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Birds of a Feather Flock Together: Correlation in BMI Categories in Long-Term Relationships.

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Title: Birds of a Feather Flock together: Correlation in BMI Categories in Long Term Relationships

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Abstract:

This is the first paper to explore partner correlations across BMI categories for couples in long term stable relationships using data from the Household Income and Labour Dynamics of Australia survey (HILDA) 2006-2011. The moderating effect of three hypotheses on this correlation are tested: 1) selection; 2) relationship stability; and 3) social obligation/environment. The results show gender asymmetric effects in the correlation in BMI categories. Selection explains the majority of the correlation for men and all of the correlation in BMI categories for women. Some evidence of variables related to stability and social obligation are significantly associated with weight outcomes for men.

Keywords: Australia; BMI; Random Effects Generalised Ordered Probit; Long term relationships;

JEL Classification: J12; I10

1. Introduction

The leading causes of death in developed countries are non-communicable diseases such as cardiovascular disease and diabetes. It is estimated that approximately, 80% of deaths from coronary heart disease and cerebrovascular disease are caused by behavioural risk factors associated with obesity such as physical inactivity and an unhealthy diet (World Health Organisation (WHO) 2011). These same behavioural risk factors are potentially influenced by personal relationships such as being in a couple. Many activities, such as eating or watching TV, are more enjoyable with others than on one's own. Additionally, partners are likely to influence individual perception regarding social norms associated with weight (Burke and Heiland 2007, Etile 2007, Oswald and Powdthavee 2007, and Blanchflower et al. 2009). For example, if one partner is obese, overtime the other partner may change their perception of an acceptable weight. Thus, a partner's BMI category gains importance over time. Wilson (2012) found using data on older adults that transitions into marriage lead to significant weight gain for both genders. Additionally, after controlling for selection into marriage, Averett et al. (2008) found that compared to unmarried or cohabiting women, married women began at a lower BMI before marriage but then gain weight after marriage occurs. Marriage may thus promote weight gain, but why?

This paper will explore the routes through which being in a long term relationship may affect BMI and if partner's weight is more important at certain points along the BMI spectrum.

This paper adds to the literature by empirically testing the factors associated with correlated BMI for couples in stable partnerships, which is defined as being in a relationship[1] with the same person for approximately three years prior to 2006 and not separating from this partner over the sample period (2006-2011). It is widely accepted that partners tend to exhibit similar health related behaviours. For example, there have been a number of studies finding shared outcomes in partner smoking (Clark and Etile 2006, Christakis and Fowler 2008, and Cutler and Glaeser 2008), alcohol consumption (Leonard and Mudar 2003 and Rosenquist et al. 2010), and obesity (Christakis and Fowler 2007, Kano 2008, Clark and Etile 2011, and Brown et al. 2014). Additionally, there have been a number of studies (Jeffery and Rick 2002, Sobal et al. 2003, Jo 2004, Averett et al. 2008, The and Gordon-Larsen 2009, and Wilson 2012) that have looked at how marriage transitions affect the likelihood of being obese. The evidence is mixed and varies by gender. Sobel et al. (2003) found that only women gained weight after marriage whereas Jo (2004) found the opposite where men were more likely to become obese after marriage but not women. In terms of the impact of

[1] Relationship refers to either cohabiting or married couples.

cohabiting relationship on body weight, The and Gordon-Larsen (2009) found using a logistic model that the likelihood of being obese and partner correlations in obesity were highest for partners that had lived together for 2 or more years (both married and cohabiting). Understanding why individuals in stable relationships tend to gain weight is important for the development of policy to reduce the burden of obesity on the health care system.

Many of the studies mentioned in the paragraph above focused on specific segments of the population: either young people aged under 35 (Jo 2004, Averett et al. 2008, The and Gordon-Larsen 2009), a worksite health promotion project in Minneapolis-St. Paul (Jeffery and Rick 2002), or older adults (Wilson 2012). In this paper, data from the Household Income and Labour Dynamics in Australia (HILDA) survey, a general population survey, covering the period 2006-2011 is used. Looking at the whole adult population in stable unions will give a better overall picture on how marriage may lead to weight gain in all adults.

The empirical analysis uses a random effects generalised ordeded probit model estimated separately for men and women to explore the correlation in partner BMI across healthy weight, overweight and obese individuals. Further analysis investigates the moderating effect of matching, relationship stability, and social obligation on this correlation. Firstly, one may choose a partner whose preferences increase the likelihood of them having a correlated BMI category. Secondly, individuals that are not planning on trying to find a new partner may find it too costly to maintain a healthy BMI and may choose to match their BMI to their partner. Finally, social obligations associated with stable relationships such as eating more and regular meals may contribute to the correlation in partner BMI. These hypotheses will be expanded upon in the next section.

2. Theoretical Models of Stable Relationships and Body Weight

2.1 Selection:

The proportion of people who never enter a co-residential relationship is very small. In 2001, only 6.1% of Australian men and 4.2% of Australian women over 60 had never married (Australian Institute of Family Studies (N.D.)). Thus, weight is not likely to affect the likelihood of being in a relationship but may affect mate quality and age at first co-residential relationship (Averett et al. 2008). Oreffice and Quintana-Domeque (2010) examine the role of anthropometric characteristics when choosing a partner. They find strong evidence that is individuals with a similar body mass index (BMI) are more likely to enter into a relationship than individuals with a widely dissimilar BMI. This is consistent with Becker's (1991) marriage model in which the gains from marriage may be maximised by choosing a partner with similar characteristics such as weight or observable preferences such as for physical activity and healthy eating.

If stable partnerships are those that are based upon positive assortative mating (choosing a partner based on complementary personal traits and preferences) then it is possible that BMI of these partnerships will become more similar over time. This would lead to couples with unhealthy habits related to weight more likely to become obese overtime. On the other hand, couples with healthy habits related to weight may be less likely to become obese overtime. Alternatively, couples may choose a partner with similar BMI and their correlation in BMI would then remain relatively stable over the partnership.

2.2 Relationship Stability

For those that are actively looking for a partner, physical appearance is likely to be an important characteristic influencing ability to choose a potential mate. Traditionally, men have stronger preferences for thinner women than women have a preference for thinner men. There is an extensive body of research supporting this idea. On average thinner women are more likely to get married (Averett and Korenman 1994, Averett et al. 2008, Wilson 2012).

If one is in a stable partnership and is no longer actively looking for a partner then maintaining a socially ideal physical appearance may be less important. If the cost involved with maintaining a lower weight when looking for a partner is higher than the utility an individual receives from this weight after having found a partner they will gain weight. This relies on the assumption that there are transaction costs associated with ending a relationship (Becker 1991). As long as the utility for both partners as one or both of them gain weight is higher than the cost of ending the relationship, weight gain will be tolerated in the union.

There is empirical evidence supporting the idea that within the first few years of a relationship, women especially tend to gain weight (Sobal et al. 2002, Jo 2004, and Averett et al. 2008). There is less evidence if this weight gain continues throughout the relationship or stops as the relationship progresses. Alternatively, societal norms regarding an ideal weight are likely to be different for men and women. Obese women are more likely to be stigmatized in all areas of life than men (Averett and Korenman 1994, Sobal 1999, Cawley 2004, Morris 2006, 2007). The costs of not being obese could then be different for men and women.

2.3 Social Obligation/Environment:

Individuals in relationships may be more likely to face obligations that encourage them to eat or reduce their opportunities for physical activity. Couples are more likely to eat regular meals and/or eat out more frequently potentially consuming more calories than single individuals (Sobal et al. 2003, Jo, 2004, Averett et al. 2008). Additionally, caring for children and other household commitments will reduce the time available for weight maintenance activities such as exercise and eating healthily. Alternatively, busy family schedules may mean that couples eat less together which could reduce the correlation in BMI. Where a household is located (i.e. urban vs rural) could impact on household BMI and correlated outcomes between partners. The local environment is likely to impact on access to healthy food which may subsequently impact on body weight and correlated weight outcomes in couples (see for example Beulac et al. 2009).

2.4 Cohabitation vs. Marriage

In the analysis we also compared cohabitation to being legally married on the correlation in partner BMI categories. As pointed out by Averett et al. (2008) the cost of becoming obese may be greater for cohabiting couples if their relationship is inherently more unstable than those that are legally married. However, cohabitation prior to or instead of marriage is becoming the norm with 75% of Australian couples cohabiting before marriage (Buchler et al. 2009). It is feasible to suppose that there may not be significant differences between cohabiting and married couples in how the above hypotheses affect the correlation in BMI categories.

3. Data

The empirical analysis uses data from waves 6 to 11 (2005-2011) of the Household Income and Labour Dynamics of Australia (HILDA) survey. Height and weight information used to calculate BMI was first collected in 2006 and has been collected in each subsequent wave. The HILDA is an annual household based panel survey which began in 2001. The panel members are followed over time and each household member over the age of 15 is interviewed. The survey collects multiple year information on financial, labour market, demographic, and health as well as health related behaviour for a general population. The survey was designed to be consistent with the British Household Panel Survey (BHPS) and the German Socio-Economic Panel (GSOEP) Survey. The motivation behind the creation of the HILDA is described in greater detail in Watson and Wooden (2006).

All analysis is limited to respondents between the ages of 25 to 65. This age group is chosen because individuals are more likely to have formed stable relationships by age 25 permitting analysis of couples not undergoing relationship transitions which may affect weight. Older individuals are excluded to reduce the likelihood of widowhood affecting relationship continuity. The sample is restricted to respondents that are observed as married or in a cohabiting partnership with someone of the opposite gender for at least three consecutive years before 2006 and do not separate over the sample period. It is possible that effects may be different for same sex couples. The sample size is too small to look at this group. There are 342 same sex couples observed over the 11 waves of the HILDA. Relationship status data collected in 2002, 2003, 2004 is used to determine if the couple has been in a stable relationship over this period. This restriction is enforced on the data to focus on the correlation in BMI categories in couples in stable unions. Previous research (for example Jo 2004, Averett et al. 2008, and Wilson 2012) has found that transitions into marriage impact on weight gain. Pregnant women are excluded from the analysis.

3.1 Dependent Variable

BMI is divided into three groups according to the WHO classification system based upon health risks associated with an increasing body mass index (BMI). The base category is healthy weight which is defined as individuals with a BMI between 18.5 kg/m^2 and 25 kg/m^2. The other two categories are overweight which is defined as individuals with a BMI between 25 kg/m^2 and 30 kg/m^2 and obese defined as individuals with a BMI of greater than 30 kg/m^2. Underweight individuals (those with a BMI less than are 18.5 kg/m^2) are excluded from the analysis. In the HILDA, BMI is calculated using self-reported height and weight. Each individual in the survey gave estimates of their own height and weight. It is well documented that height and weight which are self-reported are likely to be biased by measurement error (see for example Cawley and Burkhauser 2008). Height tends to be overstated and weight tends to be underreported. In the HILDA survey the height and weight responses were inspected via a two stage process. The first stage was a visual scan of the data to ensure that incorrect values had not be entered and the second stage involved changing unrealistic values to missing (Wooden et al. 2008). Unrealistic height values are defined as a height of less than 120cms or greater than 210cms. Unrealistic weight values are defined as a weight less than 40kg or greater than 200kg. Unrealistic height and weight combination were defined as a BMI of less than $15kg/m^2$ or greater than $60kg/m^2$.

3.2 Covariates

The key variable for the analysis is lagged partner BMI category. Lagged partner BMI category will help determine if partner's BMI category in the previous year has a significant effect on one's BMI category this year.

The moderating effect of selection into relationships is controlled for by characteristics related to relationship selection such as age partnership began, age gap between partners, two dummy variables controlling for if partners are from the same country of origin and if partners have the same educational qualifications.

To test for the moderating effect of relationship stability hypothesis the analysis controls for relationship length. Relationship length, measured in years, is calculated for married individuals using the derived variable *mrcdur*. In the first year respondents are interviewed, *mrcdur* is calculated from the month and year of current marriage to date of current interview. *Mrcdur* is updated by the data collection agency each year of the survey that partners remain together. The HILDA contains information for the amount of time that couples cohabited before marriage. For couples that cohabited before marriage this time is added to the relationship length variable; to control for the amount of time spent in the shared environment and total duration of the co-residential relationship impacting on obesity outcomes. For cohabiting individuals, there is a separate relationship length variable also measured in years, the derived variable *orcdur*; which is calculated from month and year started living with current partner to date of interview. Similar, to the marital length variable, the cohabitation length variable is updated each year the couple remains together.

The social obligation/environment hypothesis is tested by including variables related to total number of dependent children, household income, and a binary variable for living in a rural area.

The analysis also controls for a number of other individual characteristics that are likely to affect BMI such as employment status and educational attainment. A full description of the variables included in the analysis is shown in Appendix A.

3.3 Descriptive Statistics

Sample means for the 1098 couples in the sample are presented in Table 1. The table shows the means for the couples across the 5 waves (n*T). Approximately 25% of men and 24% of women in the sample are classified as obese. Approximately 46% of men and 30% of women are classified as overweight. Approximately 28% of men and 46% of women are classified as a healthy weight. The means for the different weight categories are fairly comparable to those found in the Australian Health Survey.[2] It is interesting to note that in the raw data, the means in male and female obese is more similar than the other weight categories.

Except for the dichotomous variables controlling for age difference between partners, differences in partners educational attainment, and country of birth, all variables are time varying. The raw data suggests there may be positive assortative mating influencing partner selection as 76% of the

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[2] Descriptive statistics from this survey can be found at the following website:
Australian Institute of Health and Welfare, (2015). Overweight and Obesity. *Australian Government.* Retrieved on 21 July 2015 from http://www.aihw.gov.au/overweight-and-obesity/

couples have the same level of educational attainment and are from the same country of origin. The mean age of men in the sample is 45 and the mean age of women is 43. Approximately 20% of the sample lives in a rural area and the majority of the sample have at least one dependent child. Approximately 14% of the sample are in a cohabiting relationship.

Exploring Selection in the Raw Data:

In Table 2, conditional probabilities are calculated based upon the probability that a man will be in a given weight category given his female partner is in that weight category. The highest probabilities are for the correlation in the two extremes of healthy weight and obese. If a women is healthy weight there is a 60% likelihood that her partner is healthy weight. If a woman is obese there is a 37% likelihood that her partner is obese. The econometric model will explore in further detail how the hypotheses of selection, stability, and social obligation explain this raw correlation.

To gain a better understanding of if selection leads to partner's BMI converging over time, in the raw data, the mean change in BMI between partners over the 6 waves of data is explored. This will provide some evidence if partner's BMI is converging overtime or if the correlation in partner BMI reflects similarities in BMI from the start of the relationship. Figure 1 shows the mean change in partner BMI between the 6 waves. The solid lines are one standard deviation above and below the mean difference in partner BMI across the whole sample. The mean change in the correlation in partner BMI is -5.80 providing some support that BMI is converging over time. However, the standard deviation is large (36.8) suggesting that even though for the majority of couples there is little change over this period; there are couples with large positive and negative changes in correlated BMI. Thus, from looking at the raw data it is difficult to draw any conclusions regarding a convergence of couple BMI over time. .

4. Econometric Model

We employ a simple generalised random effects ordered probit model of the three BMI categories estimated separately for men and women[3]. It is likely that the association of the explanatory variables on the likelihood of being healthy weight, overweight, and obese will not be homogenous across the independent variables. By employing this model specification, we can investigate if there are different factors that significantly impact on the likelihood of being in the different weight categories which may be important for policy development. A standard ordered probit model assumes homogenous cut-points between the categories whereas a generalised ordered probit allows for heterogeneous cut-points. A generalised random effects ordered probit control for heterogeneity in both the error term and the dependent variable (Pfarr 2010) thus reducing bias which may affect our estimates.

We start by estimating a base model where the latent variable BMI_{it}^{*} is assumed to be a function of time varying and time constant individual factors captured by the vector X_{it}, lagged partner BMI category represented by the vector $B_{p(t.-1)}$, and an error term (ε_{it}) which consists of an idiosyncratic error component, μ_{it} and time constant individual effects, α_i. Lagged partner BMI is used to identify the impact of one's partner on weight outcomes.

Following Pfarr et al. (2011) the model can be expressed as:

$$BMI_{it}^{*} = \beta X_{it} + \xi BMI_{p(t-1)} + \varepsilon_{it} \qquad (1)$$
$$\varepsilon_{it} = \alpha_i + \mu_{it}$$

Where *BMI* is a discrete ordered variable taking the value of 0 if the individual has a BMI within

[3] It is possible to estimate a bivariate generalised ordered probit model to control for correlated error terms between couples. However, the model is computationally intensive and some basic comparisons which are available upon request to the author yield similar results.

the healthy weight category, 1 if the individual has a BMI within the overweight category and 2 if the individual has a BMI within the obese category.

$$BMI_{it} = k \; if \; and \;\; only \; if \;\; \mu_{k-1} \leq BMI^{*}_{it} = \beta X_{it} + \xi BMI_{p(t-1)} + \varepsilon_{it} < \mu_k, K = 0,1,2 \tag{2}$$

The threshold parameters are individual specific and dependent on the covariates:

$$\mu_{ik} = \tilde{\mu}_k + X^{'}_{i}\gamma_k + BMI^{'}_{p(t-1)}\gamma_k \tag{3}$$

Where γ_k are the influence parameters of the covariates on the thresholds of the BMI categories.

The outcome probabilities are conditional on the individual effects (α_i) and the estimated coefficients can vary across the categories of the dependent variable.

$$\begin{aligned}
&\Pr(BMI_{it} = 0 \mid X_{it}, BMI_{p(t-1)}, \alpha_i) = F(-\beta_0 X_{it} - \xi_0 BMI_{p(t-1)} - \alpha_i) \\
&\Pr(BMI_{it} = 1 \mid X_{it}, BMI_{p(t-1)}, \alpha_i) = F(-\beta_1 X_{it} - \xi_1 BMI_{p(t-1)} - \alpha_i) - F(-\beta_0 X_{it} - \xi_0 BMI_{p(t-1)} - \alpha_i) \\
&\Pr(BMI_{it} = 2 \mid X_{it}, BMI_{p(t-1)}, \alpha_i) = 1 - F(-\beta_2 X_{it} - \xi_2 BMI_{p(t-1)} - \alpha_i)
\end{aligned} \tag{4}$$

This is referred to as the base model.

4.1 Selection

The next step of the analysis is to attempt to control for partner choice (selection) impacting on the likelihood of becoming obese. Following Averett et al. (2008) employing a fixed effects approach can help to ameliorate the bias from selection of a partner assuming that partner selection related to weight is dependent on time constant unobservable factors as well as observable partner weight. In this paper we employ a random effects specification because there are many computational issues that arise when estimating a fixed effects generalised ordered probit model. The one dimensional parameters need to be re-estimated as a potentially limitless number of (*n*+*K*)-*n* parameters. To estimate the model, therefore, it would be necessary to compute the potentially large number of constant terms at the same time. This presents a practical obstacle to estimation of a fixed effects model as there is a need to invert a potentially large second derivative matrix (Greene 2003). For this reason, the analysis in this paper focuses on removing the endogeneity bias stemming from omitted variable bias of the lagged partner BMI categories being correlated with time constant unobservable factors in the error term by applying a proxy fixed effects method proposed by Mundlak (1978). He suggests that omitted variable bias can be mitigated by taking the mean of all the time varying variables. Thus, we are able to estimate a proxy fixed effects specification avoiding the computational issues that arise when attempting to estimate a fixed effects generalised ordered probit.

As an additional mechanism to control for partner selection we also control for observable characteristics related to selection such as if partners have the same educational qualifications, are from the same country of origin, age gap between partners, and age that the relationship started. This is referred to as the Selection model.

If couples match on time constant factors related to the propensity to be obese, the Mundlak method will remove the impact of this from the coefficient on lagged partner BMI categories.

4.2 Relationship Stability Hypothesis

The relationship stability hypothesis is tested by including a variable for relationship length into equation (2). In the results section this is referred to as Stability Model. This model is estimated using the Mundlak method as a proxy fixed effects model.

4.3 Social Obligation/Environment Hypothesis

To test for the social obligation/environment hypothesis, variables controlling for household characteristics such as number of children, log of equivalised household income, and a dummy variable for if the household is an urban or rural area are included in the equation. In the results section this is referred to as the Obligation model. This model is also estimated using the proxy fixed effects specification.

If there is a moderating effect of any or all of these three hypotheses on the correlation in partner BMI outcomes it is expected that the coefficients will be smaller than in the base model, Model (1). It is possible that the three hypotheses do not have the same moderating effect across the BMI spectrum.

4.4 Differences in Cohabitation and Marriage

A dummy variable for cohabitation status is used to test for the impact of cohabitation on BMI categories compared with being in a legal marriage. This dummy variable is included in all model specifications.

5. Results

All results shown are marginal effects to give the findings a quantitative interpretation. The marginal effects are estimated separately for a positive outcome in the overweight category and a positive outcome in the obese category for men and women compared to being in the healthy weight category. For ease of exposition, the main tables included in the paper only include variables related to partner BMI category, selection, relationship stability, social obligation/environment and cohabitation status. The additional covariates included in the analysis are shown in Appendix B. The means from the time varying variables for models estimated using the Mundlak method are shown in Appendix C. The additional covariates in Appendix B merit some discussion. For men, in all model specifications being educated to the high school level and the degree level compared to no qualifications is positively and significantly associated with being overweight but negatively and significantly associated with the likelihood of being obese. This is consistent with a large body of literature (see for example Stobal and Stunkard 1989) which has found a significant association between obesity and lower levels of educational attainment. Interestingly for women, there is not a significant association between overweight and obesity and education compared to those in the healthy weight category. Across all model specifications, men who emigrated from English speaking countries are significantly more likely to be obese than healthy weight and significantly less likely to be overweight.

The main results are presented in Table 3 for men and Table 4 for women. For each model there are two columns of results one for the overweight category and one for the obese category which are compared to those in the healthy weight category. For the base model, In Table 4, the correlation of lagged partner obesity and current obesity is larger and more significant for women compared with men. If a women's partner was overweight last year she is 11% more likely to obese and if her partner was obese last year she is 24% more like to be obese. Whereas for men, if his partner was overweight last year this is not significantly associated with his likelihood of being obese. If his partner was obese last year this is associated with a 9% increased likelihood of him being obese this year. It is interesting to note that partner's lagged overweight status is negatively and significantly associated with both a women's likelihood of being overweight and obese. For men if his partner was overweight last year then this is associated with a 4% increased likelihood of being obese.

5.1 Selection:

Next, we explore the moderating effect of selection on the correlation in partner BMI categories. In Table 3, controlling for characteristics related to selection and time invariant characteristics related to BMI using a proxy fixed effects model, the magnitude of the marginal effect on the correlation on partner overweight is reduced by 50% and is no longer significant. However, there is still a significant correlation in partner obesity between men and their partners. If a man's partner was obese in the last period he is 6% more likely to be obese in the current period. Additionally, if a man has a different educational level than his partner he is 4% less likely to be overweight but 3%

more likely to be obese. Having a partner from the same country of origin compared to a different county of origin is associated with a 6% higher likelihood of being obese compared to healthy weight. A one year increase in the age gap between partners has a small but positive association with the likelihood of being obese compared to healthy weight. Thus, for men selection explains some but not all of the correlation in partner obesity. For women in Table 4, controlling for selection leads to a large reduction in the magnitude of the correlation coefficient for both overweight and obesity. The correlation in partner overweight and obesity is no longer significant for women. Differences in partner educational levels do not significantly impact the likelihood of being overweight or obese for women. The results suggest that for women time invariant characteristics related to BMI and selection explain the majority of the correlation found in the raw data and base model.

5.2 Stability:

Adding relationship length to the model does not change the correlation coefficients for overweight and obesity for men in Table 3. Compared to those in the healthy weight category each year of the relationship increases the likelihood that a man will be overweight by 8% and decreases the likelihood that he will be obese by 9%. This suggests that for men long term relationships may increase the likelihood of being overweight but not obese. The other variables related to selection are relatively similar in terms of magnitude and significance in this specification.

For women in Table 4, there is also no change in the significance or magnitude of the marginal effect on the correlation coefficient in partner obesity. Relationship length is not significant.

5.3 Social Obligation/Environment:

The final model tests for the moderating effect of social obligation/environment on the correlation in partner BMI categories. In Table 3 for men, in this model specification, the association between lagged partner overweight and current overweight status is again marginally significant. The positive and significant association between lagged partner obesity and current obesity is similar to what was seen in the stability and selection models. Having a partner from the same country has changed signs from the selection and stability model and is now significantly and negatively associated with the likelihood of being obese. In this specification, having a partner from the same country of origin is associated with a 5% lower likelihood of being overweight compared to healthy weight. Age gap is no longer significant in this model specification. Number of children is negatively and significantly associated with being overweight compared to healthy weight and the log of household income is positively and significantly associated with being overweight compared to healthy weight for men.

For women in Table 4, there is no change in the magnitude or significance of lagged partner BMI categories. None of the variables related to selection or relationship stability are significant. Living in a rural area compared to an urban area is negatively and marginally significantly associated with being overweight and positively and marginally significantly associated with the likelihood of being obese compared to healthy weight.

5.4 Cohabitation

In the base model, cohabitation is associated with a 6% reduction in the likelihood of being overweight for men. The cohabitation marginal effects are not significant in any other model specification for men. The cohabitation variable is not significantly associated with the likelihood of being overweight or obese for women in any model specification.

6. Discussion and Conclusion

Previous research (Averett et al. 2008, Wilson 2012) has found that married individuals tend to be heavier than their unmarried counterparts. However, especially for women, thinner women are more likely to get married than heavier women (Averett and Korenman 1994, Averett et al. 2008, Wilson 2012). The aim of this paper is to explore the correlation in partner BMI categories for couples in a long term stable relationship and to test the moderating effect of selection, relationship stability, and social obligation/environment on this correlation. As far as we are aware this is the first paper to look at correlations in partner BMI in couples in long term relationships. The analysis uses data from 2006-to 2011 from the HILDA survey.

The raw data shows that there is a higher probability for partner's to be in the same weight category with this relationship stronger at either end of the BMI spectrum. Suggesting that if there is selection on BMI this made at the start of the relationship rather than evolving with the relationship The raw data does not provide a clear picture if partner BMI is converging over time. . . In the base model the correlation in partner overweight and obesity is stronger for women than men. However, much of the correlation for women can be explained by selection. For men there is evidence of selection, but the correlation coefficient on partner obesity is significant in all model specifications. We find that for men relationship length is significantly associated with the likelihood of being overweight and obese. This appears to be a non-linear relationship where each additional year of a relationships is positively associated with the likelihood of being overweight and negatively associated with the likelihood of being obese than healthy weight in the stability models. For men, adding variables related to social obligation changes the magnitude and significance of some of the key variables. There is no significant difference between cohabiting and married couples in long term relationships after controlling for time invariant unobserved characteristics. This suggests that cohabiting couples in long term relationships may not be any different to those in legally married relationships.

Our findings on the correlation in partner obesity are significantly lower than results from a similar model estimated by Christakis and Fowler (2007) which found that if one's partner became obese this increased the likelihood that the individual would become obese by 37% and a symmetric effect for men and women. Christakis and Fowler estimate a univariate dynamic logistic, in which it would be expected that the coefficients would be larger than a probit model because a logit model has an exponential distribution function resulting in larger coefficients compared to a probit model which employs a normal distribution function, and use an American sample. Our results are similar to that of Kano (2008) and Brown et al. (2014) who found that the majority of the correlation in partner obesity could be explained by selection.

Our result suggest there may be some opportunity to target policies related to weight reduction at individuals in long term relationships who are more likely to be middle age and potentially starting to suffer from weight related health conditions. Interventions targeted at women may have a spillover effect on their partners, as the correlation in partner BMI outcomes goes beyond selection for men. Weight reduction interventions are more likely to be accessed by women than men (Booth et al. 2015). Public health interventions to reduce obesity targeted at women in long term stable relationships could be more effective at reducing the likelihood of becoming obese than targeting both partners. Women seem to have a slightly larger influence on their partner's likelihood of becoming obese. If women are able to influence their partner's behaviour this may also reduce both partners likelihood of becoming obese.

This study is able to shed some light on how long term relationships are associated with the correlation of BMI categories. As more waves of the HILDA become available it will be possible to empirically test the selection hypothesis to estimate a causal relationship between pre-relationship characteristics and overweight and obesity outcomes as the relationship progresses.

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Data collection for waves 9 to 12 is being undertaken by Roy Morgan Research, a private market research company, and The Nielsen Company collected waves 1 to 8. More information about the HILDA survey can be found at: http://www.melbourneinstitute.com/hilda/. The findings and views

reported in this paper, however, are those of the author and should not be attributed to either FaHCSIA or the Melbourne Institute.

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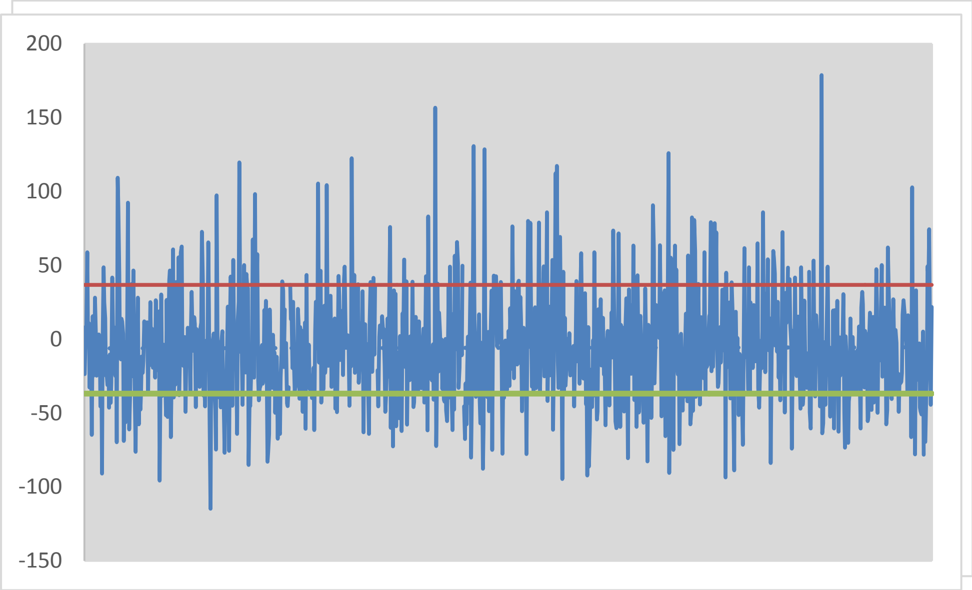
Figure 1: *Mean change in partner BMI between 2006-2011*



[a] Solid lines are one standard deviation above and below the mean change in partner BMI between 2006-2011

Table 1: *Descriptive Statistics*

	Males	Females
Healthyweight	0.28 (0.45)	0.46 (0.50)
Overweight	0.46 (0.50)	0.30 (0.46)
Obese	0.26 (0.44)	0.24 (0.43)
Age	45.57 (9.94)	43.39 (9.75)
Australian	0.78 (0.41)	0.78 (0.41)
Anglo-Saxon	0.11 (0.31)	0.09 (0.28)
Employed	0.88 (0.32)	0.73 (0.44)
Unemployed	0.01 (0.11)	0.02 (0.13)
Highschool	0.10 (0.29)	0.14 (0.35)
Some higher edu.	0.43 (0.49)	0.27 (0.45)
Degree	0.28 (0.45)	0.32 (0.46)
Household Characteristics		
Log(hhincome)	10.30 (0.66)	10.30 (0.66)
Number of children	1.31 (1.22)	1.40 (1.24)
Rural area	0.19 (0.39)	0.19 (0.39)
Relationship Characteristics		
Relationship length	16.47 (11.33)	16.47 (11.33)
Age relationship started	28.59 (7.51)	26.41 (6.92)
Cohabit	0.14 (0.34)	0.14 (0.34)
Partners diff edu	0.25 (0.43)	0.25 (0.43)
Partners same country	0.78 (0.42)	0.78 (0.42)
Sample Size	6573	6573

[a] Standard deviations are in parenthesis.
[b] The descriptive statistics are the mean across all waves that the variable is asked.
[c] Labour income and log of household income are measured in Australian dollars.
[d] Standard errors are in parenthesis.
[e] Sample size reported is n*T (i.e multiple observations for each couple)

Table 2: *Conditional Probabilities in BMI category distribution between partners*

	Male Healthy BMI	Male Overweight	Male Obese
Female Healthy BMI	**0.60**	0.43	0.35
Female Overweight	0.26	0.33	0.28
Female Obese	0.14	0.24	**0.37**

Note: This table is based upon the probability of a man being in a given weight category conditional on his partner being in a given weight category. For example given a woman is healthy weight there is a 60% probability that her partner will also be healthy weight.

Table 3: *Male models of the correlation in partner BMI*

	Base	Base	Selection	Selection	Stability	Stability	Obligation	Obligation
Variables	Overweight	Obese	Overweight	Obese	Overweight	Obese	Overweight	Obese
$Overweight_{pt-1}$	0.04**	0.004	0.02	-0.01	0.02	-0.01	0.03*	-0.0001
	(0.02)	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)
$Obese_{pt-1}$	0.01	0.09***	-0.05	0.06**	-0.05	0.06**	-0.04	0.05**
	(0.02)	(0.02)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.02)
Cohabit	-0.06**	-0.04	-0.05	-0.01	0.0004	-0.06	-0.04	-0.04
	(0.02)	(0.02)	(0.07)	(0.06)	(0.07)	(0.07)	(0.06)	(0.04)
Age gap			-0.002	0.003**	0.003	0.004**	0.001	0.002
			(0.002)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)
Age relationship start			-0.003**	0.001	0.0001	-0.01	0.002	-0.002
			(0.001)	(0.001)	(0.003)	(0.003)	(0.003)	(0.002)
Partners same country			-0.02	0.06**	-0.01	0.05**	0.02	-0.05**
			(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Partners diff. edu.			-0.04**	0.03**	-0.04**	0.02*	-0.03	0.004
			(0.02)	(0.01)	(0.02)	(0.01)	(0.02)	(0.02)
Relationship length					0.08**	-0.09**	0.01**	-0.002
					(0.02)	(0.02)	(0.003)	(0.02)

Table 3: *Male models of the correlation in partner BMI (Continued)*

Number children							-0.02**	-0.005
							(0.01)	(0.05)
Rural							0.02	0.0001
							(0.02)	(0.01)
Log of hhincome							0.02*	0.01
							(0.01)	(0.01)
Log-Likelihood	-3201.87	-3201.87	-2833.26	-2833.26	-2828.52	-2828.52	-2841.70	-2841.70
n	5264	5264	4760	4760	4760	4760	4760	4760

[a] Marginal effects are shown.
[b]Standard errors are in parenthesis.
[c] *** p<0.01, ** p<0.05, * p<0.10.
[d] The other control variables are shown in Appendix B.
[e] Sample size for men and women is not the same because of missing variables

Table 4: *Female models of the correlation in partner BMI*

	Base	Base	Selection	Selection	Stability	Stability	Obligation	Obligation
Variables	Overweight	Obese	Overweight	Obese	Overweight	Obese	Overweight	Obese
Overweight$_{pt-1}$	-0.36***	0.11***	-0.01	0.003	-0.01	0.003	-0.01	0.003
	(0.002)	(0.01)	(0.01)	(0.003)	(0.01)	(0.003)	(0.01)	(0.003)
Obese$_{pt-1}$	-0.74***	0.24***	-0.005	0.002	-0.005	0.002	-0.01	0.002
	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Cohabit	-0.01	0.003	0.02	-0.01	0.02	-0.01	0.01	-0.01
	(0.01)	(0.003)	(0.03)	(0.01)	(0.03)	(0.01)	(0.03)	(0.01)
Age gap			0.001	-0.002	0.00005	-0.0001	0.0003	-0.0001
			(0.001)	(0.003)	(0.001)	(0.0002)	(0.001)	(0.0002)
Age relationship start			0.0003	0.0001	0.0003	0.0001	0.0002	0.0001
			(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.01)	(0.0001)
Partners same country			-0.01	0.003	-0.01	0.003	-0.01	0.002
			(0.01)	(0.003)	(0.01)	(0.003)	(0.01)	(0.003)
Partners diff. edu.			-0.002	-0.002	-0.002	0.001	-0.002	0.001
			(0.001)	(0.001)	(0.001)	(0.002)	(0.01)	(0.002)
Relationship Length					-0.01	0.004	-0.01	0.004

Table 4: *Female models of the correlation in partner BMI (Continued)*

					(0.002)	(0.01)	(0.02)	(0.01)
Number children							0.01	-0.002
							(0.01)	(0.003)
Rural							-0.05*	0.02*
							(0.02)	(0.01)
Log of hhincome							0.003	-0.001
							(0.01)	(0.004)
Log-Likelihood	-2813.73	-2813.73	-1580.99	-1580.99	-1580.83	-1580.83	-1579.65	-1579.65
n	5216	5216	4729	4729	4729	4729	4729	4729

[a] Marginal effects are shown.
[b]Standard errors are in parenthesis.
[c] *** p<0.01, ** p<0.05, * p<0.10.
[d] The other control variables are shown in Appendix B.
[e] Sample size for men and women is not the same because of missing variables

Appendix A: *Variable List and Description*

Variable	Description	HILDA code
Dependent Variable		
Obese	0-BMI <=29.9 kg/m^2 1-BMI >=30 kg/m^2	bmi
Individual Characteristics		
Age	Age in years	hgage
Australian	0=Not born in Australia 1=Born in Australia	ancob
Anglo-Saxon	0=Not born in an English speaking country (excluding Australia) 1=Born in an English speaking country (excluding Australia)	ancob
Employed	0=Unemployed/Not in the labour force 1=Employed	esbrd
Unemployed	0=Employed/Not in the labour force 1=Employed	esbrd
Highschool	0=No qualifications 1=High school degree equivalent (year 12 education)	edhigh
Some higher edu.	0=No qualifications 1=Certificates I-IV, Diploma, Advanced Diploma	edhigh
Degree	0=No qualifications 1=First degree or higher	edhigh
Household Characteristics		
Loghhincome	Log(Household income/household size)	Hifefp/hhpers
Number of children	Number of dependent children in the household	tcr
Rural area	0=Lives in urban or bounded locality, or is migratory 1=Lives in rural area	hhsos
Relationship Characteristics		
Relationship length	Marriage length +years cohabitated before married (if married) OR Years cohabited (if cohabiting and not legally married)	mrcdur+ mrplvt OR orcdur
Age relationship started	Age-relationship length	hgage- mrcdur+ mrplvt OR hgage- orcdur
Cohabit	0=Married 1=Currently cohabiting	mrcurr
Partners diff edu	0=Partners have different levels of educational attainment 1=Partners have same level of educational attainment	edhigh-edhigh partner
Partners same country	0=Partners from different countries of origin 1=Partners from same country of origin	

Appendix B: *Additional Results from Base, Selection, Stability, and Social Obligation Models*

	Base	Base	Matching	Matching	Stability	Stability	Obligation	Obligation
	Overweight	Obese	Overweight	Obese	Overweight	Obese	Overweight	Obese
MEN								
Age	-0.01	0.01	0.02	0.001	-0.05*	0.09***	-0.05*	0.09***
	(0.01)	(0.01)	(0.02)	(0.01)	(0.03)	(0.03)	(0.03)	(0.03)
Age Squared	0.0001	-0.0001	-0.0003	0.0001	-0.0003	0.0001	-0.0003	0.0001
	(0.00001)	(0.00001)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Australian	-0.03	0.11***	-0.002	0.05**	-0.002	0.05**	0.003	0.05**
	(0.03)	(0.03)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Anglo-Saxon	-0.11**	0.14***	-0.08**	0.12***	-0.07**	0.11**	-0.07**	0.09***
	(0.03)	(0.03)	(0.03)	(0.02)	(0.03)	(0.03)	(0.03)	(0.03)
Employed	0.04	-0.02	0.03	-0.004	0.03	-0.003	0.03	0.001
	(0.02)	(0.02)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Unemployed	0.09	-0.05	0.07	-0.03	0.06	-0.03	0.06	-0.02
	(0.06)	(0.05)	(0.07)	(0.06)	(0.07)	(0.06)	(0.07)	(0.06)
Highschool	0.14***	-0.27***	0.15***	-0.31***	0.13**	-0.28**	0.13***	-0.27***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.02)
Some higher edu.	0.04**	-0.08***	0.02	-0.09***	0.01	-0.07	-0.0006	-0.05**
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Degree	0.10***	-0.24***	0.11***	-0.23***	0.10**	-0.22**	0.09***	-0.19***
	(0.02)	(0.02)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.02)
Women:								
Age	0.001	-0.0004	-0.03***	0.01**	-0.02	0.01	-0.03	0.01
	(0.004)	(0.01)	(0.01)	(0.004)	(0.02)	(0.01)	(0.02)	(0.01)
Age Squared	-0.00001	0.00004	0.0002**	0.0001*	0.0002**	-0.0001**	0.0003**	-0.0001**
	(0.00004)	(0.00001)	(0.0001)	(0.00004)	(0.0001)	(0.00004)	(0.0001)	(0.00004)
Australian	-0.03**	0.01**	-0.001	0.0002	-0.001	0.0002	-0.001	0.0004
	(0.01)	(0.004)	(0.01)	(0.003)	(0.01)	(0.003)	(0.01)	(0.003)
Anglo-Saxon	-0.01	0.004	-0.01	0.003	-0.01	0.003	-0.01	0.002
	(0.02)	(0.01)	(0.01)	(0.004)	(0.01)	(0.005)	(0.01)	(0.005)
Employed	0.01	-0.002	0.003	-0.001	0.003	-0.001	0.004	-0.001
	(0.01)	(0.003)	(0.01)	(0.004)	(0.01)	(0.004)	(0.01)	(0.004)
Unemployed	0.04	-0.01	0.02	-0.01	0.02	-0.01	0.02	-0.01
	(0.03)	(0.01)	(0.03)	(0.01)	(0.03)	(0.01)	(0.03)	(0.01)
Highschool	0.01	-0.005	-0.001	0.0004	-0.001	0.0005	-0.002	0.001
	(0.01)	(0.004)	(0.01)	(0.003)	(0.01)	(0.003)	(0.01)	(0.003)

Appendix B: *Additional Results from Base, Selection, Stability, and Social Obligation Models (Continued)*

Some higher edu.	0.01							
		-0.002	-0.0001	0.00002	-0.0002	0.0001	-0.001	0.0002
	(0.01)	(0.003)	(0.01)	(0.003)	(0.01)	(0.003)	(0.01)	(0.003)
Degree	-0.01	-0.01**	0.01	-0.002	0.01	-0.002	0.01	-0.002
	(0.01)	(0.003)	(0.01)	(0.003)	(0.01)	(0.003)	(0.01)	(0.003)

[a] Marginal effects are shown.
[b]Standard errors are in parenthesis.
[c] *** p<0.01, ** p<0.05, * p<0.10.

Appendix C: *Marginal Effects of Means of Time Varying Variables for Matching, Stability, and Social Obligation Models*

	Matching	Matching	Stability	Stability	Obligation	Obligation
	Overweight	Obese	Overweight	Obese	Overweight	Obese
MEN						
Mean Age	-0.05**	0.03	0.03	-0.07*	0.02	-0.06*
	(0.02)	(0.02)	(0.03)	(0.03)	(0.03)	(0.02)
Mean Age Squared	0.0001**	-0.0003	0.001**	-0.0004**	0.0001**	-0.0004**
	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Mean lagged BMI category	0.04*	0.04**	0.04*	0.03*	0.03*	0.04*
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Mean Employed	0.04	-0.03	0.07	-0.06	0.05	-0.03
	(0.05)	(0.04)	(0.05)	(0.04)	(0.05)	(0.04)
Mean Unemployed	0.20	-0.05	0.21	-0.07	0.22	-0.06
	(0.15)	(0.14)	(0.15)	(0.14)	(0.16)	(0.14)
Mean log hhincome	-0.02	0.01	-0.02	0.01	-0.01	-0.02
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Mean Rural	0.06	-0.13**	0.07	-0.13**	0.06	-0.11**
	(0.05)	(0.04)	(0.05)	(0.04)	(0.05)	(0.04)
Mean Marriage Duration			-0.07**	0.09***	0.08**	0.08***
			(0.02)	(0.02)	(0.02)	(0.02)
Mean Number Children					0.01	-0.01
					(0.02)	(0.01)
Women:						
Mean Age	0.04***	-0.01**	0.03	-0.01	0.03	-0.01
	(0.01)	(0.004)	(0.02)	(0.01)	(0.02)	(0.01)
Mean Age Squared	0.0003	0.00001	0.0003	0.00001	-0.0002*	0.00001
	(0.0001)	(0.00004)	(0.0001)	(0.00004)	(0.0001)	(0.00004)
Mean lagged BMI category	-0.38***	0.13***	-0.38***	0.13***	-0.38***	0.13***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Mean Employed	-0.01	0.004	-0.01	0.004	-0.01	0.005
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)
Mean Unemployed	-0.05	0.02	-0.05	0.02	-0.05	0.02
	(0.05)	(0.02)	(0.05)	(0.02)	(0.05)	(0.02)
Mean log hhincome	-0.0004	0.0002	-0.0004	0.0001	0.002	0.0001
	(0.01)	(0.004)	(0.01)	(0.004)	(0.01)	(0.004)
Mean Rural	0.05*	-0.02*	0.05*	-0.02*	0.05*	-0.02*
	(0.03)	(0.01)	(0.03)	(0.01)	(0.03)	(0.01)
Mean Marriage Duration			0.01	-0.004	0.01	-0.004

Appendix C: *Marginal Effects of Means of Time Varying Variables for Matching, Stability, and Social Obligation Models*

	(0.02)	(0.01)	(0.02)	(0.01)
Mean Number Children			-0.003	0.001
			(0.01)	(0.003)