Associations between neighbourhood socioeconomic disadvantage and body mass index: longitudinal evidence from the Household, Income and Labour Dynamics in Australia Survey (2006–2021)

Jennifer Nkemdilim, Venurs Loh, Rebecca A Reid, Jerome N Rachele

Victoria University, Melbourne, Victoria, Australia

Correspondence to
Dr Jerome N Rachele;
Jerome.Rachele@vu.edu.au

Received 10 February 2025
Accepted 12 May 2025

ABSTRACT

Background Obesity prevalence differs by neighbourhood. One such characteristic of these neighbourhoods is the level of socioeconomic disadvantage. Understanding the nature of neighbourhood socioeconomic inequalities is important for shaping targeted interventions and policies to promote equitable access to resources and opportunities that support healthy living. The aim of this study was to examine associations between neighbourhood socioeconomic disadvantage and body mass index (BMI) over a 16-year period among a population-representative Australian sample.

Methods This study used data from 208 309 observations collected between 2006 and 2021 from the Household, Income and Labour Dynamics in Australia Survey. Neighbourhood disadvantage was measured via a census-derived index, and participants self-reported height and weight, which was computed to BMI. Data were analysed using multilevel and fixed effects regression to examine overall associations, trends over time and changes in neighbourhoods with changes in BMI.

Results There was an overall association between neighbourhood socioeconomic disadvantage and BMI. BMI was higher among those in the most disadvantaged neighbourhoods compared with the least disadvantaged neighbourhoods (β=1.31, 95% CI 1.15 to 1.46). BMI trends over time were widening with greater increases in BMI among those in the most disadvantaged neighbourhoods (Q1: β=0.04, 95% CI 0.02 to 0.06 and Q2: β=0.05, 95% CI 0.03 to 0.06). Changes in the level of neighbourhood socioeconomic disadvantage were positively associated with changes in BMI, with the strongest association among those transitioning to more disadvantaged neighbourhoods (Q1: β=0.10, 95% CI 0.02 to 0.18 and Q2: β=0.08, 95% CI 0.02 to 0.15).

Conclusions Using methodologically rigorous epidemiological approaches along with longitudinal, national data, this study found strong evidence of neighbourhood socioeconomic inequalities in BMI. Understanding the neighbourhood-level mechanisms likely to exacerbate these inequalities remains a future research priority.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Many studies have demonstrated an association between neighbourhood socioeconomic disadvantage and obesity. However, they have weak causal inference due to lack of temporal precedence or are limited by the length of the design period.

WHAT THIS STUDY ADDS

⇒ This study provides the most comprehensive study of this association to date, providing a strong basis to infer causation. It includes 16 waves of data, multifaceted analyses including overall associations, trends over time and changes in exposure associated with changes in the outcome, and finally, utilisation of a novel exposure data for neighbourhood socioeconomic disadvantage, which accounts for changes over time in geographical measures and time between censuses.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Implications for research include the comprehensive analytic approach and the novel use of changing neighbourhood disadvantage exposures. The findings support tailored, neighbourhood-level interventions, as well as urban planning policy reforms that mitigate socioeconomic disadvantage.

INTRODUCTION

Obesity is a complex, chronic disease that poses significant threats to global health, including increased risk of developing non-communicable diseases, leading to substantial economic costs.[1 2] Between 1990 and 2022, the global prevalence of obesity has more than doubled.[2] In 2022, 2.5 billion adults were found to be overweight and 890 million were estimated to be living with obesity globally.[2] Furthermore, in Australia, almost two-thirds of the adult population were found to be overweight and obese, increasing from 19% in 1995 to 32% in 2022.[3]

The health risks associated with high body mass index (BMI), including type 2 diabetes, stroke, digestive disorders, chronic respiratory diseases, cardiovascular diseases, arthritis, asthma and certain cancers, are becoming increasingly well understood and documented.[4] Overweight and obesity are predicted to cost over US$4 trillion of income to the global economy in 2035.[1] Unemployment,

Check for updates

To cite: Nkemdilim J, Loh V, Reid RA, *et al*. *J Epidemiol Community Health* Epub ahead of print: [*please include* Day Month Year]. doi:10.1136/jech-2025-223799

lower income, higher discrimination and social exclusion rates have been linked to higher BMI.[5 6]

Obesity prevalence differs by where you live. One such characteristic of these areas is neighbourhood socioeconomic disadvantage.[7–12] In Australia, adults living in the most socioeconomically disadvantaged areas were more likely to be overweight or obese (68%) than those from the least socioeconomically disadvantaged areas (60%).[3] Several Australian cross-sectional studies have supported the assertion of neighbourhood-level socioeconomic inequalities in obesity. Three cross-sectional studies in Australia have found that those living in disadvantaged neighbourhoods had higher weight status than those in the least disadvantaged neighbourhoods.[13–15] Among longitudinal Australian research, analysis of seven waves of the Household, Income and Labour Dynamics in Australia (HILDA) Survey found associations between higher neighbourhood socioeconomic disadvantage and higher BMI among survey participants between 15 and 24 years, with neighbourhood inequalities widening among women until 54 years of age.[16] Similarly, another Australian study found that those living in the more disadvantaged neighbourhoods had higher weight status than those in the least disadvantaged neighbourhoods.[17] However, a longitudinal study which used data from a mid-to-older aged cohort in Brisbane, Australia, found no causal relations between BMI and neighbourhood disadvantage among those who moved neighbourhoods.[18] The environmental characteristics of disadvantaged neighbourhoods may influence behaviours, such as dietary choices and physical activity levels, that are associated with BMI, potentially contributing to socioeconomic inequalities in obesity.[19] Such environments that comprise elements that encourage obesogenic behaviours and promote weight gain are known as obesogenic environments.[20 21] Obesogenic environments can influence dietary behaviours (the availability, affordability and accessibility of food outlets)[22] and physical activity levels (through proximity of parks, streets interconnectivity and availability of walking opportunities).[23–25]

While numerous studies have explored the environmental determinants of obesity, gaps in understanding this relationship remain. Most studies in this area are cross-sectional,[13 14 26] which by their design provide weaker causal inference due to a lack of temporal precedence.[27] Existing longitudinal studies[7 16–18] have either only examined people who relocated (ie, movers) or did not consider both movers and stayers. While 'mover' studies provide stronger causal inference as they allow for changes in exposure over time, such 'stayer' studies only take the level of neighbourhood disadvantage at a single point in time and assume consistency over the study period.[28] This is a key limitation of 'stayer' studies. Furthermore, some longitudinal cohort studies[17 18] use census data from a single census year. However, the Australian Bureau of Statistics (ABS) does not recommend the use of their socioeconomic disadvantage index for longitudinal analysis for two reasons: First, the Index of Relative Socio-economic Disadvantage (IRSD) is derived from census data collected every 5 years, limiting its timeliness. Second, geographical boundaries may be updated every census.[29] Therefore, it is possible that area level changes such as gentrification or population growth may not be accounted for.

This study aims to overcome these limitations by examining associations between neighbourhood socioeconomic disadvantage and BMI over a 16-year period among a population representative Australian sample using three analytic approaches: (1) overall associations, (2) trends over time and (3) changes in neighbourhood socioeconomic disadvantage and changes in BMI. This study seeks to address the gaps in previous research by accounting for both movers and stayers and by using a novel method that employs spatially and temporally consistent neighbourhood socioeconomic data to consider how neighbourhoods change over time, including between each census year. This approach provides stronger causal insights into the relationship between neighbourhood disadvantage and obesity.

METHODS

Population and data

This study used data from the HILDA Survey. The HILDA Survey is an annual household-based, nationally representative Australian longitudinal survey that covers a broad range of information about income, health, education, labour market and family.[30] The HILDA Survey was initiated in 2001 and consisted of 7682 households and 13 969 individual respondents, with an additional 2153 households and 4009 individual respondents known as the top-up sample added to the study in 2011.[31] The survey involves people aged 15 years and above. Data are collected through face-to-face interviews and self-completed questionnaires. Detailed information about the HILDA Survey design and data sampling collection methodology is available elsewhere.[30]

Variables

Outcome

BMI: HILDA collects self-reported height and weight data yearly, from which BMI was estimated for each participant using the formula: weight in kilograms divided by participant's height in metre square.

Exposures

Neighbourhood-level socioeconomic disadvantage: to overcome the limitations of relying on census data for longitudinal analysis, neighbourhood disadvantage was measured using spatially and temporally consistent data derived from the ABS IRSD. This dataset was standardised to the boundaries of ABS 2021 Statistical area level 1 (SA1) census. The methodology used to generate these data is described in detail elsewhere.[32] The neighbourhoods were classified into quintiles with Q1 representing the most disadvantaged and Q5 representing the least disadvantaged neighbourhoods. The IRSD measures only relative disadvantage by using a weighted combination of social and economic variables of households and the people living within an area such as low income, unemployment and low education attainment.[33] Using annual socioeconomic indexes for areas data, rather than 5 yearly data, at a small geographic scale addresses key challenges associated with tracking neighbourhood socioeconomic factors over time.

Confounders

To address possible sources of confounding, a range of variables including age, gender, person-level socioeconomic factors and demographic factors were identified based on the previous literature.[34]

Age: in this study, age was subsequently coded into seven categories: 18–24, 25–34, 35–44, 45–54, 55–64, 65–74 and 75 years and over.

Education: HILDA Survey participants were asked about their highest level of attained education. The nine categories provided were subsequently coded in this study into four categories: bachelor's degree or higher; advanced diploma, diploma or certificate; year 12; year 11 or below.

Occupation: occupation was coded according to the Australian and New Zealand Standard Classification of Occupations[35] and classified into nine categories, which were subsequently coded into three categories in this study: high (professional; manager); medium (personal and community service workers; technicians and trades workers; administrative and clerical workers); and low (labourers; machinery operators and drivers; sales workers). An additional category was created to accommodate participants who were not in the labour force.

Household income: household income was coded into seven income categories: AU$156 000 or more, AU$130 000–AU$155 999, AU$104 000–AU$129 999, AU$78 000–AU$103 999, AU$52 000–AU$77 999, AU$26 000–AU$51 999 and less than AU$25 999.

Movers: participants were asked if they had changed address since the last interview. This was coded into two categories: (1) mover (participants who had relocated since the last wave) and (2) stayer (those who had not moved since the last wave). Participants were classified as movers in any wave if they reported changing address, meaning participants could be movers in multiple waves if they moved more than once throughout the study period. The mover variable was updated for each wave to ensure that transitions across neighbourhoods over time were captured.

Statistical analysis

This study used data from wave 6 to wave 21 (2006–2021) for the analysis, as BMI was introduced from wave 6, and 2021 was the most recent ABS census, and therefore the most recent available neighbourhood-level socioeconomic disadvantage data. From the original sample of 256 787 observations, participants under the age of 18 were omitted (12 720 observations), resulting in an in-scope sample of 244 067. Although the HILDA Survey includes participants aged 15 years and older, we restricted our sample to adults (18 years and over) to ensure consistency in the interpretation of BMI. BMI in individuals under 18 is interpreted using age-specific and sex-specific

Table 1 Sociodemographic characteristics and body mass index (BMI) of the baseline and final wave of the analytic sample: Household, Income and Labour Dynamics in Australia Survey

	2006		2021		Pooled	
	Analytic sample (n=) %	BMI Mean (SD)	Analytic sample (n=) %	BMI Mean (SD)	Analytic sample (n=) %	BMI Mean (SD)
Neighbourhood disadvantage						
Q1 (most disadvantaged)	18.8	27.30 (5.74)	18.3	29.34 (7.35)	18.3	28.21 (6.52)
Q2	20.1	26.78 (5.26)	19.4	28.50 (6.74)	19.8	27.56 (6.02)
Q3	17.7	26.32 (5.24)	20.8	27.87 (6.05)	19.7	27.19 (5.64)
Q4	21.5	26.29 (4.99)	20.4	27.48 (5.90)	21.3	26.73 (5.38)
Q5 (least disadvantaged)	21.9	25.61 (4.56)	21.1	26.40 (5.29)	21.0	25.95 (4.80)
Sex						
Male	47.2	26.78 (4.53)	46.1	27.89 (5.53)	47.1	27.30 (4.98)
Female	52.8	26.12 (5.69)	53.9	27.85 (6.97)	52.9	26.91 (6.30)
Education						
Bachelor degree or higher	23.0	25.60 (4.62)	31.6	26.66 (5.53)	27.3	26.12 (5.03)
Advanced diploma, diploma or certificate	29.8	26.7 (5.00)	34.3	28.67 (6.46)	32.9	27.66 (5.73)
Year 12	15.0	25.81 (5.23)	15.4	27.35 (6.51)	15.7	26.36 (5.84)
Year 11 or below	32.2	27.08 (5.58)	18.8	28.88 (6.88)	24.2	27.88 (6.14)
Occupation						
High	25.7	26.18 (4.74)	27.2	27.16 (5.70)	26.2	26.64 (5.14)
Medium	25.9	26.46 (5.18)	27.9	27.91 (6.14)	25.2	27.01 (5.58)
Low	15.1	26.31 (5.22)	28.0	28.02 (6.31)	13.8	27.21 (5.68)
Not in labour force	33.4	26.67 (5.48)	28.3	28.34 (6.91)	34.8	27.45 (6.21)
Income						
AU$156 000 plus	9.8	25.54 (4.44)	33.4	27.33 (5.75)	22.8	26.56 (5.14)
AU$130 000–AU$155 999	6.6	26.44 (4.93)	10.4	27.76 (5.92)	9.7	27.04 (5.59)
AU$104 000–AU$129 999	10.8	26.54 (5.01)	11.2	28.31 (6.49)	12.3	27.25 (5.71)
AU$78 000–AU$103 999	16.2	26.34 (4.88)	11.9	28.43 (6.99)	14.5	27.32 (5.87)
AU$52 000–AU$77 999	20.4	26.72 (5.33)	13.1	28.25 (6.61)	15.2	27.28 (5.92)
AU$26 000–AU$51 999	20.8	26.50 (5.49)	14.3	28.18 (6.72)	16.6	27.45 (6.04)
less than AU$25 999	15.2	26.56 (5.44)	5.6	27.59 (6.89)	8.9	26.93 (5.99)
Age, (years)						
18–24	12.4	24.09 (4.63)	10.2	25.92 (6.79)	12.2	24.92 (5.51)
25–34	16.4	25.97 (5.05)	19.5	27.46 (6.66)	18.1	26.52 (5.76)
35–44	20.9	26.72 (5.37)	16.4	27.97 (6.29)	17.1	27.36 (5.84)
45–54	19.3	27.26 (5.39)	15.6	28.86 (6.46)	17.8	27.86 (5.91)
55–64	14.4	27.54 (4.93)	16.2	28.53 (6.17)	15.8	28.10 (5.63)
65–74	9.6	26.86 (4.73)	13.1	28.39 (5.93)	11.5	27.84 (5.31)
75 and over	7.1	25.69 (4.87)	8.9	27.15 (5.16)	7.6	26.31 (4.79)

growth charts, which differ from the fixed cut-off points used for adults.[36] Of the remaining observations, 118 were missing on occupation, 45 were missing on SA1 and 34430 were missing on BMI. The remaining 209474 observations were merged with the IRSD data, with 1165 dropped due to missing IRSD decile. A small number of SA1s do not receive an IRSD Score if they have a low population or insufficient data quality to maintain confidentiality and data reliability.[37] This resulted in a final analytic sample of 208309 observations (85.3% of the in-scope sample) analysed in the present study. Details of the analytic sample are presented in table 1. Sensitivity analysis indicated that missing participant data were associated with covariates rather than our outcome variable, BMI. As the missing data are related to the covariates rather than the outcome, they are considered missing at random. Model estimations remain unbiased if the dropout-related covariates are included in the models and there are no other unmeasured covariates associated with dropout.[38]

The analysis was undertaken in three stages. First, to examine the overall association between neighbourhood socioeconomic disadvantage (categorical) and BMI (continuous), a multilevel linear regression pooling all waves between 2006 and 2021 was undertaken. Second, to examine trends in BMI over time by level of neighbourhood socioeconomic disadvantage, an interaction term between neighbourhood socioeconomic disadvantage and time was added to the model. Change in model fit was examined using a likelihood ratio test. Last, to examine whether changes in neighbourhood disadvantage were associated with changes in BMI, a fixed effects model with cluster-robust standard errors was undertaken. All data analyses were undertaken using STATA/MP V.18.0.[39] Potential confounders such as sex, age, household income, occupation and educational attainment were adjusted for in all the models. For analysis, the reference groups were the least disadvantaged group (Q5), bachelor's degree or higher (education), professionals and managers (occupation) and household income of AU$156 000 and over (household income).

RESULTS

The mean BMI for participants is presented in table 1, and mean BMI across neighbourhood disadvantage quintiles is presented in figure 1. Those residing in the most disadvantaged neighbourhoods, women, lowest education attainment, not in the labour force and adults aged 45–64 had the highest BMI within their respective categories in 2006 and 2021.

Changes (ie, transitions) in neighbourhood disadvantage over the course of the study period are presented in table 2. The majority of participants remained in a neighbourhood with the same level of disadvantage throughout the study period. Those residing in the least disadvantaged neighbourhoods (Q5) were most likely not to have a change in their level of neighbourhood disadvantage (88.1%). Among those moving neighbourhoods, changes most frequently occurred between adjacent quintiles. The greatest movement was among those from Q4 to Q3 (8.4%), followed by Q3 to Q4 (8.3%) and Q2 to Q3 (7.9%). Transitioning into or out of the most disadvantaged (Q1) and the least disadvantaged (Q5) neighbourhoods was less common.

The findings of each of the regression models are presented in table 3. There was a graded overall association between neighbourhood socioeconomic disadvantage and BMI: those living in the most disadvantaged neighbourhoods had greater BMI than those living in the least disadvantaged neighbourhoods (β=1.31, 95% CI 1.15to 1.46).

Examining trends over time, those in more disadvantaged neighbourhoods experienced greater increases in BMI over time, with similar effect sizes observed for those in Q1 (β=0.04, 95% CI 0.02 to 0.06) Q2 (β=0.05, 95% CI 0.03 to 0.06) and Q3 (β=0.04, 95% CI 0.02 to 0.05). This model was a significantly better fit (likelihood ratio test $\chi^2(4)=52.38$, $p<0.001$). Figure 2 shows widening of inequalities in BMI by neighbourhood disadvantage over time, with greater increases in BMI observed among those in more disadvantaged neighbourhoods compared with the least disadvantaged neighbourhoods (Q4 and Q5).

Last, changes in neighbourhood socioeconomic disadvantage were associated with changes in BMI in fixed effects models, with greater effects among those with changes to neighbourhoods with higher levels of disadvantage. Specifically, those who transitioned into the most disadvantaged neighbourhoods (Q1) had the greatest increase in BMI (β=0.10, 95% CI 0.02 to 0.18), followed by those who transitioned into a Q2 neighbourhood (β=0.08, 95% CI 0.02 to 0.15). Transitioning to a Q3 or Q4 neighbourhood also resulted in a small increase in BMI (Q3:

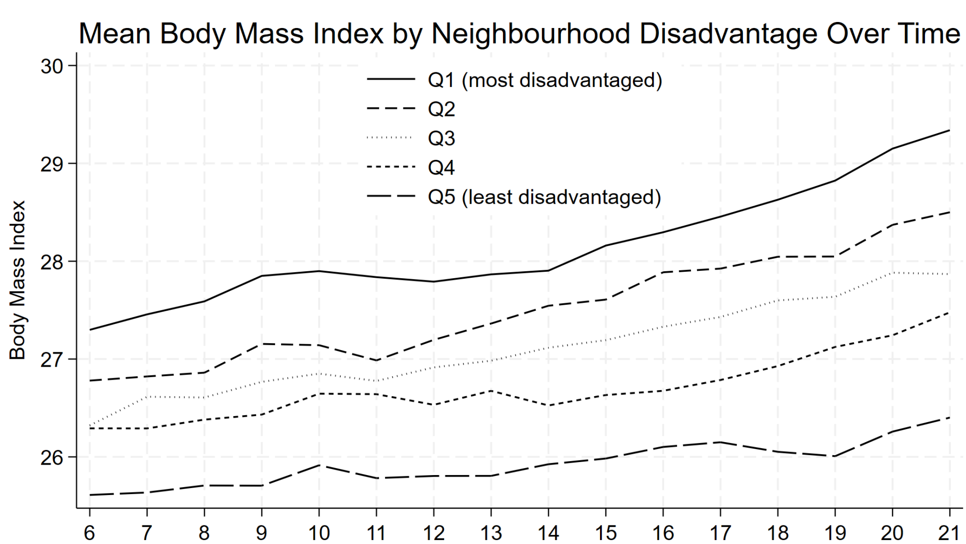

Figure 1 Mean body mass index over time across quintiles of neighbourhood socioeconomic disadvantage: the Household, Income and Labour Dynamics in Australia Survey (2006–2021).

Table 2 Transitions between neighbourhood disadvantage quintiles between 2006 and 2021 in the Household, Income and Labour Dynamics in Australia Survey

Baseline neighbourhoods quintiles distribution	Final neighbourhood quintiles distribution*					
	Q1	Q2	Q3	Q4	Q5	Total
Q1						
Frequency	28 420	2482	940	632	306	32 780
Per cent	86.7	7.6	2.9	1.9	0.9	100
Q2						
Frequency	2544	28 880	2830	1006	654	35 924
Per cent	7.1	80.4	7.9	2.8	1.8	100
Q3						
Frequency	892	2799	28 309	2965	848	35 813
Per cent	2.5	7.8	79.1	8.3	2.4	100
Q4						
Frequency	576	962	3270	31 549	2792	39 149
Per cent	1.5	2.5	8.4	80.6	7.1	100
Q5						
Frequency	301	624	901	2768	33 846	38 440
Per cent	0.8	1.6	2.3	7.2	88.1	100
Total	32 743	35 747	36 250	38 920	38 446	182 106
Per cent	17.98	19.63	19.91	21.37	21.11	100

*Q1 represents the most disadvantaged neighbourhoods and Q5 represents the least disadvantaged neighbourhoods.

β=0.06, 95% CI 0.01 to 0.12 and Q4: β=0.06, 95% CI 0.01 to 0.11).

DISCUSSION

In this study, we examined whether neighbourhood socioeconomic disadvantage was associated with BMI over a 16-year period among a representative Australian population, focusing on overall associations, trends over time and concurrent changes in neighbourhood disadvantage and BMI. Our study found an overall association between neighbourhood disadvantage and BMI, that inequalities in BMI by neighbourhood disadvantage were widening over time and that a change in the level of neighbourhood disadvantage resulted in a change in BMI. The first finding supports the existing longitudinal evidence conducted in Australia[18 40] and the USA,[41] where those living in more disadvantaged neighbourhoods had higher BMI than those living in less disadvantaged neighbourhoods.

Our study also found that inequalities in BMI by neighbourhood disadvantage were widening over time, with those living in the most disadvantaged neighbourhoods experiencing greater increases in BMI over the study period compared with those in more advantaged neighbourhoods. This contrasts with findings from Rachele *et al*[28] who found no evidence of differences in the rate of BMI change over time across levels of neighbourhood disadvantage among adults aged 40–65 years in Brisbane. A possible explanation for the inconsistency in findings is that our study included a broader age range, suggesting that the impact of neighbourhood socioeconomic disadvantage on BMI may begin earlier in life. This is supported by Feng and Wilson,[16] who determined that inequalities in BMI were already evident among young adults aged 15–24 years, with those in more disadvantaged neighbourhoods exhibiting higher BMI than those in more advantaged neighbourhoods.

Previous studies investigating changes in neighbourhood socioeconomic disadvantage and changes in BMI have reported mixed findings. Our findings are consistent with three US studies[42–44] where moving to more disadvantaged neighbourhoods was associated with greater weight gain over time than staying in a similar or less disadvantaged neighbourhood. Specifically, Leonard *et al*[42] found that an increase in the level of neighbourhood condition (a market-based valuation of neighbourhood desirability) was associated with less weight gain. Another study among US-based mothers found that moving to a higher socioeconomic area was associated with a 50% reduction in the odds of being obese.[44] However, Rachele *et al*[18] found no relationship

Table 3 Associations between neighbourhood socioeconomic disadvantage and body mass index in the Household, Income and Labour Dynamics in Australia Survey 2006–2021: multilevel and fixed effects models*

n=208 303	β (95% CI)
Model 1 (pooled)	
Time (waves)	0.09 (0.08 to 0.09)
Q5 (least disadvantage)	Ref
Q4	0.33 (0.22 to 0.43)
Q3	0.56 (0.43 to 0.68)
Q2	0.91 (0.77 to 1.05)
Q1 (most disadvantaged)	1.31 (1.15 to 1.46)
Model 2 (trends)	
Q5 (least disadvantage)×time	Ref
Q4×time	0.01 (–0.01 to 0.02)
Q3×time	0.04 (0.02 to 0.05)
Q2×time	0.05 (0.03 to 0.06)
Q1 (most disadvantaged)×time	0.04 (0.02 to 0.06)
Model 3 (fixed effects)	
Q5 (least disadvantage)	Ref
Q4	0.06 (0.01 to 0.11)
Q3	0.06 (0.01 to 0.12)
Q2	0.08 (0.02 to 0.15)
Q1 (most disadvantaged)	0.10 (0.02 to 0.18)

*Adjusted for age, sex, education, occupation and household income.

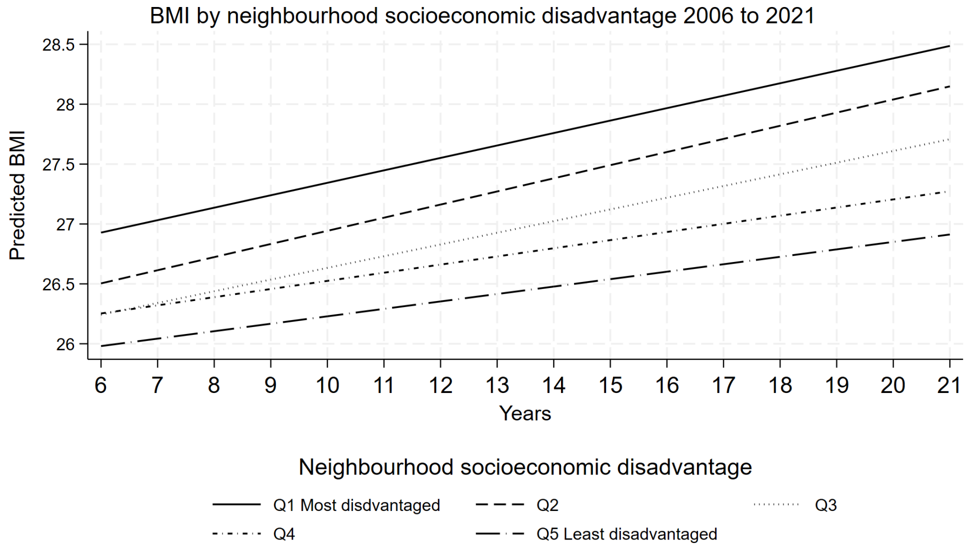

Figure 2 Trends over time between neighbourhood socioeconomic disadvantage and body mass index (BMI): analysis of the Household, Income and Labour Dynamics in Australia Survey (2006–2021).

between changes in neighbourhood disadvantage and changes in BMI. Several reasons may explain the inconsistent findings. First, the study by Rachele *et al*[18] focused on older adults, and as previously discussed, the effect of neighbourhood disadvantage on BMI may begin from a younger age, such that moving later in adulthood does not impact weight trajectories. In addition, the shorter follow-up period in their study (6 years compared with 16 years) may limit the ability to detect changes in BMI. Last, relocation typically occurred between neighbourhoods with the same or adjacent level of disadvantage, potentially reducing power to identify associations.

Policy implications

Our findings support both previous international[10–12 45] and Australian studies[7 13 16 17 40] that have examined associations between neighbourhood disadvantage and BMI. Higher quality causal evidence for associations between neighbourhood socioeconomic disadvantage and BMI supports the need for policies that address drivers of disadvantage to reduce inequalities and prevent non-communicable diseases and premature mortality linked to higher BMI.[5] Urban planning policies aimed at improving the built environment have the potential to improve health outcomes in disadvantaged neighbourhoods. For example, recent Australian research suggests that greenspace is likely to reduce neighbourhood socioeconomic disadvantage inequalities in BMI.[46] However, while such policies are likely beneficial, future research is needed to better understand the causal mechanisms underlying the relationship between neighbourhood disadvantage and BMI, including using approaches such as causal mediation analysis.[47] Additionally, it is likely that the associations between neighbourhood disadvantage and BMI vary according to individual-level characteristics, such as culturally and linguistically diverse backgrounds or disability. Research efforts should seek to further disentangle these complex relationships to inform more targeted and effective intervention strategies.

Strengths and limitations

This study has several key strengths. First, a large Australian representative sample from the HILDA Survey was used, which included a long period of observation (2006–2021). Second, analytic approach of this study was comprehensive, including overall associations, trends over time and associations between changes in exposures and changes in outcomes. Third, we used spatially and temporally consistent IRSD data to more accurately capture changes in the neighbourhood exposure. Additionally, we were able to capture changes in the level neighbourhood socioeconomic disadvantage due to participants moving to new neighbourhoods, as well as neighbourhoods changing over time for participants that did not move (eg, gentrification or neighbourhood decline). This study also has several limitations. First, the estimation of BMI using self-reported weight and height. This method of estimation is subject to measurement error, often leading to BMI underestimation.[48] Second, BMI as a measure of cardiometabolic health is limited because it is an indirect measure of adiposity, which does not reflect fat distribution or body fat amount.[49 50]

CONCLUSIONS

In conclusion, this study is among the most comprehensive investigations of neighbourhood socioeconomic disadvantage and BMI to date, combining rigorous epidemiological methods with longitudinal, national data. It provides robust evidence of neighbourhood socioeconomic inequalities in BMI. Future research should focus on identifying the mechanisms driving this association and informing effective policy strategies to reduce obesity-related inequalities.

X Jerome N Rachele @jn_rachele

Contributors JN and JNR designed the study. JNR, RAR and VL designed the analytical strategy and helped to interpret the findings, while RAR conducted the analysis. JN conducted the literature review, prepared the Introduction and Discussion, and JNR and RAR prepared the Methods and Results sections of the text. All authors critically revised the manuscript for intellectual content and approved the manuscript submission. JNR acted as the guarantor.

Funding This paper uses unit record data from the Household, Income and Labour Dynamics in Australia (HILDA) Survey. The HILDA Project was initiated and is funded by the Australian Government Department of Social Services and is managed by the Melbourne Institute of Applied Economic and Social Research.

Disclaimer The findings and views reported in this paper, however, are those of the author and should not be attributed to either the Australian Government Department of Social Services or the Melbourne Institute of Applied Economic and Social Research.

Competing interests None declared.

Patient consent for publication Consent obtained directly from patient(s).

Ethics approval This study involves human participants. The Household, Income and Labour Dynamics in Australia (HILDA) survey's ethical approval was given by the human ethics advisory committee of the University of Melbourne (ID no. 1647030). The Australian Government Department of Social Services provided approval for the de-identified survey data's use. Participants gave informed consent to participate in the study before taking part.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available upon reasonable request. Household, Income and Labour Dynamics in Australia Survey data can be accessed via the Australian Government Department of Social Services Longitudinal Studies Dataverse.

ORCID iDs
Rebecca A Reid http://orcid.org/0000-0002-8911-5861
Jerome N Rachele http://orcid.org/0000-0002-5101-4010

REFERENCES

1 World Obesity Federation. World obesity atlas 2023. 2023.
2 World Health Organization. Overweight and obesity. 2024.
3 Australian Institute of Health and Welfare. Overweight and obesity. Canberra AIHW; 2024.
4 Nyberg ST, Batty GD, Pentti J, *et al*. Obesity and loss of disease-free years owing to major non-communicable diseases: a multicohort study. *Lancet Public Health* 2018;3:e490–7.
5 WHO GS. Global status report on noncommunicable diseases 2010. 2014.
6 Spahlholz J, Baer N, König H-H, *et al*. Obesity and discrimination - a systematic review and meta-analysis of observational studies. *Obes Rev* 2016;17:43–55.
7 Keramat SA, Sathi NJ, Haque R, *et al*. Neighbourhood Socio-Economic Circumstances, Place of Residence and Obesity amongst Australian Adults: A Longitudinal Regression Analysis Using 14 Annual Waves of the HILDA Cohort. *Obesities* 2021c;1:178–88.
8 Jones M, Huh J. Toward a multidimensional understanding of residential neighborhood: a latent profile analysis of Los Angeles neighborhoods and longitudinal adult excess weight. *Health Place* 2014;27:134–41.
9 Wang Y, Beydoun MA. The obesity epidemic in the United States--gender, age, socioeconomic, racial/ethnic, and geographic characteristics: a systematic review and meta-regression analysis. *Epidemiol Rev* 2007;29:6–28.
10 Chen M, Creger T, Howard V, *et al*. Association of community food environment and obesity among US adults: a geographical information system analysis. *J Epidemiol Community Health* 2019;73:148–55.
11 Gurka MJ, Filipp SL, DeBoer MD. Geographical variation in the prevalence of obesity, metabolic syndrome, and diabetes among US adults. *Nutr Diabetes* 2018;8:14.
12 Samouda H, Ruiz-Castell M, Bocquet V, *et al*. Geographical variation of overweight, obesity and related risk factors: Findings from the European Health Examination Survey in Luxembourg, 2013-2015. *PLoS One* 2018;13:e0197021.
13 King T, Kavanagh AM, Jolley D, *et al*. Weight and place: a multilevel cross-sectional survey of area-level social disadvantage and overweight/obesity in Australia. *Int J Obes* 2006;30:281–7.
14 Bonney A, Mayne DJ, Jones BD, *et al*. Area-Level Socioeconomic Gradients in Overweight and Obesity in a Community-Derived Cohort of Health Service Users - A Cross-Sectional Study. *PLoS One* 2015;10:e0137261.
15 Rachele JN, Schmid CJ, Brown WJ, *et al*. A multilevel study of neighborhood disadvantage, individual socioeconomic position, and body mass index: Exploring cross-level interaction effects. *Prev Med Rep* 2019;14:100844.
16 Feng X, Wilson A. Getting Bigger, Quicker? Gendered Socioeconomic Trajectories in Body Mass Index across the Adult Lifecourse: A Longitudinal Study of 21,403 Australians. *PLoS ONE* 2015;10:e0141499.
17 Feng X, Wilson A. Do neighbourhood socioeconomic circumstances not matter for weight status among Australian men? Multilevel evidence from a household survey of 14 691 adults. *BMJ Open* 2015;5:e007052.
18 Rachele JN, Kavanagh AM, Brown WJ, *et al*. Neighborhood Disadvantage and Body Mass Index: A Study of Residential Relocation. *Am J Epidemiol* 2018;187:1696–703.
19 Black JL, Macinko J. Neighborhoods and obesity. *Nutr Rev* 2008;66:2–20.
20 Swinburn B, Egger G, Raza F. Dissecting Obesogenic Environments: The Development and Application of a Framework for Identifying and Prioritizing Environmental Interventions for Obesity. *Prev Med* 1999;29:563–70.
21 Kirk SFL, Penney TL, McHugh T-LF. Characterizing the obesogenic environment: the state of the evidence with directions for future research. *Obes Rev* 2010;11:109–17.
22 Boone-Heinonen J, Gordon-Larsen P, Kiefe CI, *et al*. Fast food restaurants and food stores: longitudinal associations with diet in young to middle-aged adults: the CARDIA study. *Arch Intern Med* 2011;171:1162–70.
23 Brug J. Determinants of healthy eating: motivation, abilities and environmental opportunities. *Fam Pract* 2008;25 Suppl 1:i50–5.
24 Mackenbach JD, Rutter H, Compernolle S, *et al*. Obesogenic environments: a systematic review of the association between the physical environment and adult weight status, the SPOTLIGHT project. *BMC Public Health* 2014;14:1–15.
25 Sallis JF, Floyd MF, Rodríguez DA, *et al*. Role of built environments in physical activity, obesity, and cardiovascular disease. *Circulation* 2012;125:729–37.
26 Ghosh A, Charlton KE, Batterham MJ. Socioeconomic disadvantage and its implications for population health planning of obesity and overweight, using cross-sectional data from general practices from a regional catchment in Australia. *BMJ Open* 2016;6:e010405.
27 Levin KA. Study design III: Cross-sectional studies. *Evid Based Dent* 2006;7:24–5.
28 Rachele JN, Kavanagh A, Brown WJ, *et al*. Neighborhood socioeconomic disadvantage and body mass index among residentially stable mid-older aged adults: Findings from the HABITAT multilevel longitudinal study. *Prev Med* 2017;105:271–4.
29 Australian Bureau of Statistics. Socio-economic indexes for areas (SEIFA): technical paper. Canberra Australian Bureau of Statistics; 2021.
30 Watson N, Wooden MP. The HILDA Survey: a case study in the design and development of a successful household panel survey. *Longit Life Course Stud* 2012;3:369–81.
31 Melbourne Institute Applied Economic and Social Research. The household, income and labour dynamics in Australia survey: selected findings from waves 1 to 21. 2023.
32 Reid RA, Mavoa S, Gilmartin-Thomas J, *et al*. Derived spatially consistent annual socio-economic indexes for areas (SEIFA) data for Australian statistical areas, 1996 – 2021. 2024.
33 Australian Bureau of Statistics. Construction of the indexes. 2021.
34 Diez Roux AV, Mair C. Neighborhoods and health. *Ann N Y Acad Sci* 2010;1186:125–45.
35 Australian Bureau of Statistics. 1220.0 - ANZSCO -- Australian and New Zealand Standard Classification of Occupations, 2013, Version 1.2. 2013.
36 World Health Organization. Growth reference 5 19 years. Geneva WHO; 2007.
37 Australian Bureau of Statistics. Construction of the indexes. ABS; 2021.
38 Fitzmaurice GM, Laird NM, Ware JH. *Applied longitudinal analysis*. John Wiley & Sons, 2012.
39 StataCorp. Stata statistical software: release 18. College Station, TX StataCorp LLC; 2023.
40 Keramat SA, Alam K, Gow J, *et al*. Impact of Disadvantaged Neighborhoods and Lifestyle Factors on Adult Obesity: Evidence From a 5-Year Cohort Study in Australia. *Am J Health Promot* 2021;35:28–37.
41 Zhang D, Bauer C, Powell-Wiley T, *et al*. Association of Long-Term Trajectories of Neighborhood Socioeconomic Status With Weight Change in Older Adults. *JAMA Netw Open* 2021;4:e2036809.
42 Leonard T, Ayers C, Das S, *et al*. Do neighborhoods matter differently for movers and non-movers? Analysis of weight gain in the longitudinal dallas heart study. *Health Place* 2017;44:52–60.
43 Powell-Wiley TM, Cooper-McCann R, Ayers C, *et al*. Change in Neighborhood Socioeconomic Status and Weight Gain: Dallas Heart Study. *Am J Prev Med* 2015;49:72–9.
44 Sheehan CM, Cantu PA, Powers DA, *et al*. Long-term neighborhood poverty trajectories and obesity in a sample of california mothers. *Health Place* 2017;46:49–57.
45 Lovasi GS, Hutson MA, Guerra M, *et al*. Built Environments and Obesity in Disadvantaged Populations. *Epidemiol Rev* 2009;31:7–20.
46 Zhang B, Loh V, Reid RA, *et al*. The moderating effects of greenspace on the association between neighbourhood disadvantage and obesity among mid-to-older aged Australian adults. *Health Place* 2024;87:103263.
47 VanderWeele T. *Explanation in causal inference: methods for mediation and interaction*. Oxford University Press, 2015.
48 Gosse M. How accurate is self-reported BMI? *Nutr Bull* 2014;39:105–14.
49 Sweatt K, Garvey WT, Martins C. Strengths and Limitations of BMI in the Diagnosis of Obesity: What is the Path Forward? *Curr Obes Rep* 2024;13:584–95.
50 Wu Y, Li D, Vermund SH. Advantages and Limitations of the Body Mass Index (BMI) to Assess Adult Obesity. *Int J Environ Res Public Health* 2024;21:757.