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Research Article

The relationship between obesity and self-esteem: longitudinal evidence from Australian adults

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Abstract

We examine whether low self-esteem increases the risk of obesity in a panel of Australian adults. To address the problem of endogeneity, we look at weight changes following exogenous shocks to self-esteem, such as the unexpected death of friends and family members. We find that negative shocks adversely affect self-esteem in turn leading to large increases in weight via increased food consumption and reduced exercise. The effects of the negative shocks were found to be larger for the lower educated and females.

Keywords: social comparisons, myopia, self-esteem, life events, longitudinal analyses, obesity

INTRODUCTION

In 2022, over 650 million adults and 350 million children are believed to be obese, leading to increases in cardiovascular diseases, diabetes and musculoskeletal disorders (WHO, 2022). In the past 10 years, rates of obesity have only increased, despite governments trying to promote healthy eating via campaigns and taxes on unhealthy food (Malik et al., 2020). Estimates of the direct and indirect costs of obesity vary between 2% and 5% of GDP (Okunogbe et al., 2021).

The socio-economic determinants of obesity have been extensively studied in the past decades, including the role of cheap and high-nutritional value food (Swinburn et al., 2011), increased income levels and urbanization (Gollin and Probst, 2015), changes in occupational structure and general increase in sedentary lifestyles (Malik et al., 2020), habits surrounding the preparation of food (Loewenstein et al., 2016; Godard, 2016) and changing cultural norms around ideal body shapes (Dragone and Savorelli, 2012; Strulik, 2014). In this paper we consider the causal path from self-esteem to obesity.

In general, self-esteem correlates negatively with obesity and physical activity (Dale et al., 2019), which is often understood to mean that obesity causes poor self-esteem. A 26-year Finnish follow-up study among a birth cohort (Kiviruusu et al., 2016, p. 355) echoed this by looking at Body Mass Index (BMI) and changes in self-esteem: 'Among females, higher and increasing BMI is associated with lower and more slowly increasing self-esteem. This association is not restricted to adolescent years but persists and gets stronger in mid-adulthood. Among males, associations are weaker but indicate more age-related differences'.

There are studies that suggest causality from self-esteem to obesity, but none that we found included a clear causal empirical framework. A popular suggested causal mechanism is that self-esteem is a resource for resisting the temptations of bad diets and poor exercise (e.g. Gow et al., 2020). Oswald and Powdthavee (2007, p. 1), when speculating on why unhappy people were more obese, already argued that 'psychological distress has been rising through time in modern Great Britain', and opined that this increased obesity rates. Muenster et al. (2011) found at the individual level that job insecurity led to more stress on people's self-esteem and also increased obesity rates, though they do not examine how much this explains the general rise in obesity or to what degree this relationship is causal.

Some authors take it as axiomatic that low self-esteem increases obesity and then look for things that might, in recent decades, have increased low self-esteem in order to explain the increase in obesity. One such argument is that modern media confronts individuals with a sanitized, cultivated self-image of the most successful people in the world, leading to stronger negative comparisons and lower self-esteem among those who cannot attain such an image (Neira et al., 2014; Vogel et al., 2014; Gow et al., 2020). Tellingly, de Vries & Khne (2015) found that individuals who use social networking relatively more, or who are particularly personally invested in it, make more negative self-comparisons and have correspondingly lower self-esteem than those who are less involved. Kelly et al. (2018) using the British Millennium cohort study similarly found, particularly for girls, that greater use of social media adversely affected self-esteem.

So there is a missing element in the literature: actually nailing down whether self-esteem has a causal effect on obesity and how strong that path is.

One endogeneity problem is that those individuals who experience greater stress throughout their lives are not random

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members of the public. Another is that high weight might itself add to pressures on self-esteem. A third problem is that social desirability bias drives individuals to under-report BMI (Uhrig, 2011), something they might be more prone to do in periods when they feel bad about themselves (so when self-esteem is low). To overcome these problems, we look at how unexpected life events affect self-esteem and then body weight in order to allow for both individual fixed-effects and for potential reverse-causality. We examine whether an individual's self-esteem adapts to the negative life event and whether weight then returns to its original level or remains at the elevated level. We look for the causal mechanisms through which self-esteem would affect weight, i.e. its effects on food intake, exercise and the degree to which individuals care about the future and hence the negative effects of weight gain. Finally, we examine the 'media reference group' hypothesis by looking at whether self-esteem relates to media comparison groups, measured by their frequency of exposure to magazines.

The paper proceeds by briefly discussing the most related studies in the literature, after which we present a simple decision-theoretic utility model based on individuals' decisions about their energy balance, resulting from their self-esteem, future discounting and social comparisons. Then we introduce the data and empirical methodology, after which we present the analyses and conclude.

RELATED LITERATURE

Self-esteem is often defined as an individual's evaluation of their competence and worth (Coopersmith, 1967). It typically includes views of one's academic success, social standing and/or physical appearance. Self-esteem has been heavily studied in psychology as it is predictive of high levels of life satisfaction, happiness and general wellbeing (Taylor and Brown, 1988).

The literature on self-esteem and weight has two tracts: one that looks at the relationship between self-esteem and weight, and a larger literature that assumes there is a relationship between self-esteem and weight and looks at what might have increased the stresses of normal life in the past few decades. Our contribution is primarily to the first body of literature, but also adds a bit to the second, as we look at whether larger media comparison groups strengthen the relation between self-esteem and excess weight.

To our knowledge, there are only a handful papers that directly look at self-esteem and weight, and these have resulted in conflicting findings. Klesges et al. (1992) tested the prospective relationship between self-esteem and body fat in a cohort of children participating in a larger cardiovascular health study. The sample comprised 132 children between the ages of 3 and 6 years; self-esteem was measured only at the initial consultation, and body fat was measured by triceps skinfold in yearly intervals for the following 3 years. Using a simple multiple regression formulation, it was concluded that there was no consistent relationship between self-esteem of the child and body fat, although children who had a higher initial opinion of their own physical appearance subsequently gained less weight during the study period.

Hesketh et al. (2004) used the Health of Young Victorians study to analyse 1157 Australian primary school children between the ages of 5 and 10 years, intending to assess whether poor self-esteem precedes or follows weight gain. This involved the measurement of self-esteem and weight at an initial consultation and a follow-up after 4 years. While BMI and self-esteem were strongly negatively related at both time-points, initial self-esteem did not explain change in BMI while change in BMI did explain change in self-esteem, leading the authors to conclude the causality was from BMI to self-esteem.

Viner & Cole (2006) investigated the role of several psychological factors, including self-esteem, in overweight and obesity among 4461 individuals in the 1970 British Birth Cohort, finding no significant relationship between teenage self-esteem (measured at the age of 16 years) and adult BMI. Ternouth et al. (2009) also used the 1970 British Birth Cohort study and found that there was an effect of childhood self-esteem (measured at the age of 10 years) on adult BMI. They explain the discrepancy with the Viner & Cole (2006) results by pointing to the greater instability of self-esteem in adolescence, making the measurement of self-esteem at the age of 10 years a more reliable measure of long-run self-esteem than the measure at the age of 16 years. The essential argument is that self-esteem during adolescence does not affect BMI, but does seem to do so at other ages, which also rationalizes the findings in Hesketh et al. (2004) who measured BMI among adolescents.

Following Mocan et al. (2011), a recent economics paper by Baldursdottir et al. (2021) looks at the opposite direction, namely from BMI to self-esteem (measured via the supposed effect of self-esteem on life-satisfaction). They use a Swiss panel but do not worry about causality problems between BMI and self-esteem (though they do worry about the endogeneity of income), hence taking the negative correlation between BMI and self-esteem as evidence of causation.

In summary, there is a lot of evidence for a strong relationship between BMI and self-esteem. There is some indication that the relationship in puberty differs from the relationship at other times, with a strong probability that BMI causes changes in self-esteem (see, e.g., Hesketh et al., 2004; Emery et al., 2015; Baldursdottir et al., 2021). Yet, none of these studies drew on exogenous variation in self-esteem. So the main 'identified gap' in the literature is an attempt at the causal effect of self-esteem changes on weight gain.

In the literature that takes the causal effect of self-esteem on weight for granted, the question of just how pressures on self-esteem translate into higher weight is not yet clear, but an important hypothesis has been the role of myopia. Ternouth et al. (2009) speculate that low self-esteem may cause a fatalistic or deterministic world view, resulting in less effort to control weight. They thus suggest a difference in time preference caused by changes in self-esteem, which we explicitly look for in our data.

The connection between time preference and bodyweight itself is more widely accepted: weight control involves choices about food consumption and physical activity that affect future health, so moderating food intake involves delayed gratification (Offer, 2001). Several panel-data analyses support this hypothesis. Smith et al. (2005) used the United States National Longitudinal Survey of Youth to show that individuals who tend to dissave (interpreted as lacking the patience to save) have a higher chance of becoming obese later in life. Similarly, Ikeda et al. (2010) demonstrated that individuals with self-stated intertemporal discount rates one standard deviation above baseline have a BMI 0.3 points higher than average and are approximately 3% more likely to become obese. This study was conducted using a standardized psychological survey specifically designed to measure discount rates. A survey conducted in Italy came to similar conclusions (Cavaliere et al., 2014).

Measures to combat obesity in the general population have so far miserably failed, with BMI rates in the population only increasing over time around the world. One of the many recently suggested counter-measures is more activities involving nudity: in a 4-day intervention on 15 British adults, nudity was found to make people more comfortable with their body and less affected by comparisons (West, 2020). Whether that would work at scale is doubtful, but the basic idea that comparison-oriented behaviour is highly socially malleable is well established (see Chapter 2 of Frijters and Krekel, 2021), meaning that one could think of other interventions.

It has been suggested that increases in social group size may lead to more unfavourable comparisons with others in the group, causing a decline in self-esteem and subsequent weight gain. Evidence from Africa and Asia lends support to this hypothesis: Lear et al. (2014) performed a cross-sectional analysis involving more than 150 000 individuals over several countries with varying income levels and found that individuals who own televisions and computers are significantly more likely to become obese. Critically, the effect was only significant in lower-income countries and was the strongest in those with the least income (for example, Zimbabwe, Bangladesh and India). This suggests that sudden, large increases in interconnectedness may cause significant weight gain, possibly due to an increase in unfavourable comparisons.

Relevantly, recent decades have seen a rise in the popularity of electronic media and social networking. There is evidence that the latter can be deleterious to self-esteem. Neira et al. (2014) surveyed approximately 1800 Australian high school students and found that individuals who frequently use social networking and are highly emotionally invested in it have significantly lower self-esteem. Kelly et al. (2018) found the same in the UK for the millennium cohort born in the year 2000. Vogel et al. (2014) showed that one's self-esteem declines substantially upon viewing the social media profiles of individuals perceived to be 'better' than oneself. Hence, unfavourable comparisons with the most successful members of society could well be a driver of increases in obesity rates.

In summary, the literature has strongly suggested that negative pressures on self-esteem have a significant role in the increases in obesity rates observed across the world, but there is a lack of research on causality and intermediate mechanisms.

Methodology

This section describes a model linking self-esteem to body weight and its connection to social comparisons and intertemporal discounting. It then sets out the estimation strategy.

Consider a simple model consisting of two time periods: $t=0$ and $t=1$. The agent chooses a 'net energy balance', $\varnothing$, at $t=0$. This consists of the net effects of food consumption and physical activity. Increased food consumption and decreased physical activity, in the form of a high net energy balance, both give the individual immediate gratification, but at the expense of an eventual increase in excess weight E.

The individual's utility maximization equation is given by

$$\max U_{\varnothing} = u_0(\varnothing) + \beta(S(C_i|n))\,U_1(E(\varnothing)), \tag{1}$$

where the individual receives instant utility $u_0(\varnothing)$ at $t=0$ from the net energy balance at $t=0$(the aforementioned immediate gratification). This instant utility is concave in $\varnothing$; $u_1(E\varnothing)$ denotes the disutility in the second period from the individual's excess weight (i.e., BMI above 23) in the second period, which is 0 if excess weight is 0, and is decreasing at a non-increasing rate in $\varnothing$; $\beta(S(C_i|n))$ is the degree to which the second period is discounted, which itself depends on the level of self-esteem S that in turn depends on media comparisons C_i that depend on the size n of the media reference group.

These assumptions need some discussion because of course all the 'results' are baked into them. The idea that individuals in some sense know what they are doing and hence can be seen as maximizing a utility function is a standard idea in economics, but of course is not uncontroversial in the social sciences because in many cases people do not know how the world works nor are their choices a clear balance of their conflicting feelings and desires. In this case, however, we are not talking about one-off choices for which it is strange to assume that people know what they are doing, but rather a choice that comes up again and again in life: the struggle to keep down weight. In this kind of repeated choice scenario it is more reasonable to think people do rationalize their own choices in some way (for lengthy discussions, see Chapters 2 and 4 in Frijters and Krekel, 2021).

The idea that the 'pleasure' of high energy balance tails off (which is what 'concave' means) is a satiation and convenience argument, both on the food-intake side and the low-exercise side. The idea that the disutility of the higher weight itself tails off (which is what 'decreasing at a non-increasing rate' means) conveys the idea that the difficulties with high weight (lower mobility, large health problems, social problems) are somewhat self-exhausting: one runs out of things that get difficult with higher weight. The idea that higher self-esteem makes people care more about the future (β increases with S) is the standard argument that more self-confidence and a sense of self-worth makes people less insular and more outward oriented, including over time.

Now, of course one could put lots of other plausible mechanisms into this kind of two-period utility model, such as the idea that there is a feedback from BMI to self-esteem, leading to possible lock-in effects. Such things greatly complicate models like this, quickly making them very hard to interpret. So essentially as a means of story-telling and highlighting particular mechanisms (rather than surveying all plausible mechanisms) one has these stylized two-period models. They help think about the empirics and place the results in an interpretative schema, but they should of course not be treated as the final say.

If we make all these assumptions, then in an interior solution for an individual with some excess weight ($E>0$), the utility-maximizing choice of $\varnothing$ must satisfy the first-order condition:

$$u_0'(\varnothing) + \beta(S(C_i|n))\,u_1'(E(\varnothing))\,E'(\varnothing) = 0, \tag{2}$$

which shows the trade-off between the positive effect of the immediate gratification ($u_0'(\varnothing) > 0$) versus the negative effect on the second period ($\beta(S(C_i|n)u_1'(E(\varnothing)E'(\varnothing) < 0$) From this we can derive the comparative statics as follows:

$$\frac{dE}{dn} = S'(n)\frac{-\beta'(S)u_1'(E(\varnothing))E'(\varnothing)}{u_0''(\varnothing) + \beta\Big(S\big[u_1''(E(\varnothing))E'(\varnothing)^2 + u_1'(E(\varnothing))E''(\varnothing)\big]}.$$

This result indicates that increases in social group size cause increases in excess BMI.

The media determinants of self-esteem

What could the mechanism be for how social group size affects self-esteem and therefore the discount rate, i.e. for $S(C_i|n)$? We provide a little model for such a mechanism.

The media reference group component of an individual's self-esteem, C_i, is taken to come from comparisons of the individual's own attribute, θ_i, with the attributes of others in their media reference group. We hypothesize that individuals compare their attribute to those of the 'best' person in their media reference group, which provides the strongest possible negative comparison:

$$C_i = f(\theta_i|\theta_1, \ldots, \theta_n) = \frac{\theta_i}{\max_{i \neq j}(\theta_j)}. \quad (3)$$

This approach of comparing to the 'best' group member differs from most assumptions in the relative income literature, where it is more typical to compare to the mean or median group member. This is also why we speak of the 'media reference group' rather than the average reference group or the social reference group: the modern media gives a lot of attention to the 'stars' of our world, whether it be the sports stars, the movie stars, the top-politicians, the top artists or the wealthiest individuals. We then have in mind that individuals more exposed to the media will compare themselves with the top individuals in a greater media reference group.

We are interested in how changes in the size of social reference group n affects C_i. From basic distribution theory, we know that each increase in reference group size has a chance of increasing $\max_{i \neq j}\theta_j$, regardless of the distribution of θ, so on average, as n grows, $\max_{i \neq j}\theta_j$ increases in expectation, which in turn means C_i decreases in expectation as n increases. We show this formally in Appendix 6.1.

We can then derive the expectation of self-esteem, S, conditional on group size:

$$\mathbb{E}(S_i|n) = \int_0^\infty S(C_i) f(C_i|n)\, dC_i = \int_0^1 S\left(F_n^{-1}(x)\right) dx, \quad (4)$$

where $F(.)$ is the cumulative distribution function of $C_i, f(C_i) = \frac{\delta F(C_i)}{\delta C_i}$, and $x = F(C_i|n)$. The integral should be read in the Lebesque sense.

The level of status self-esteem that is higher or equal than a proportion x is then $F_n^{-1}(x)$. An important characteristic is that $\mathbb{E}(S_i|n)$ decreases with n (see Appendix 6.1). Intuitively, this is because the maximum can only increase with greater group size, meaning that the average comparison gets worse as groups increase.

We can then derive the effect of social group size on energy balance:

$$\mathbb{E}(E|n+1) = \mathbb{E}(E|n) \int E(S) dG(S|n+1) - \int E(S) dG(S|n) > 0, \quad (5)$$

which thus denotes that we expect excess weight to increase when an individual compares to a greater number of other individuals. This increases the average comparison, resulting in reduced self-esteem; the individual then becomes more myopic, increases their energy balance this period and gains weight.

Note that this model is about energy balance, not BMI. Implicitly, an energy balance of 0 is associated with a lack of change in BMI, not with any particular level of BMI. This is important when it comes to interpreting empirical results, because it means the model is really mainly useful for looking at the relation between exogenous changes in self-esteem (or size of reference group) and the change in BMI. It leaves open the possibility that low self-esteem has an ongoing increasing effect on BMI, meaning that one need not see a (further) decrease in self-esteem to nevertheless rationalize an ongoing increase in BMI as the result of a certain level of self-esteem.

Empirical model

If we linearize the implicit function $E(.)$ of the structural model and interpret excess BMI as relating to $E(.)$, we can write

$$EBMI_{i,t} = \beta_1 S_{i,t} + x'_{i,t}\beta + \alpha_i + \varepsilon_{i,t}, \quad (6)$$

where $EBMI_{i,t}$ is individual i's excess BMI at time t; $S_{i,t}$ is their self-esteem at time t; and $x_{i,t}$ is a vector of controls.

The key issue involved is the presence and handling of individual heterogeneity: the potential spurious relation between the error term $(\alpha_i + \varepsilon_{i,t})$ and $S_{i,t}$. Despite the inclusion of extensive controls, the model cannot account for all factors affecting excess BMI, primarily due to limitations of the dataset, and so cannot account for all fixed and time-varying inter-individual differences. We attempt to overcome this by using fixed-effects estimation (which eliminates the term α_i)and using instruments for $S_{i,t}$. Note that using fixed-effects effectively removes the variation between individuals and focuses on changes over time for individuals, which can amplify problems of social desirability bias in obesity measurement, which are known to be large (Uhrig, 2011).

As for our instruments, we used 4 of the 20 'life events' recorded in each wave of the survey. We excluded the life events with a plausible direct link to BMI, such as becoming pregnant, having a child, being injured or being affected by a violent crime. We also excluded life events with potentially ambiguous effects on self-esteem, such as divorce or separation. The four life events that were used are as follows: whether an individual was fired or made redundant in the past 12 months, whether an individual was promoted at work in the past 12 months, whether an individual experienced the death of a close friend in the past 12 months and whether an individual experienced the death of a family member in the past 12 months. These instruments together are denoted as the vector $Z_{i,t}$and are assumed to affect $EBMI_{i,t}$ through a direct effect on $S_{i,t}$

$$S_{i,t} = x'_{i,t}b + Z'_{i,t}\gamma + \alpha_i^* + u_{i,t},$$

where the identifying assumption is that $Z'_{i,t}\gamma$ is uncorrelated with $\varepsilon_{i,t}$, and thus that the effect of employment shocks and deaths of friends and families on excess weight runs exclusively via self-esteem. This is motivated by the literature, which has found strong effects of these life events on self-esteem. Importantly, self-esteem itself has generally been shown not to affect the occurrence of life events, which is a key requirement for a good instrument (Sheeran et al., 1995; Joiner et al., 1999; Orth and Luciano, 2015). Because we have more than one instrument, we can run tests for over-identification and we can check whether using only the strongest instrument (the unexpected death of a friend) begets different results from using the full set of instruments.

DATA

The Household Income and Labour Dynamics in Australia (HILDA) survey is a large-scale, household-based longitudinal study developed by the Melbourne Institute of Applied Economic and Social Research in collaboration with the Commonwealth Government Department of Family and Community Services[1]. The survey's first wave was conducted in 2001 (Watson & Wooden, 2013a,b).

[1] The HILDA Project was initiated and is funded by the Australian Department of Social Services and is managed by the Melbourne Institute of Applied Economic and Social Research (Melbourne Institute). We thank them for access to this data.

The survey includes a large number of standardized questions, which are asked in every wave, with particular modules only asked in alternate waves. The variables used to construct the self-esteem factor are among those available in alternate waves. Our resultant HILDA samples for the required variables results in a 2006–2020 self-esteem sample of 162 363 year–person observations, while the excess BMI sample is of 191 183 observations for 2006–2020 (Table 1).The survey asks about individual health in each wave—notably, height, weight, food consumption and physical activity, along with many other health measures. BMI has been calculated as the weight of a person in kilos divided by the square of the height in metres. A BMI above 30 defines obesity, and between 25 and 30 defines overweight. However, we did not want to look at the naive measure of BMI, as there is a range of BMI values which arguably do not have adverse health effects. Nor does this paper address the issues of exceedingly low weight (BMI below 18.5) as the reasons for becoming underweight, such as a major illness, are probably quite different from the reasons for becoming overweight (Pinquart, 2013). Thus, underweight respondents were excluded from the analysis.[2] As a result, we defined excess BMI as the amount of BMI above a threshold, i.e. we define

$$EBMI_{i,t} = \left(BMI_{i,t} - T\tau\right) I_{(T\tau,\infty)}\left(BMI_{i,t}\right).$$

We estimated the threshold $T\tau$ by looking at an index of impairment of physical functioning (including difficulty walking, bathing and lifting and carrying groceries). Our threshold model of physical function and BMI is provided in Appendix 6.2. The regression shows that the relationship abruptly changes at a BMI of approximately 22.2 (which we round upwards) after which a strong and almost linear relationship can be observed between increased physical impairment and BMI. There is little relationship between physical function and weight below the threshold (insignificant even at the 10% level), justifying our assumption that all levels of BMI below 23 as having no excess weight. After that, an additional BMI point leads to an increase in physical impairment of 0.008 (with higher-order polynomials adding little to the fit, indicating a near-linear relation[2]).

Our threshold of 23 coincides with research that found that weight-related health risk begins to increase at a BMI of approximately 23–24 (Singh-Manoux et al., 2014), and the World Health Organization (WHO), which already in 2009 announced a BMI of 23 as a recommended threshold for public health action (WHO, 2009). Determining this threshold using the data itself also helps to overcome the problem that we use reported BMI, which is known to be under-estimated in self-reports. Considering all self-reported BMIs above 23 to be problematic because the same respondents then start noticing problems with physical functioning alleviates the self-reporting bias, which would result from using a BMI threshold of 25.

Self-esteem

Self-esteem was initially measured using mental health and personality evaluation variables available in the data that overlap with self-esteem scales prominent in psychology (Cast and Burke, 2002)—in particular, the Tennessee Self-Concept Scale (TSCS; Fitts, 1965) and the Feelings of Inadequacy Scale (FIS; Janis and Field, 1959), both of which are widely used (Robinson et al., 2013, p. 119). After extensive investigations, however, we decided to focus on a single item as our preferred measure of self-esteem. Respondents were asked the following:

In the past 4 weeks, about how often did you feel: psychological distress: worthless?

1 All of the time;
2 Most of the time;
3 Some of the time;
4 A little of the time;
5 None of the time.

Sample characteristics

Figure 1 shows the changes in this time period for BMI, excess BMI and self-esteem. We see a 0.2 unit drop in the average self-esteem of Australians (from 4.7 to 4.5), a rise of over 1 point in average excess BMI (from 4 to 5) and an increase in average BMI from 26.6 to 27.6.

These trends fit the national data: 'In 2017–18, an estimated 2 in 3 (67%) Australians aged 18 and over were overweight or obese (36% were overweight but not obese, and 31% were obese). That's around 12.5 million adults. Men had higher rates of overweight and obesity than women (75% of men and 60% of women), and higher rates of obesity (33% of men and 30% of women)' (AIHW, 2020, p. 1).

Figure 2 shows the raw relationship between self-esteem and excess BMI (95% confidence band in grey), with excess BMI being 2.5 points higher for those with the lowest self-esteem versus the highest self-esteem.

ESTIMATION RESULTS

We begin with a naïve ordinary least squares (OLS) regression in Table 2. The first column gives a simple OLS on the levels, so without fixed effects. It shows that 1 point higher self-esteem is related to about 0.703 lower excess weight in BMIs, meaning that the difference between the top and the bottom of the self-esteem scale (from 5 to 1) explains a difference of about 2.8 BMI points, a substantial relationship that almost exactly mimics Fig. 2.

The second column shows what happens when fixed effects are included: a dramatic reduction in the size of the relationship (from −0.703 to −0.068), indicating that the between-people variation displays a far stronger relationship than the over-time relation, begging the obvious question where the between-people relation then comes from. We see two main possible reasons for this. The first is a classic selection argument in which the same traits that lead to low self-esteem also lead to high weight or high weight gain, but very little 'direct effect' from self-esteem to weight. That explanation sees column 2 as 'the causal relation' and hence column 1 as biassed.

The second explanation is that there is a major measurement problem with excess weight changes over time within individuals, a measurement problem that is related to changes in self-esteem. One possible structural measurement bias of that type would be social desirability bias being higher in years with low self-esteem and less high in years with high self-esteem. So the idea is that respondents would be more honest about their weight (so reporting a higher weight) in the years they feel relatively good about themselves (high self-esteem), which would also mean that year-to-year reductions in self-esteem would mean that self-reported weight goes down (because the bias increases in the direction of under-reporting) while actual weight might go up. Either possibility should be overcome with a good instrument, so revealing which of these two possibilities is more plausible.

[2] *Similarly, life satisfaction and happiness were both found to decrease linearly with impairment of physical function, indicating that the effect of excess weight via changes in physical function are also linear.*

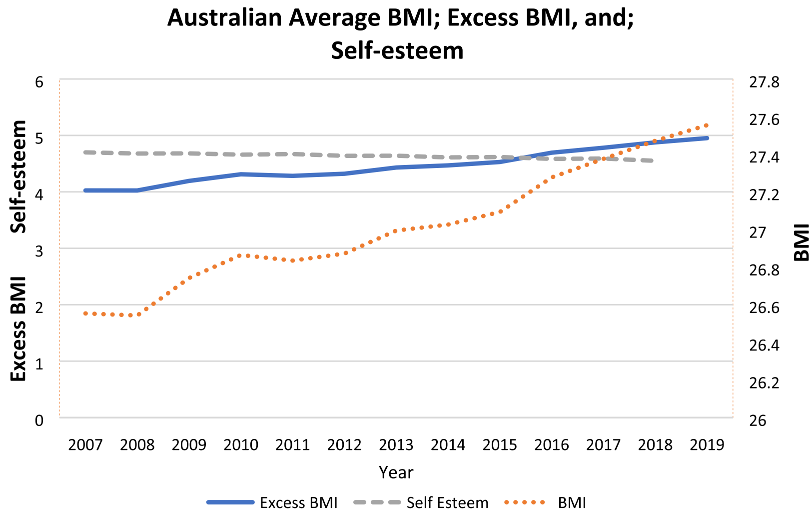

Figure 1. Average Australian self-esteem, BMI and excess BMI, 2007–2017.

Table 1. Summary of descriptive statistics of the key variables of self-esteem and excess BMI and the additional controls incorporated in the model

Variable name	Obs	Mean	Std. Dev.	Min	Max
Dependent variables					
Self-esteem	162 317	4.63	0.75	1	5
Excess BMI	191 183	4.51	5.08	0	65.60
Change in excess BMI $_{t - t\text{-}1}$	160 768	0.15	2.08	−41.90	44.60
Independent variables					
Year	200 067	2013.55	4.20	2006	2020
Age	200 067	45.16	18.51	15	101
Age squared	200 067	2382.26	1795.64	225	10 201
Log of annual income	200 067	10.42	1.11	0	14.30
Married	200 067	0.49	0.50	0	1
Separated	200 067	0.03	0.17	0	1
Divorced	200 067	0.09	0.29	0	1
Widowed	200 067	0.04	0.21	0	1
De facto	200 067	0.12	0.32	0	1
Phd or Masters	200 067	0.05	0.22	0	1
Graduate diploma	200 067	0.06	0.23	0	1
Bachelor's degree	200 067	0.15	0.35	0	1
Diploma	200 067	0.31	0.46	0	1
Year 12 education	200 067	0.15	0.36	0	1
0–4 Children	200 067	0.17	0.48	0	4
5–14 Children	200 067	0.29	0.70	0	7
Unemployed	200 067	0.04	0.19	0	1
Instruments: life events					
Fired from job	200 067	0.03	0.18	0	1
Promoted at work	200 067	0.06	0.24	0	1
Death of a friend	200 067	0.11	0.31	0	1
Death of a relative	200 067	0.11	0.32	0	1

The third column shows how the change in excess weight (so not the level) relates to self-esteem, again without fixed-effects. A 1 point higher self-esteem is related to an increase in 0.038 in BMI every year, so about 0.57 over 15 years.

The final column shows the same no-fixed-effects specification as in column 1, but then with two lags of self-esteem. Interestingly, the sum of these three is −0.94, substantially larger than the effect of just self-esteem in the current period found in column 1. There is also the strange finding that self-esteem in the previous period appears positively while that of two periods ago strongly negatively. What this suggests is that there indeed might be a measurement issue that relates to recent changes in self-esteem (note that a standard selection problem should be very similar for current levels and lags of self-esteem, so a selection problem would not lead to this neg-pos-neg pattern in the effect of lags). If so, weight gain relates to some notion of 'long-run' self-esteem. This is also in line with Ternouth et al. (2009) who found high explanatory power of childhood self-esteem at the age of 10 years on adult BMI but not of self-esteem measured at 16 years, which they explain as a problem with measurement at the age of 16 years: more volatile reasons for self-esteem during puberty.

We then look at the IV results in Table 3.

The first column shows the results of the first-stage regression, where at the bottom we see the four instruments, each strongly affecting self-esteem in the hypothesized direction. For example, redundancy causes a drop in self-esteem of approximately 0.133

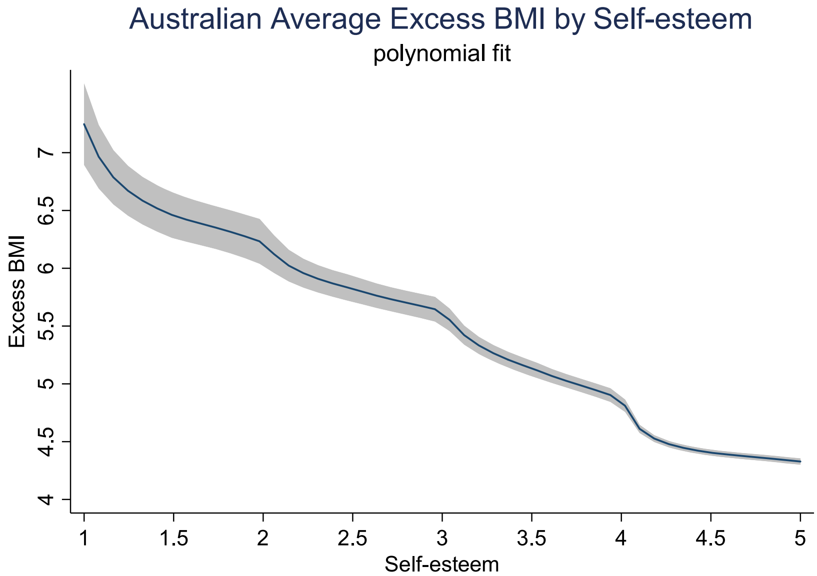

Figure 2. Average Australian excess BMI and self-esteem, 2006–2020.

points, while being promoted causes self-esteem to increase by 0.106 points. The magnitude of the effects is consistent throughout the models. Other lags and forecasts of the instruments were tested but did not indicate adaptation or anticipation effects. Note that these are fixed-effect analyses, so the effects of the shock are not due to selection but changes over time.

The second column shows the second-stage results, with one unit increase in self-esteem reducing excess BMI by −1.412. This is far bigger than the raw fixed effect regression result of column 2 of Table 2, but somewhat closer to the results of column 4 in Table 2 that found an effect of −0.94 for the joint effects of self-esteem and its two lags. The difference between these regression results is large. It fits the idea of a strong long-run relation between self-esteem and excess BMI masked by systematic measurement error of BMI related to short-run changes in self-esteem.

The coefficients on age and age squared are statistically significant and indicate a concave relationship with excess BMI over time, with the peak at the age of 60 years. This accumulation of weight throughout early life and gradual loss in old age is a common pattern in demographic research. Marital status also has a significant effect on excess weight: an individual in a marital or de facto relationship has, respectively, 1.633 and 0.764 more BMI points than an individual not in a relationship. This is consistent with Kifle & Desta (2012). Further, additional children have an insignificantly small but negative effect on BMI.

Interestingly, after accounting for self-esteem, unemployment slightly reduces BMI while higher education is associated with higher BMI. Previous literature found both variables to have a significant, negative effect on weight (see, for example, McLaren, 2007). What this indicates is that employment and education may affect excess weight through changes in self-esteem. Having a job and a higher level of education indeed both improve self-esteem, which would then have a negative effect on excess weight (see Sheeran et al., 1995; de Araujo and Lagos, 2013). This finding thus strengthens the evidence that self-esteem is likely to be a primary factor in the accumulation of excess weight.

As the number of instruments (4, when including the lags) exceeds the number of endogenous variables (1) in this specification, the model is over-identified. The Kleibergen LM statistic on the null hypothesis of under-identified instruments (i.e. inconsistency between the instruments) is rejected at the 1% level; this suggests that the excess instruments are validly included, giving weight to the proposition that the set of instruments is valid overall. What drives this is that the effects of each of these shocks on excess weight are opposite their effect on self-esteem.

The F-statistic on the test for weak instruments similarly rejects the null at a 1% level, revealing strong effects of the instruments in the first stage. We can mention that the new Lee et al. (2021) methods for adjustments to instrument strengths[3] do not change our test results qualitatively as the instruments have such robust strong effects that they continue to be highly jointly significant even with large adjustments to the standard errors. Rather, the uncertainty in our estimation results come from the second stage: the effects of the instrument on excess weight are not very tightly identified.

In Table 4, we divide the sample into different groups and re-run the IV analyses for each. The strength of the instruments is generally higher for the elderly, the well educated and females. We can see that the signs of the effects of shocks are consistent throughout and of similar magnitude across groups.

We find the effects of self-esteem on excess BMI to be particularly high for those with fewer than 12 years of education. This makes sense intuitively as we know obesity is more of a problem among the poor, but we note that this finding relies heavily on 'being promoted' as the instrument, which is our least favoured instrument because it is arguably less exogenous than the other instruments. For females we find a strong negative effect, larger than for men. While the direction of effects is consistent across group, there is a clear loss of significance from not pooling these groups, indicating that the effect of the instruments on excess BMI is highly variable. Also, they might contain quite a bit of measurement error themselves (which is not a problem if there is enough data).

Robustness tests

Alternative measures of weight: in Table 5, we consider two alternative measures of weight: raw BMI score, and a binary variable for obese defined as a BMI greater than 30.

[3] We understand the Lee et al. (2021) method is not applicable to clustering methods as employed in our data, so we can only discuss it qualitatively.

Table 2. OLS regression of the effect of self-esteem and controls on excess BMI/annual change in BMI, with and without fixed effects

	(1)	(2)	(3)	(4)
	Excess BMI	Excess BMI	Annual change in excess BMI	Excess BMI
Self-esteem	−0.703**	−0.068**	−0.038**	−0.616**
	(0.020)	(0.020)	(0.007)	(0.061)
Self-esteem$_{t-1}$				0.241*
				(0.097)
Self-esteem$_{t-2}$				−0.564**
				(0.062)
Age	0.266**	0.316**	−0.012**	0.249**
	(0.005)	(0.010)	(0.001)	(0.006)
Age squared	−0.002**	−0.002**	0.000**	−0.002**
	(0.000)	(0.000)	(0.000)	(0.000)
Log of annual income	0.043**	0.006	0.006	−0.007
	(0.013)	(0.009)	(0.004)	(0.017)
PhD or Masters	−2.122**	−0.191	−0.055**	−2.201**
	(0.053)	(0.127)	(0.014)	(0.066)
Graduate diploma	−1.521**	0.037	−0.043**	−1.657**
	(0.055)	(0.133)	(0.014)	(0.067)
Bachelor's degree	−1.639**	0.080	−0.060**	−1.850**
	(0.042)	(0.092)	(0.012)	(0.053)
Diploma	−0.396**	0.403**	−0.017	−0.547**
	(0.036)	(0.081)	(0.010)	(0.047)
Year 12 education	−0.591**	0.253**	−0.018	−0.888**
	(0.042)	(0.062)	(0.013)	(0.057)
Unemployed	0.455**	−0.058	−0.014	0.538**
	(0.083)	(0.044)	(0.037)	(0.117)
Married	0.105*	0.594**	0.071**	0.059
	(0.050)	(0.073)	(0.014)	(0.064)
Separated	−0.027	0.027	−0.014	−0.060
	(0.088)	(0.105)	(0.028)	(0.113)
Divorced	0.216**	0.196+	0.101**	0.218**
	(0.065)	(0.109)	(0.018)	(0.082)
Widowed	0.578**	0.258+	0.094**	0.592**
	(0.083)	(0.135)	(0.024)	(0.107)
De facto	0.205**	0.418**	0.093**	0.056
	(0.050)	(0.052)	(0.018)	(0.068)
0–4 Children	0.169**	−0.030	−0.092**	0.150**
	(0.028)	(0.025)	(0.009)	(0.036)
5–14 Children	0.022	−0.090**	−0.012+	0.012
	(0.021)	(0.022)	(0.006)	(0.025)
Fixed effects	No	Yes	No	No
N	155 447	155 447	141 711	101 403
R-squared	0.063	0.064	0.004	0.058

Marginal effects; standard errors in parentheses and clustered by individual. + $P < 0.10$. *$P < 0.05$. **$P < 0.01$. Specification 3 is the change in current BMI from the previous period.

We see that the effect on BMI of a one unit increase in self-esteem is −1.2, a large effect. Still, considering how self-esteem dropped by 0.2 in the period 2006–2020, only 0.24 in the increase in BMI is thus 'explained' by the change in self-esteem, which is only 25% of that change.

The effect of a one unit increase in self-esteem on whether someone is obese is −0.28, or 28 percentage points. That is a very large effect, indicating that very high levels of BMI and low self-esteem go hand in hand.

Mechanisms

Intertemporal discounting and energy balance: our theoretical model linked changes in the intertemporal discount factor with self-esteem and excess BMI. Specifically, a person with low self-esteem was argued to discount the future more, consume more and be less active and subsequently gain weight. Here, we look for these mechanisms in the data.

The HILDA dataset includes a question asking the individual to identify their financial planning horizon; this is commonly used as a proxy for time preference (see Brown and van der Pol, 2015). The question asks, 'In planning your saving and spending, which of the following time periods is most important to you?', providing six possible answers, ranging from the next week to more than 10 years ahead. Although this primarily measures the financial planning horizon, it has been taken as a useful proxy for time preference as the two exhibit systematic correlation (Adams and Nettle, 2009). Our measure is hence equal to 1 if the individual's planning horizon is longer than 1 year (a long planning horizon) and equal to 0 otherwise.

The effect of self-esteem on an individual's time preference was assessed by regressing the time preference dummy variable

Table 3. IV regression of the effect of self-esteem on excess BMI, with life event shock instruments

	(1)	(2)
	Stage 1 Self-esteem	Stage 2 Excess BMI
Self-esteem		−1.412*
		(0.615)
Log of annual income	0.004+	0.098**
	(0.002)	(0.010)
PhD or Masters	−0.061+	1.522**
	(0.039)	(0.137)
Graduate diploma	−0.121**	1.479**
	(0.037)	(0.156)
Bachelor's degree	−0.085**	1.229**
	(0.024)	(0.106)
Diploma	−0.083**	1.269**
	(0.021)	(0.097)
Year 12 education	−0.057**	0.753**
	(0.016)	(0.073)
Unemployed	−0.054**	−0.171**
	(0.012)	(0.061)
Married	0.001	1.633**
	(0.016)	(0.075)
Separated	0.127**	1.023**
	(0.026)	(0.135)
Divorced	0.216+	1.448**
	(0.130)	(0.114)
Widowed	0.040	1.273**
	(0.185)	(0.148)
De facto	0.188**	0.764**
	(0.062)	(0.061)
0–4 Children	−0.068*	−0.055*
	(0.031)	(0.028)
5–14 Children	−0.107**	−0.028
	(0.028)	(0.024)
Fired from job	−0.133**	
	(0.041)	
Promoted at work	0.106**	
	(0.029)	
Death of a friend	−0.070**	
	(0.022)	
Death of a relative	−0.116**	
	(0.021)	
N	150 641	150 641
Partial R-squared of excluded instruments:	0.0011	
F(4, 18 566)	11.48	
Under identification test (Kleibergen-Paap rk LM statistic)		45.545
Weak identification test (Kleibergen-Paap Wald rk F statistic):		11.484

Marginal effects; standard errors in parentheses and clustered by individual. $^{+}P < 0.10$. $^{*}P < 0.05$. $^{**}P < 0.01$.

on self-esteem using a probit model. In Table 6 we see a strong positive effect of self-esteem on the likelihood that someone has a longer planning horizon than a year, i.e. time preference. While there is considerable uncertainty about both measures and we are not using a causal design here, the strong positive relationship does at least support the argument that self-esteem is related to more forward-looking behaviour. That, incidentally, also supports the idea that self-esteem might relate to more generally dealing with life with a more open attitude, thus affecting response honesty to questions of high social desirability, like weight.

Diet and activities [5]: dummy variables for frequent physical activity and frequent consumption of fried food, confectionery and baked goods were then regressed on self-esteem. In Table 6, we see that self-esteem has the expected relation with most of them in a significant manner: higher self-esteem strongly increases physical activity and reduces the consumption of fried goods. The effect on confectionary consumption is negative but small. Somewhat unexpected, the effect of self-esteem on the consumption of cake is actually positive, perhaps because cakes get served at parties and parties improve self-esteem (or, alternatively, higher self-esteem gets one into more parties!).

In the last column of Table 6, excess BMI was regressed on time preference as well as the four food and activity variables considered above, using a fixed-effects formulation. Again, all the results are as expected: physical activity reduces excess BMI while consumption of high-calorie foods increases it. Conditional on all these exercise and food intake variables, the residual effect of time preference is insignificantly negative, so the expected sign but no longer significant. This is not surprising as self-reported measures of time preference are very noisy, with the main effects being absorbed in actual exercise and eating behaviour.

Another interesting observation about the final column in Table 6 is also how much or little the exercise and food items explain. If you set all of these to their optimal levels (so frequent exercise and no intake of cakes, fried food, or confectionary) then a person has an excess BMI of about 0.8 lower than if you take all these at their most negative levels. That is a substantial difference, but still only about 20% of the average excess BMI in the sample (about 4.5). This will partly be because these measures of food intake and exercise are not capturing all the relevant variation in those realms, but also signify a general 'baseline problem' that even many people with healthy habits have excess weight issues.

We then take a final look at whether reference groups matter.

The theoretical model suggested that self-esteem is a product of an individual's interaction with others, both face-to-face and through other media. To get some idea as to whether this held, we regressed self-esteem on the measures of media in our data. We included whether people read magazines at least once a week. We also wanted to look at whether it mattered that people use computers daily, but there was not enough variation in the underlying data for this to be useful.

In Table 7 we show the results of the augmented self-esteem regression that now includes our measure of social media exposure, i.e. reading magazines frequently. The sign is as expected, but the effect is minute and totally insignificant. This might well indicate that magazine reading is not a good measure of social media exposure or the number of reference persons an individual takes account of.

CONCLUSIONS

This paper explored the relationship between social groups, self-esteem and weight, using data from the HILDA survey. The primary finding is that self-esteem does, in fact, have a significant effect on weight; using a 7-point scale, a 1-point decrease in self-esteem results in an excess BMI of approximately 1.4 points. The reduction in self-esteem in this period of about 0.2 can thus explain an excess BMI increase of about 0.3, which is 30% of the observed average excess BMI increase in the 15 years of the data.

The mechanisms tested indicate that individuals with low self-esteem tend to engage in less future planning; this was subsequently linked to increased food consumption and decreased physical activity, though the ability to explain population changes in weight is minimal. In terms of deeper mechanisms about how the modern economy might have increased the pressure on

Table 4. Summary of IV regressions of the effect of self-esteem on excess BMI, with life event shock instruments by social categories

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	All	Females	Males	Age, ≤30	Age, >30	Year 12 education	Above year 12 education
IV First Stage							
Fired from job	−0.029**	−0.040*	−0.020	−0.038+	−0.025*	−0.027	−0.025*
Promoted at work	0.026**	0.024*	0.029**	0.010	0.043**	0.040**	0.022**
Death of a friend	−0.010**	−0.018+	−0.009	−0.045**	−0.004	−0.001	−0.010*
Death of a relative	−0.016 *	−0.019**	−0.013*	−0.018	−0.013	−0.020	−0.014**
F-Stat	11.48	6.06	5.91	3.62	13.76	3.14	7.57
IV Second Stage							
Excess BMI	−1.422*	−1.695+	−0.925	−0.597	−1.038+	−2.453+	−1.155
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	150 641	78 698	71 943	35 919	113 885	22 319	127 409
Number of clusters	18 567	9689	6068	6514	10 250	11 224	16 324

Marginal effects; standard errors in parentheses and clustered by individual. +P < 0.10. *P < 0.05. **P < 0.01.

Table 5. IV regression of the effect of self-esteem on: (1) BMI; (2) Obesity, with life event instruments

	(1)	(2)
	BMI	Obese
IV First Stage		
Fired from job	−0.029**	−0.029**
Promoted at work	0.026**	0.026**
Death of a friend	−0.010**	−0.010**
Death of a relative	−0.016*	−0.016*
F-Stat	11.48	12.07
IV Second Stage		
Self-esteem	−1.212+	−0.280**
Controls	Yes	Yes
Fixed effects	Yes	Yes
N	150 641	157 283
Number of clusters	18 567	9689

Marginal effects; standard errors in parentheses and clustered by individual. +P < 0.10. *P < 0.05. **P < 0.01.

self-esteem, individuals who were more frequent magazine readers (and thus had a large media-defined social reference group) were found to experience lower self-esteem but the effect was insignificant and small. This suggests we need better measures of social media usage to nail down this causal chain, preferably with random variation in media usage.

Our findings are consistent with research performed in the UK (Ternouth et al., 2009) who finds that self-esteem affects adult adiposity, though our found effects are stronger than theirs. Their study suggested that self-esteem measured at the age of 16 years is much less informative than self-esteem measured at the age of 10 years, which was thus taken as a more reliable measure of permanent self-esteem. We find something similar: the long-run effect is far larger than the more volatile immediate effect, though in our data the measurement problem seems to lie with the measurement of excess weight while in the cohort study used by Ternouth et al. (2009) BMI was nurse-measured. Our results suggest that in the years that individuals feel relatively better about themselves (high self-esteem) they are also more honest about their weight and thus report higher numbers, creating a large downward bias in the found relation between observed excess weight gain in a year and self-esteem changes that year. Using instrumental variables recovered a relationship that was somewhat close to the 'naïve' sample relationship. This is somewhat surprising in that the used instrument is highly variable and thus not itself permanent.

The study has many limitations. A major one is that BMI levels are derived from self-reported height and weight, which introduces social desirability bias, which in our case seems to be of high importance. This raises the question of whether our hypothesized endogeneity problem can be found in datasets that include measures of self-esteem over time as well as self-reported BMI plus a more objective BMI measure.

Another limitation is that the IV results suggest an effect of self-esteem levels on weight change within a certain environment, meaning that one should not expect this relationship to hold in different periods. If it were, then individuals would have had to be far heavier in previous generations. The change in self-esteem itself does not explain that much of the recent increases in BMI, even though self-esteem does strongly identify which individuals gain weight.

In terms of policy, preventing adverse life events or their effects on self-esteem may be impossible, as the death of family members cannot be prevented. Nor would it seem to be politically possible to artificially keep comparison groups small and prevent individuals from reading magazines or using computers.

Still, while the empirical results do not contain anything resembling a policy variable, the theoretical model does suggest a broad direction of policy change, namely social comparisons and social pressure. Status given to anything is highly socially malleable, with a large role for authority to lead by reward and example (Frijters and Krekel, 2021). Pursuing that line of thought gives rise to many somewhat radical possibilities to explore in future research. So, for instance, authorities can start to openly disapprove of offering calorie-rich food during festivities, offices and social gathering. While Australian Government-funded schools have begun to do this by offering 'Healthier menus for school canteens' (NSW., 2017), authorities could extend interventions beyond school age by depicting offering cookies

Table 6. Mechanisms: effect of self-esteem on consumption choices (1)–(5), and; time preference and consumption choices on excess BMI (6)

	(1)	(2)	(3)	(4)	(5)	(6)
		Consumption				
	Time preference[1]	Cake	Fried foods	Confectionary	Physical activity	Excess BMI
Self-esteem	0.091**	0.026*	−0.076**	−0.011	0.231**	
	(0.010)	(0.012)	(0.011)	(0.012)	(0.007)	
Time preference						−0.042
						(0.031)
Consumption:						
Fried foods						0.217**
						(0.035)
Confectionary						0.024
						(0.035)
Cake						0.085*
						(0.039)
Physical activity						−0.442**
						(0.039)
Age	0.024**	−0.051**	−0.042**	−0.060**	−0.007**	0.309**
	(0.003)	(0.004)	(0.003)	(0.004)	(0.003)	(0.015)
Age squared	−0.000**	0.001**	0.000**	0.000**	−0.000*	−0.002**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Log of annual income	0.048**	−0.018+	0.050**	0.037**	0.002	0.004
	(0.006)	(0.009)	(0.009)	(0.009)	(0.006)	(0.019)
PhD or Masters	0.793**	0.117*	−0.618**	−0.053	0.359**	−0.221
	(0.047)	(0.054)	(0.052)	(0.053)	(0.041)	(0.209)
Graduate diploma	0.567**	0.186**	−0.511**	0.027	0.362**	0.105
	(0.048)	(0.052)	(0.050)	(0.050)	(0.040)	(0.208)
Bachelor's degree	0.366**	0.064+	−0.457**	0.010	0.256**	0.145
	(0.033)	(0.036)	(0.035)	(0.036)	(0.027)	(0.155)
Diploma	−0.001	−0.005	−0.080**	−0.033	0.089**	0.326*
	(0.027)	(0.028)	(0.027)	(0.028)	(0.021)	(0.141)
Year 12 education	−0.071*	−0.018	−0.161**	−0.001	0.077**	0.259*
	(0.029)	(0.033)	(0.031)	(0.033)	(0.024)	(0.121)
Unemployed	−0.120**	−0.155**	0.098*	−0.158**	0.013	−0.306**
	(0.032)	(0.045)	(0.045)	(0.046)	(0.026)	(0.109)
Married	0.305**	0.198**	0.002	0.144**	−0.163**	0.540**
	(0.031)	(0.036)	(0.035)	(0.036)	(0.026)	(0.116)
Separated	−0.067	−0.117+	0.003	−0.034	−0.193**	0.027
	(0.049)	(0.060)	(0.059)	(0.060)	(0.040)	(0.166)
Divorced	0.020	−0.083+	−0.051	−0.026	−0.174**	0.181
	(0.043)	(0.047)	(0.046)	(0.046)	(0.035)	(0.165)
Widowed	−0.006	−0.102	−0.265**	−0.021	−0.291**	0.153
	(0.058)	(0.064)	(0.063)	(0.062)	(0.045)	(0.202)
De facto	0.060*	−0.013	0.076*	−0.001	−0.096**	0.384**
	(0.026)	(0.034)	(0.033)	(0.034)	(0.023)	(0.083)
0–4 Children	−0.049**	0.141**	0.082**	0.076**	−0.215**	−0.047
	(0.013)	(0.020)	(0.018)	(0.020)	(0.012)	(0.041)
5–14 Children	−0.071**	0.054**	0.112**	0.063**	−0.029**	−0.124**
	(0.010)	(0.014)	(0.013)	(0.014)	(0.009)	(0.034)
N	150 954	50 091	49 998	50 011	162 317	42 982
R Squared						0.083

Marginal effects; standard errors in parentheses and clustered by individual. +P < 0.10. *P < 0.05. **P < 0.01. [1]Time preference is rolled forward a single period to years it is not collected: 2007,9,11,13,15,17 and 19.

and chocolates as a form of social micro-crime, i.e. a 'micro-temptation' detrimental to food habits and health. Similarly, exercise can be built into publicized regular office routines, parliamentary and Cabinet office routines, the design of cities and the use of stairs and more use of the public transport that forces us to exercise by actually 'walking' to catch our transport home. Rather than have ministers picked up in front of cameras by taxis, making such forms of transport high status, there could for instance be a blanket rule of no motorized transport for any of the top politicians and members of the royal family, in order to give the right example on exercise. Visiting heads of state would get carrots and celery rather than champagne and roast.

Supplementary Data

Supplementary data are available at *Oxford Open Economics* online.

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Table 7. Mechanisms: effect of consumption of magazines on self-esteem

	(1)
	Self-esteem
Frequently reads magazines	−0.005
	(0.004)
Age	−0.019**
	(0.005)
Age squared	0.000**
	(0.000)
Log of annual income	0.001
	(0.006)
PhD or Masters	0.029
	(0.073)
Graduate diploma	−0.067
	(0.089)
Bachelor's degree	−0.045
	(0.055)
Diploma	−0.056
	(0.044)
Year 12 education	−0.017
	(0.042)
Unemployed	−0.045
	(0.033)
Married	0.016
	(0.034)
Separated	−0.111*
	(0.053)
Divorced	0.057
	(0.053)
Widowed	0.012
	(0.077)
De facto	0.029
	(0.028)
0–4 Children	−0.022+
	(0.012)
5–14 Children	−0.017
	(0.011)
N	25 364
R-squared	0.007

Marginal effects; standard errors in parentheses and clustered by individual. +$P < 0.10$. *$P < 0.05$. **$P < 0.01$.

Conflict of Interests

The article's conclusions, implications and opinions are those of the authors, and, there are no perceived conflicts of interest. The HILDA Survey data is available to researchers living in Australia or overseas from DSS Longitudinal Studies Dataverse (Australian Government Department of Social Services).

Data availability

The data and analysis programs used for this paper are freely available from the authors. The data is also freely available for researchers upon registration at https://dataverse.ada.edu.au/dataverse/DSSLongitudinalStudies.

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