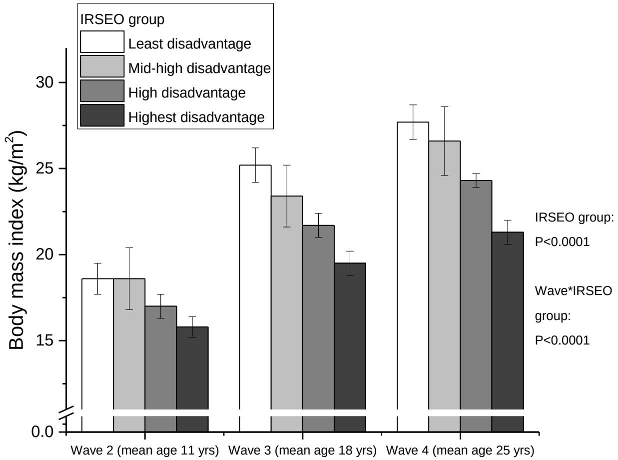
Supplemental Figure 2: Title: Socioeconomic position and diastolic blood pressure. Legend: Diastolic blood pressure in study Waves 2-4 according to different socioeconomic variables at birth. Least square means, their 95% confidence intervals and P-values are from linear mixed models including also data on sex, BMI and study wave.

Table 1

Characteristics of the study participants

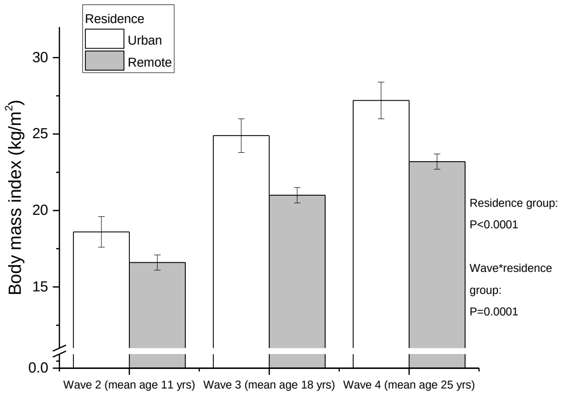
Variable	N	Mean (SD)	%
Participants			
Wave-2	570		
Wave-3	442		
Wave -4	427		
Mean age			
Wave-2		11.0(1.2)	
Wave-3		17.8(1.1)	
Wave-4		25.3(1.2)	
Males			
Wave-2	303		53.2
Wave-3	221		50.0
Wave-4	207		48.4
IRSEO at birth			
Least diasdvantage	120		21.1
Mid-high disadvantage	30		5.3
High disadvantage	201		35.2
Highest disadvantage	219		38.4
Residence at birth			
Urban	101		17.7
Remote	469		82.3
Mother's parity at birth			
1 child	190		33.5
2-3 children	227		39.8
4-5 children	110		19.3
≥6 children	43		7.5

IRSEO = Indigenous Relative Socioeconomic Outcomes



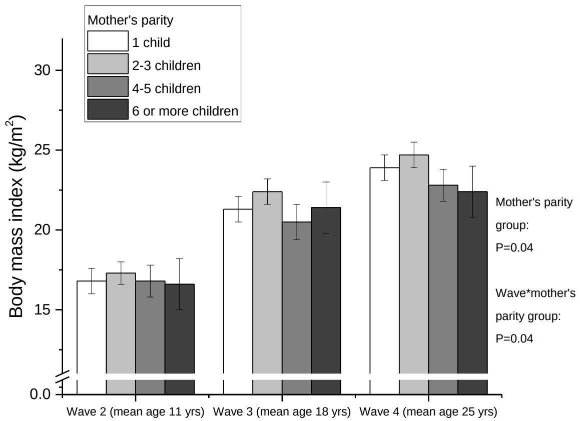
IRSEO group
Least disadvantage
Mid-high disadvantage
High disadvantage
Highest disadvantage
Body mass index (kg/m^2)
0.0
15
20
25
30
Wave 2 (mean age 11 yrs)
Wave 3 (mean age 18 yrs)
Wave 4 (mean age 25 yrs)
IRSEO group:
P<0.0001
Wave*IRSEO
group:
P<0.0001

a)



Residence
Urban
Remote
Body mass index (kg/m^2)
0.0
15
20
25
30
Wave 2 (mean age 11 yrs)
Wave 3 (mean age 18 yrs)
Wave 4 (mean age 25 yrs)
Residence group:
P<0.0001
Wave*residence
group:
P=0.0001

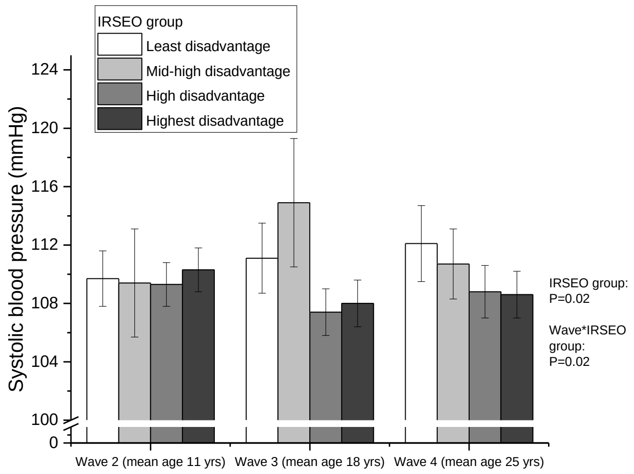
b)



Mother's parity
1 child
2-3 children
4-5 children
6 or more children
Body mass index (kg/m^2)
0.0
15
20
25
30
Wave 2 (mean age 11 yrs)
Wave 3 (mean age 18 yrs)
Wave 4 (mean age 25 yrs)
Mother's parity
group:
P=0.04
Wave*mother's
parity group:
P=0.04

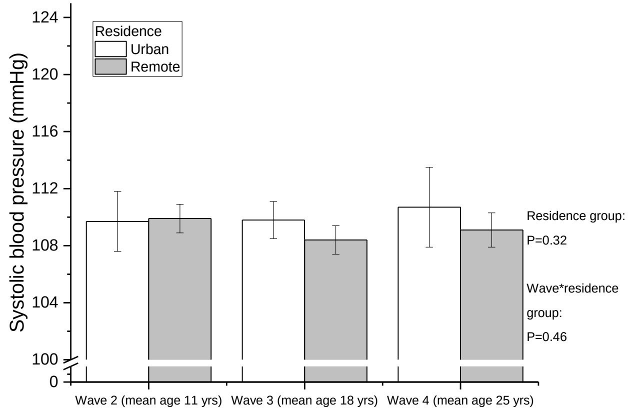
c)

Figure 1



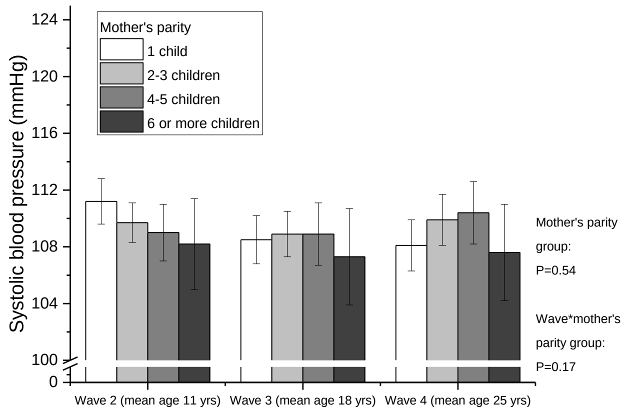
IRSEO group
Least disadvantage
Mid-high disadvantage
High disadvantage
Highest disadvantage
Systolic blood pressure (mmHg)
124
120
116
112
108
104
100
0
Wave 2 (mean age 11 yrs)
Wave 3 (mean age 18 yrs)
Wave 4 (mean age 25 yrs)
IRSEO group: P=0.02
Wave*IRSEO group: P=0.02

a)



Residence
Urban
Remote
Systolic blood pressure (mmHg)
124
120
116
112
108
104
100
0
Wave 2 (mean age 11 yrs)
Wave 3 (mean age 18 yrs)
Wave 4 (mean age 25 yrs)
Residence group: P=0.32
Wave*residence group: P=0.46

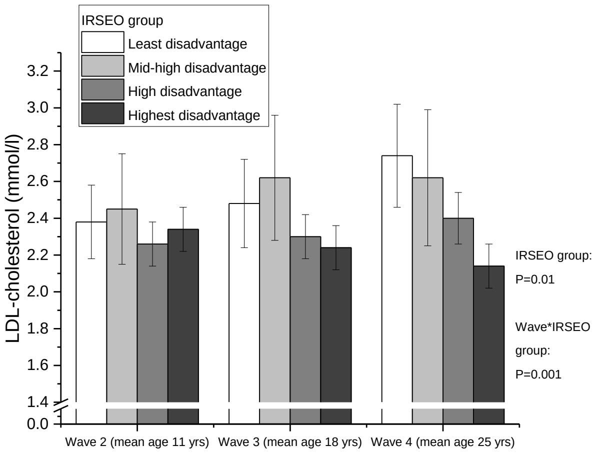
b)



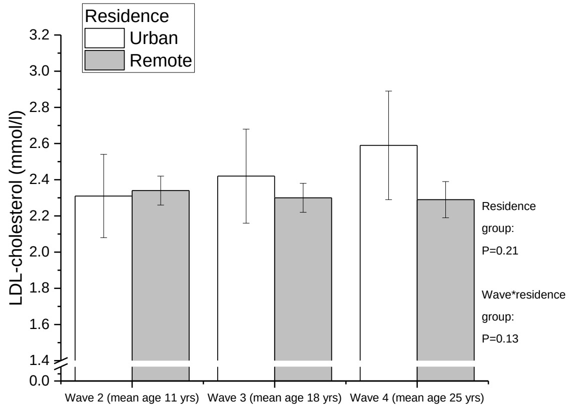
Mother's parity
1 child
2-3 children
4-5 children
6 or more children
Systolic blood pressure (mmHg)
124
120
116
112
108
104
100
0
Wave 2 (mean age 11 yrs)
Wave 3 (mean age 18 yrs)
Wave 4 (mean age 25 yrs)
Mother's parity group: P=0.54
Wave*mother's parity group: P=0.17

c)

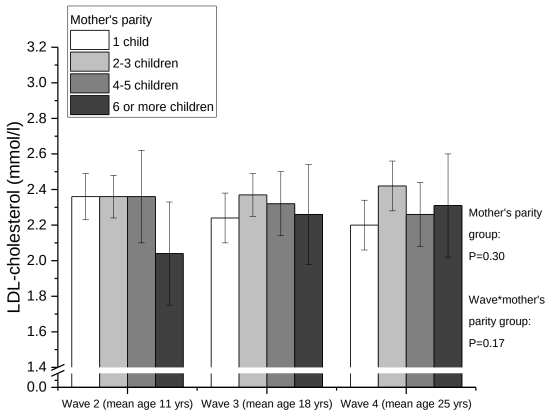
Figure 2


IRSEO group
Least disadvantage
Mid-high disadvantage
High disadvantage
Highest disadvantage
LDL-cholesterol (mmol/l)
3.2
3.0
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
0.0
IRSEO group:
P=0.01
Wave*IRSEO
group:
P=0.001
Wave 2 (mean age 11 yrs)
Wave 3 (mean age 18 yrs)
Wave 4 (mean age 25 yrs)

a)

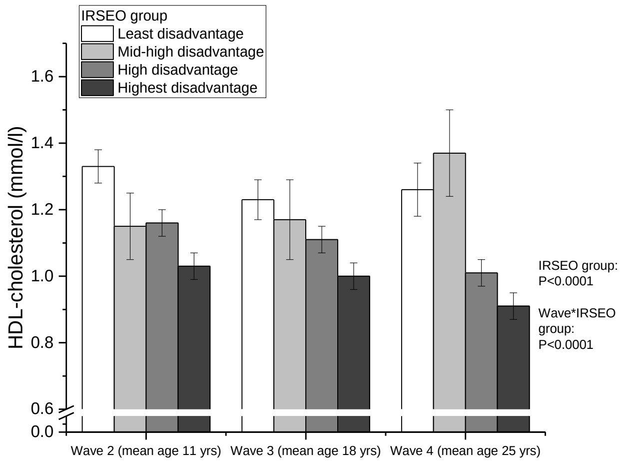

Residence
Urban
Remote
LDL-cholesterol (mmol/l)
3.2
3.0
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
0.0
Residence
group:
P=0.21
Wave*residence
group:
P=0.13
Wave 2 (mean age 11 yrs)
Wave 3 (mean age 18 yrs)
Wave 4 (mean age 25 yrs)

b)

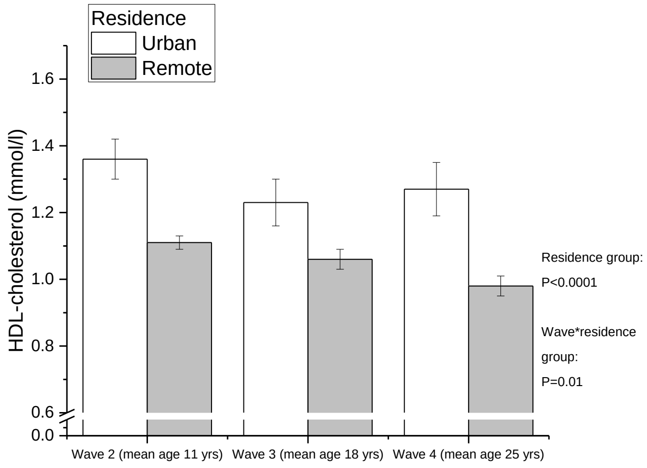

Mother's parity
1 child
2-3 children
4-5 children
6 or more children
LDL-cholesterol (mmol/l)
3.2
3.0
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
0.0
Mother's parity
group:
P=0.30
Wave*mother's
parity group:
P=0.17
Wave 2 (mean age 11 yrs)
Wave 3 (mean age 18 yrs)
Wave 4 (mean age 25 yrs)

c)

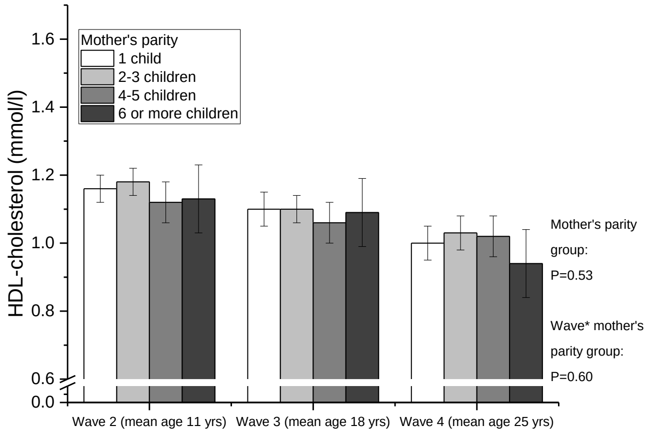
Figure 3


IRSEO group
Least disadvantage
Mid-high disadvantage
High disadvantage
Highest disadvantage
HDL-cholesterol (mmol/l)
1.6
1.4
1.2
1.0
0.8
0.6
0.0
IRSEO group: P<0.0001
Wave*IRSEO group: P<0.0001
Wave 2 (mean age 11 yrs)
Wave 3 (mean age 18 yrs)
Wave 4 (mean age 25 yrs)

a)

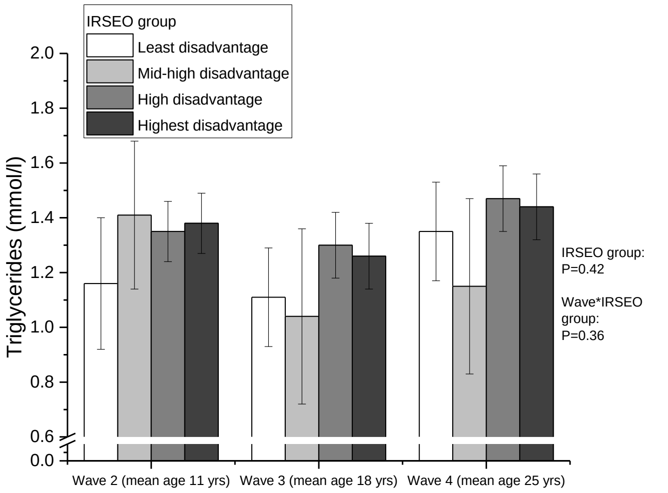

Residence
Urban
Remote
HDL-cholesterol (mmol/l)
1.6
1.4
1.2
1.0
0.8
0.6
0.0
Residence group:
P<0.0001
Wave*residence group:
P=0.01
Wave 2 (mean age 11 yrs)
Wave 3 (mean age 18 yrs)
Wave 4 (mean age 25 yrs)

b)

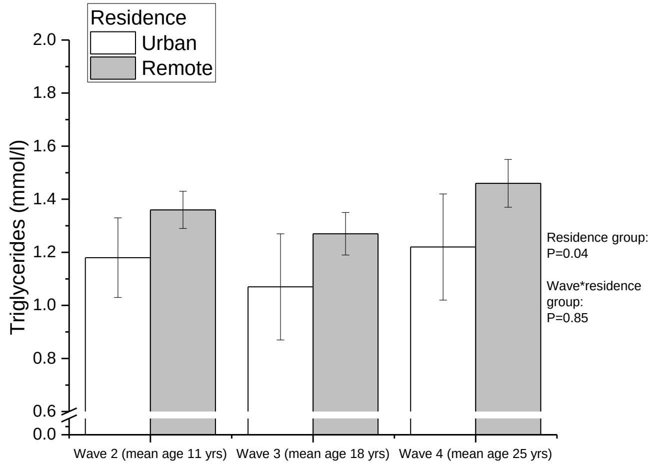

Mother's parity
1 child
2-3 children
4-5 children
6 or more children
HDL-cholesterol (mmol/l)
1.6
1.4
1.2
1.0
0.8
0.6
0.0
Mother's parity group:
P=0.53
Wave* mother's parity group:
P=0.60
Wave 2 (mean age 11 yrs)
Wave 3 (mean age 18 yrs)
Wave 4 (mean age 25 yrs)

c)

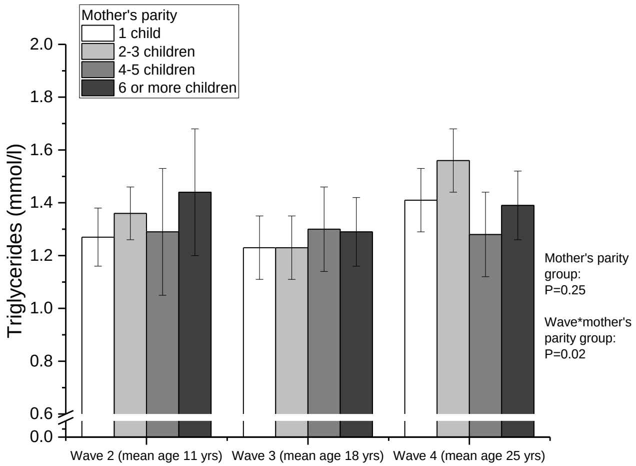
Figure 4


IRSEO group
Least disadvantage
Mid-high disadvantage
High disadvantage
Highest disadvantage
Triglycerides (mmol/l)
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.0
Wave 2 (mean age 11 yrs)
Wave 3 (mean age 18 yrs)
Wave 4 (mean age 25 yrs)
IRSEO group:
P=0.42
Wave*IRSEO
group:
P=0.36

a)


Residence
Urban
Remote
Triglycerides (mmol/l)
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.0
Wave 2 (mean age 11 yrs)
Wave 3 (mean age 18 yrs)
Wave 4 (mean age 25 yrs)
Residence group:
P=0.04
Wave*residence
group:
P=0.85

b)


Mother's parity
1 child
2-3 children
4-5 children
6 or more children
Triglycerides (mmol/l)
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.0
Wave 2 (mean age 11 yrs)
Wave 3 (mean age 18 yrs)
Wave 4 (mean age 25 yrs)
Mother's parity
group:
P=0.25
Wave*mother's
parity group:
P=0.02

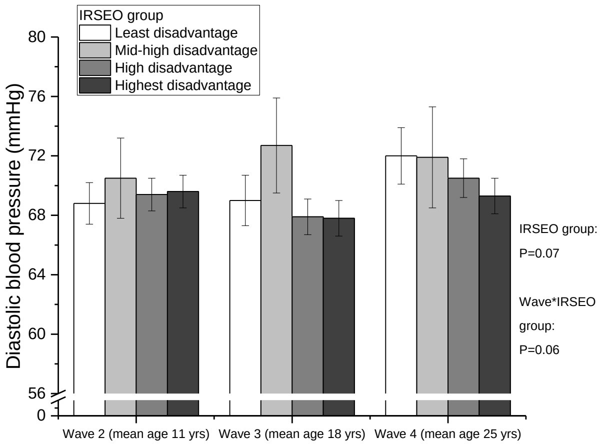
c)

Figure 5

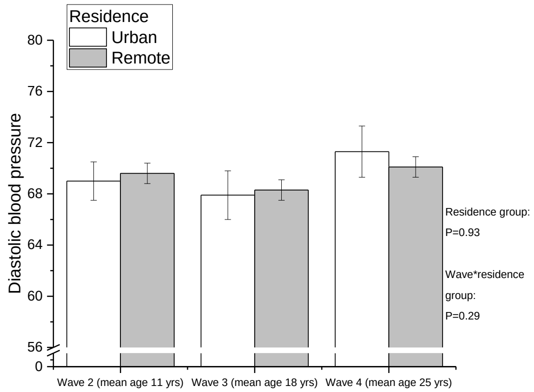
Variable	Wave 3			Wave 4		
	Non-participants	Participants	P-value	Non-participants	Participants	P-value
N	128	442		147	423	
Mean age (years, mean(SD))	11.3(1.3)	10.9(1.2)	0.005	11.1(1.3)	11.0(1.2)	0.19
Males (N (%))	40 (64.1)	221 (50.0)	0.005	98 (66.7)	205 (48.4)	0.0001
IRSEO at birth (N (%))			0.01			0.0002
Least disadvantage	40 (31.3)	80 (18.1)		49 (33.3)	71 (16.8)	
Mid-high disadvantage	4 (3.1)	26 (5.9)		9 (6.1)	21 (5.0)	
High disadvantage	42 (32.8)	159 (36.0)		44 (30.0)	157 (37.0)	
Highest disadvantage	50 (38.8)	177 (40.1)		45 (30.6)	175 (41.3)	
Residence at birth (N (%))			0.005			<0.0001
Urban	36 (28.1)	65 (14.7)		42 (28.6)	59 (13.9)	
Remote	92 (71.9)	377 (85.3)		105 (71.4)	364 (86.1)	
Mother's parity at birth (N (%))			0.35			0.04
1 child	41 (32.0)	149 (33.7)		47 (32.0)	144 (34.0)	
2-3 children	58 (45.3)	169 (38.2)		71 (48.3)	155 (36.8)	
4-5 children	23 (18.0)	87 (19.7)		23 (15.7)	87 (20.5)	
≥6 children	6 (4.7)	37 (8.4)		6 (4.1)	37 (8.7)	

Supplementary Table 1. Attrition analyses.

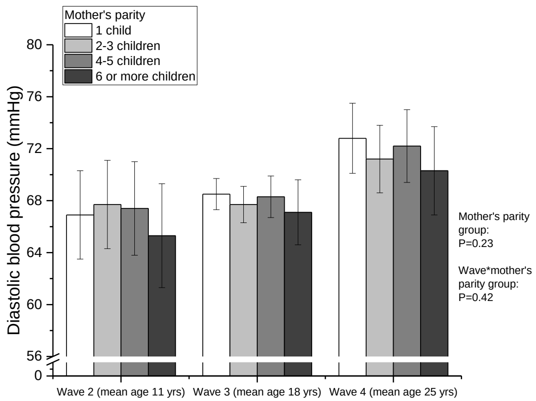
P-values are from t-tests for continuous and chi-square tests for categorical variables.



a)



b)



c)

Supplemental Figure 1