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Household Income during Childhood and Young Adult Weight Status: Evidence from a Nutrition Transition Setting*

KAMMI SCHMEER

The Ohio State University

Abstract

This article explores whether household income at different stages of childhood is associated with weight status in early adulthood in a nutrition transition setting (developing countries with both underweight and overweight populations). I use multinomial logistic regression to analyze prospective, longitudinal data from Cebu, Philippines. Results suggest that increasing prenatal income is associated with lower risk of being underweight at age 21, while increasing income during childhood is associated with an increased risk of being overweight at age 21. When gender differences are considered, prenatal income has an important protective effect against the risk of being overweight for girls. Prenatal income has little effect on boys' overweight status, but early childhood income increases the risk of becoming overweight for boys. For both boys and girls, income in mid-childhood (ages 9–12) is associated with a particularly high risk of becoming overweight by age 21, net of earlier income. These results suggest that, in this nutrition transition setting, childhood income operates through complex developmental and behavioral mechanisms to affect early adult overweight status; and that increasing household income after birth may do little to prevent underweight status in early adulthood in these settings.

Research across settings suggests that abnormal body mass index (BMI) can have serious consequences on individual well-being. Young adults with exceedingly low or high BMI may have worse jobs or job conditions (Carr and Friedman 2005; Tunceli, Li, and Williams 2006) and lower health-related quality of life (Sach et al. 2007). Abnormal BMI also directly reduces life chances, increasing health risks and illnesses and reducing life expectancy (Flegal et al. 2005; Katzmarzyk, Craig, and Bouchard 2001; Khongsdier 2002).

Developing countries undergoing the nutrition transition have complex BMI-related public health issues, as a large underweight population coexists with a growing overweight population. In such settings, it is not yet clear how increasing household income (often a strategy of social policies and a result of country-level development) may impact individuals' risk of becoming underweight or overweight in adulthood. Of particular interest

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Address correspondence to Kammi Schmeer, Department of Sociology, The Ohio State University, 238 Townshend Hall, 1885 Neil Ave., Columbus, OH 43210 (schmeer.1@sociology.osu.edu)..

Kammi Schmeer is an Assistant Professor of Sociology and affiliate of the Initiative in Population Research at The Ohio State University. Her research focuses on household dynamics and child health.

here is the impact of childhood household resources, when individuals are in their formative stages, on young adult weight status. Although a few studies have addressed this question in developed countries, we know little about the role of childhood income in affecting both under- and overweight problems in developing country settings.

To address this gap in the literature, this article uses prospective, longitudinal data collected over 22 years to assess whether and when childhood income affects young adult weight status in Cebu, Philippines. During the study period (1983–2005), the Philippines experienced extensive social change and economic growth, and Metro Cebu was one of the fastest economic growth areas in the country. Rapid development, modernization, and social change have converged to produce a “nutritional transition” in the Philippines, institutionalizing new consumption patterns and ways of spending work and leisure time. The result has been increased consumption of high fat, high sugar diets, reduced physical activity, and a growing prevalence of obesity and related chronic illnesses (Popkin 2001; Popkin and Gordon-Larsen 2004). Evidence of the nutritional transition and its impact on the body mass of children and young adults in the Philippines is clear: in 1998, 36 percent of individuals aged 13–19 were underweight and 5.8 percent of individuals aged 13–19 were overweight or obese. These weight problems continue into adulthood, with 12 percent of Filipino adults underweight and 17 percent overweight (Food and Agricultural Organization [FOA] of the United Nations 2001). These trends have been evident in Cebu as well, which has both large undernourished and growing overweight populations (Adair 2004; FAO 2001; Ricci and Becker 1996).

The main contribution of this article is to evaluate the relative impact of household income at multiple stages of childhood on weight status in early adulthood (age 21) in this nutrition transition setting. Being able to identify stages of childhood when income matters can improve our understanding of the development of adult weight status problems and allow for possible targeting of government or other assistance during critical periods. The nutrition transition setting allows for a study of both underweight and overweight problems in the same sample as well as the opportunity to compare results with those from developed countries to assess whether similar patterns hold across settings.

BACKGROUND

Childhood Income and Young Adult Weight Status

In developed countries, poorer children are more likely to have an unhealthy food environment, consume high fat and sugar foods, get less exercise, and be at risk for obesity in childhood and adulthood (Armstrong et al. 2003; MacFarlane et al. 2007; Riediger, Shooshtari, and Moghadasian 2007). In such settings, there is evidence that lower childhood socioeconomic status (SES) increases the risk of becoming an overweight or obese adult (James et al. 2006; Parsons et al. 1999; Power and Parsons 2000; Power et al. 2005; Salsberry and Reagan 2007; Ziol-Guest, Duncan, and Kalil 2009).

In developing countries, however, having fewer resources during childhood traditionally has been linked with stunting and wasting during childhood, and to underweight adults through difficult-to-change growth trajectories (Alderman, Hoddinott, and Kinsey 2006; Martorell

and Habicht 1986). However, as the nutrition transition has taken hold in these settings, increasing household income may carry risks of adult overweight problems. In many developing countries, as household income rises, so too does the intake of “modern” foods (higher in fat and sugar than traditional foods), as well as more sedentary lifestyles, creating an environment for unhealthy weight gain and related health problems (Popkin 2001). Thus, in nutrition transition settings childhood income may be an important determinant of both underweight and overweight status in young adulthood.

One of the few empirical studies of childhood SES on early adult BMI in a developing country setting used data from Cebu, Philippines (the data utilized here) and found that both higher prenatal SES and SES change from the prenatal period to age 19 increased BMI in males and reduced BMI in females at age 21 (Adair 2007). However, the use of linear BMI rather than weight categories leaves the question of whether SES in childhood is associated with abnormally low and high BMI (i.e., underweight and overweight status) in early adulthood. Further, the effect of SES was not the focus of the article (it was a control variable), and thus the author did not test for household income effects (only an aggregate SES measure), nor timing differences across multiple periods of childhood, which are the aims of this study.

Timing Matters

Childhood involves multiple periods of physical development and parental and individual behavioral changes as infants grow into children and then into adolescents. Thus, there is reason to believe that household resources may have different associations with adult outcomes, depending on when they were available during childhood. Developmental research suggests that household resources as far back as the prenatal period may affect adult BMI by affecting womb conditions that may affect individuals’ risk of obesity later in life (Barker 1990; Bettiol et al. 2007). After birth, in infancy and early childhood, resources may affect both underweight and overweight status. Traditional malnutrition research suggests that lack of resources in early periods of childhood could result in growth restrictions that are too severe to overcome later in childhood (Alderman et al. 2006). This stage also encompasses the period of adiposity rebound, when children's BMI begins to increase (ages 4–6) following a period of decline (from birth). Research suggests that earlier adiposity rebounding (before ages 4 or 5) is linked with higher risk of adult obesity (Adair 2008; Jones-Smith, Fernald, and Neufeld 2007; Rolland-Cachera et al. 1994; Whitaker et al. 1998). Thus, in a nutrition transition setting, increasing household income during early childhood may be associated with both preventing underweight status and increasing the risk of overweight status in young adulthood.

Mid- and late childhood include extensive physical change and growth (i.e., puberty), as well as children taking on more of their own health behaviors and decision-making, which may cumulate or alter children's path to adult weight status. In developing country settings, it may be that increasing income in mid- and late childhood allows children to make up some of the growth lost earlier in childhood, reducing the chance of being underweight in early adulthood (Adair 1999; Eckhardt 2004). However, increasing income may also induce unhealthy eating and exercise behaviors, increasing individuals’ risk of becoming

overweight by early adulthood. Further, the pubertal growth spurt in mid-childhood (ages 9–15) has been cited as a key time when changes in BMI may affect the risk of becoming overweight in adulthood (Adair 2008). For these reasons, household income at later stages of childhood may be important in determining early adult weight status as well.

Research also suggests that these timing patterns may differ by gender due to biological differences in growth and gendered norms and behaviors (Sweeting 2008). In early childhood, gender norms may affect parental feeding behaviors, especially if boys are expected to need more food than girls. As they age, boys may be more likely to increase their consumption with increases in income, since gender norms may favor “bigger” boys than bigger girls. With more pressure to be thin girls may be less likely to use increases in income to increase their food intake. The timing of the income effects in mid- to late childhood may also differ by gender because girls experience puberty earlier (around ages 9–15) than boys do (around ages 12–16).

There are very few studies that have addressed the issue of timing of childhood income (or any socioeconomic status measure) on early adult weight status. One recent study from the United States found early (prenatal to age 1) income to be related to adult obesity, while income between ages 1 and 5 and 6 and 15 was not (Ziol-Guest et al. 2009). Research from the British cohort study, however, found that higher parental social class at birth was important for reducing adult male risk of obesity, while parental social class at age 7 lowered the chance of adult obesity among females (Power, Manor, and Matthews 2003). Taken together, developed country research suggests that childhood economic resources matter for adult overweight status; and that timing is important and may work differently by setting and gender.

This study furthers the literature in this area by assessing whether and when childhood household income is associated with early adult weight status in a nutrition transition setting. In addition to timing, we also consider differences in the effects of income by gender and weight status (under- vs. overweight). Addressing the distinct income effects for the two extremes of BMI (under- and overweight) in the same sample is possible only with longitudinal data from a nutrition transition setting. These settings have the further advantage of experiencing extensive social and economic change that may result in more dynamic household income over time, allowing for distinguishing among income effects at different stages of childhood.

METHODS

Data

The data used in this study are from the Cebu Longitudinal Health and Nutrition Study, a study following children born to all pregnant women in 33 randomly selected barangays (17 urban and 16 rural) in metro Cebu in 1983 and 1984 (Adair and Popkin 2001). Community (i.e., barangay), household, and index child information was gathered for the resulting 3,080 live, singleton births at multiple points during the child's life in follow-up surveys. This study uses data from the waves collected during the prenatal period, and at average ages 2, 9, 12, 16, 19, and 21. This high quality prospective information on

household resources and health status throughout childhood (beginning prenatally) and into early adulthood provides an excellent opportunity to investigate the relationship between childhood income and early adult weight status in a nutrition transition setting.

By 2005, 1,886 of the original children remained in the study with valid body mass index (BMI). Seventy-three had invalid BMI measures due to being pregnant at the time of the survey. An additional 219 children had valid 2002 BMI measures, which were used in place of missing 2005 BMI measures to bring the sample up to 2,032. Of these, 21 were missing independent variables used in the analysis. Cases with missing dependent or independent variables were dropped, yielding a final sample of 2,011 children. The missing cases were more likely than those children remaining in the sample by 2005 to speak an ethnic language, have slightly more maternal education (0.3 year difference), have fewer siblings by age two (0.3 difference), and have lived in a more urban area at birth. The missing children did not differ from those included in the analysis on BMI during childhood, maternal BMI, maternal age, maternal work status, or birth order.

The dependent variable is a categorical weight status variable (underweight, overweight, or normal weight) based on body mass index (BMI), which is calculated as weight (in kilograms) divided by height (in meters) squared. Both weight and height were assessed by trained personnel (rather than self-reports). Based on international cutoffs, an individual is considered to be underweight if BMI is less than 18.5 and overweight if BMI is greater than 25 (Cole et al. 2000).¹ Those between 18.5 and 25 are considered to have normal body mass. These categorical BMI measures are used to focus on the risk of becoming unhealthy (i.e., BMI greater or less than certain cutoffs that indicate health problems) rather than growth (i.e., increases or decreases in linear BMI over time). In conducting robustness tests, the linear BMI models were consistent with the findings from the categorical models, but yielded little insight into the early adult health problems of interest (i.e., overweight or underweight). For conceptual reasons, then, the categorical BMI measures are preferred. Consistent with the nutrition transition, by average age 21 about 21 percent of the individuals in the sample are underweight, while 9 percent are entering adulthood as overweight or obese. (This is the opposite of developed countries such as the United States, where rates of underweight are low and a large portion of the population is overweight or obese.) The Cebu sample also shows a relatively large gender difference in underweight but not overweight status: by age 21, 28% of women and 14% of men were underweight; and, 8% of women and 10% of men were overweight.

Household income was collected consistently across survey waves by asking the respondent (usually the mother) to enumerate income earned for various types of economic activities for each household member. Individual income was summed to produce weekly household income, which was converted into per capita income by dividing total household income

¹Using a BMI cutoff of 23 for overweight status (some evidence suggests BMI > 23 can be unhealthy for Asians) was considered, but the preference was for the more standard and well-tested BMI > 25 cutoff for overweight status. There is little agreement on different cutoff points for specific populations (e.g., the many populations within Asia), and no evidence that the Philippines has a specific lower cutoff for obesity. Since there is more evidence to support BMI > 25 as a real health disadvantage across settings, the World Health Organization recommends the use of BMI > 25 for defining overweight status (WHO 2004). Further, using this measure makes this study more comparable to other studies of obesity. However, I did test the models with overweight defined as BMI > 23 and the results are consistent with the results using the BMI > 25 cutoff point.

(adjusted to 1983 pesos) by the number of household members. All per capita income measures were given a minimum value of 1 and a maximum value of 500 pesos, and were then logged to adjust for the skewed distributions.

Table 1 provides the mean values of logged per capita household income during childhood for the sample (in pesos). The mean (and median) household income across childhood for this sample is 46 pesos, or about \$4.25 per person, per week. Table 1 illustrates that in this sample: per capita household income increases, on average, from early to late childhood, reflecting both the economic development of Cebu from 1983 to 2002 and the aging of the sample households. There is also significant change in per capita household income at the individual level (not shown in Table 1), with the sample children experiencing, on average, a 14 percent increase in income between early and late childhood. This average percent change includes both gains and losses over time: twenty-five percent of the sample children experience a 30 percent or greater loss of household income, while 25 percent experienced a 40 percent or larger gain in household income. The dynamic childhood household economic environment in this sample indicates the importance of taking a longitudinal view of household economic resources, even among these relatively poor households; and, it allows for testing timing effects of household income across stages of childhood.

Analytic Strategy

The effects of income at various childhood stages on early adult weight status is assessed through multinomial logistic regression analysis, which uses maximum likelihood to estimate the log-odds of being in a given weight category (underweight, overweight) compared with the reference category (normal BMI). This allows for separate slope estimates for both under- and overweight, and for a comparison to the ideal group, young adults with normal BMI (Long 1997).

The models were tested for different functional forms of income, with the preferred functional form (in terms of fit and significance) being logged per capita income with splines for high and low prenatal, mid-childhood, and late childhood income (early childhood income fit better as a continuous variable). The splines allow for different coefficients for households below and above the spline knots. The location of the spline knot was determined by significance and model fit, and differed by stage of childhood: prenatal income was divided at 16 pesos (\$1.50) per person per week (about 18% of sample was at or below this level); mid-childhood income at 33 pesos (about \$3) per person per week (30% of sample was at or below this level); and late childhood income measure was split at 45 pesos (about \$4) per person per week (47% of the households were at or below this level). The spline coefficients represent the effects of a one unit increase in logged per capita income on weight status for households at or below the spline knot (i.e., low) and above the knot (i.e., high).

The models test both the total and direct effects of household income at different stages. The total effects assess how income at a given stage is associated with weight status with no other income measures in the model. The direct effects models, which aim to test whether income matters at a given stage controlling for past income, include measures of income at multiple stages. In these models, multicollinearity among the income measures is an issue.

The highest correlation is between high-mid and high-late childhood income, with a correlation of $r = .65$, while the other measures are correlated at less than $r = .5$ (see Table 2). A recently published study suggested that even with high ($r = .7$) correlations in their income measures, the individual level variance over time allowed for including multiple income measures in the model at the same time (Ziol-Guest et al. 2009). As previously mentioned, there is extensive individual-level variation in household income in this sample. Further, the total effects models provide comparative models to assess whether multicollinearity is strongly influencing the results.

All models control for potential confounders by including multiple control variables: gender (female is the reference group), status as first-born child, exact age when BMI was assessed, number of siblings at age two, maternal age at birth, maternal indigenous status, maternal BMI at child's age two, maternal education (dummy of over 7 years, the sample mean, of schooling), whether the child lived in an extended family household at birth, whether the mother ever changed spouses, whether the child was ever living in a household other than his or her mother's household, and dummy variables for the community in which the child lived at birth. To address the question of gender differences in income effects, gender-by-income interaction terms were included in the final models (with all income variables included). For brevity, these models are not shown, but a summary of the results is provided in Table 5. I assessed significance of the coefficients in all models using two-tailed tests at an alpha level of $p < .05$.

RESULTS

The regression results are provided in Tables 3–5 in the form of relative risk ratios (i.e., exponentiated coefficients), which indicate the probability of being either underweight (first column for each model) or overweight (second column for each model) divided by the probability of being of normal weight status at age 21. Ratios between zero and one represent negative effects, and ratios greater than one indicate positive effects. Since the income variables are in log form, the effects shown represent the change in the relative risk ratio with a 1 percent increase in per capita household income.

Table 3 shows the total effects of household income averaged across childhood and by specific stages. Model 1 indicates that increasing average childhood income by 1 percent is associated with more than a two-fold increase in the risk of becoming overweight, but has no effect on being underweight by average age 21. This indicates that income may be used during childhood for foods that promote overnutrition, or that children living in households that are generally wealthier over the 19-year period have lifestyles that are associated with overweight risk factors (more sedentary behaviors, TV watching, etc.). It is important to note that this relatively large effect of childhood income on overweight status at age 21 is net of maternal BMI at baseline. Surprisingly, average childhood income does little to prevent underweight status in early adulthood.

Models 2–5 further specify household income effects by stage of childhood, illustrating that average childhood income masks significant stage differences. As model 2 indicates, when prenatal income is considered apart from the rest of childhood income, it appears to reduce

the risk of being underweight in adulthood, although only for children born to households in the top 80 percent of the income distribution (i.e., it does not help the poorest children). Later household income in early, mid-, and late childhood, however, is not associated with underweight status in early adulthood. Models 3–5 further illustrate that in this nutrition transition setting, household income in early, mid-, and late childhood are all associated with an increase in the risk of becoming overweight in early adulthood. These effects differ somewhat by stage of childhood and household income level, where increasing income during mid childhood in lower-income households seems to have a particularly strong effect on young adult overweight status (see Table 3, model 4). The control variables indicate, among other things, that women are more likely than men to be underweight at age 21 (perhaps due to gender-based body images), and that mothers' BMI at baseline is an important predictor of their children's weight status in young adulthood.

Table 4 shows the results of a more rigorous test of the timing effects, with multiple income measures entered concurrently in the model predicting early adult weight status. Although multicollinearity may be an issue, the Pearson correlation coefficients in Table 2 indicate relatively low correlations across these measures, with the exception of high-mid and high-late childhood income ($r = .65$). The underweight results in models 1 and 2 illustrate that prenatal income in higher-income households has a significant protective effect, reducing the risk of becoming an underweight young adult, even when controlling for subsequent household income.

Table 4 also shows that higher income in early, mid-, and late childhood has a positive effect on the risk of becoming overweight by age 21 even when controlling for prenatal household income. Further, these effects are additive since many remain statistically significant even when income measures at multiple stages are included in the model. The overweight results further indicate that when controlling for income through childhood, increasing income in very low-income households during the prenatal period may be protective of early adult overweight status (see Table 4).

In model 1, mid-childhood (ages 9–12) stands out as a particularly risky time for increases in household income (when a 1% increase in household per capita income is associated with a 3.5-fold increase in the risk of being overweight in lower income households and a 1.5 increase in higher income households). Model 2 adds the late childhood income splines to the model, illustrating that later childhood (age 16–19) household income is associated with an increased risk of becoming overweight by age 21, regardless of past childhood income, and is in addition to the mid-childhood income effect. The model also indicates that in lower income households, mid-childhood income does not seem to be working through late childhood income, but rather is an important stage-specific effect. As noted at the bottom of Table 4, most of these stage-specific effects are statistically different from one another.

A final question I pose is whether there are significant differences in childhood household income effects on early adult weight status by gender in this nutrition transition setting. Table 5 summarizes the results from models that included gender-by-income interaction terms (full models not shown). The effects of income on underweight status did not differ by gender; however, several income-by-gender interactions were significant for overweight

status. The significant interaction terms indicate that women are more likely to be protected from early adult overweight status by prenatal income (in all households) while men are not. Men, on the other hand, are more likely to be at increased risk of overweight status in early adulthood with increases in income in early childhood. The strong middle childhood income effect does not differ by gender, but late childhood income matters more for men's than women's overweight status. This may be due in part to puberty occurring later for boys, or to girls' efforts to lose weight in higher income households during late adolescence. The significant gender interaction for underweight status during this stage of childhood supports the latter explanation, where increasing income in the higher income households seems to be associated with a higher risk of becoming underweight by age 21 among women but not men (although the coefficients are not significantly different from 0).

In sum, in this nutrition transition setting, childhood income matters for the development of abnormal BMI in early adulthood. Only prenatal income in higher income households is related to a lower risk of becoming an underweight young adult, while income at multiple stages of childhood has additive effects on the risk of becoming overweight by age 21. The associations between childhood household income and early adult overweight status are complex, depending on when income is experienced, the income level of the household, and the child's gender.

CONCLUSION

This article investigated how childhood household income in the prenatal, early childhood, mid-childhood, and late childhood stages was associated with individuals' weight status at age 21 in a nutrition transition setting. Utilizing data from the Philippines (a country experiencing both under- and overnutrition problems) allowed for a comparison of the effects of income at both ends of the BMI spectrum in the same sample and for individuals experiencing extensive changes in childhood income.

The findings from this study illustrate that childhood income can work in multiple ways, differing across stages of childhood, by gender, and for different outcomes. The effect of prenatal income on underweight status in early adulthood (net of income at other stages) supports the idea that economic resources are important for preventing undernutrition in developing country settings, and that stunting and wasting are established early in life and can be difficult to overcome later in childhood (Alderman et al. 2006; Martorell and Habicht 1986). However, this protective effect of household income was not present in the poorest 18 percent of households, indicating that other factors may be important for decreasing undernutrition among children born in the poorest households.

At the other end of the BMI spectrum, the results suggested a consistent and strong association between childhood income and increasing risk of becoming overweight. Although this is the opposite of developed country findings, it is what would be expected in a nutrition transitions setting where income is increasingly used for processed, sugary foods and to promote more sedentary lifestyles. The timing models were important, revealing details about when household income may have put children on a path to early adult overweight status. Prenatal income was associated with a lower risk of overweight status at

age 21 when controlling for subsequent income and maternal BMI. The long-term effect of prenatal income on overweight status is consistent with the idea that the lack of resources prenatally could lead to abnormal BMI later in life through developmental mechanisms, which include restricted fetal growth coupled with accelerated infant growth (Barker 1990; Bettiol et al. 2007; Dietz 1994). A similar result was found in a recent study in a sample of children born between 1968 and 1975 in the United States, although maternal BMI was not controlled for (Ziol-Guest et al. 2009). This consistency suggests that low income in the prenatal years may affect later life overweight and obesity through biological pathways that hold across social settings.

When interacted with gender, however, the negative effect of prenatal income on overweight status held only for women in this sample. One question this study generated, then, is why there is no evidence of this prenatal income effect for men (the Ziol-Guest et al. study did not test for gender differences). No other study has tested gender differences in the effects of prenatal income, net of income at other stages. Based on the findings here, it may be that in the Philippines (and possibly elsewhere) girls are allocated fewer resources than boys during infancy and early childhood, and thus having sufficient prenatal income may be critical in establishing girls' healthy weight trajectories early on.

Early childhood (age 2) income was more important for men's overweight status than prenatal income, but worked to increase rather than decrease the risk. This is consistent with what was found by a British cohort study: that SES at birth was positively associated with later life BMI for boys but not girls (Power et al. 2003). For boys, the early childhood income effects are consistent with the theories that more rapid growth during early childhood may result in a higher risk of later overweight status. Thus, early childhood may be an important developmental period when higher income produces parental infant feeding patterns that set boys at risk for early adult overweight status.

The stage-specific models also suggested that there are mid- and late childhood income effects in addition to early income effects. Household income during middle childhood (ages 9–12) seemed to have the strongest impact on adult weight status. This may be due, in part, to the pubertal growth spurt, when unhealthy decisions about food and lifestyle may impact BMI trajectories more strongly than in other stages of growth. This also may be a time in children's lives when they are beginning to make more food choices and possibly changing their physical activity patterns, while still being highly dependent on household resources. However, it is interesting to note that the largest effect was for households in the bottom 30 percent of the income distribution, indicating that increasing income during mid-childhood in households that are still relatively poor may be an important determinant of early adult overweight status in this setting.

Late childhood household income (ages 16–19) continued to add to the risk of becoming an overweight young adult, even when controlling for income at earlier stages. However, the effect was found only for households in the top half of the income distribution. There was an important gender difference in late childhood income, with the overweight risk increasing only for boys in these higher income households. This may reflect that girls in higher income households are more concerned than boys with body image in late adolescence and

make more efforts to lose weight (Adair 2007). This is consistent with the significant gender interaction found for underweight status, which suggested that increasing household income at ages 16–19 in wealthier households was associated with women having a higher risk of being underweight in early adulthood.

This study has several limitations that should be considered. First, using cohort data means that it is not possible to empirically distinguish whether the timing effects are due to individual development or to changes in the macro context during this time. The changing macro context of development and modernization may be an underlying cause of both increasing income and increasing BMI over time, and thus an unobserved bias in the overweight status results. A macro development explanation would be consistent with results that suggest that income matters more as the country moves into the nutrition transition. However, late childhood income effects did not significantly differ from the effect of early childhood (age 2) income, while mid-childhood effects did. This suggests a stronger association between income and overweight status in 1991–1994 (when the children were ages 9–12) than in the later stage (1998–2002) when the children were 16–19 years old. The presence of early effects before the nutrition transition had taken hold (i.e., the prenatal and age 2 effects in 1983 and 1986, respectively) also suggests that individual developmental and behavioral factors are at work.

Although this study utilized longitudinal data, causal conclusions cannot be drawn due to the potential for unobserved factors at the family or individual levels to be accounting for the observed relationships. The inclusion of maternal BMI helped reduce the bias from family factors that may be related to childhood household income and BMI in early adulthood, but there may be other health or social factors at the household level that both increase household income and the risk of becoming overweight in early adulthood.

Another limitation of this study is the lack of representativeness of the sample, which means the results can be generalized only to married couple households with children in Cebu. Given that Cebu follows similar socioeconomic and developmental patterns as the Philippines as a whole, it is plausible to extend the findings to similar households in the Philippines. However, it is not possible to say whether we would expect the effects of childhood income on early adult weight status, and particularly these timing patterns, to hold in other nutrition transitions settings with different income distributions and family conditions.

Taking these limitations into account, the findings from this study contribute to our understanding of the origins of adult health disparities by providing a longitudinal approach to assessing the effects of childhood income on early adult weight status. Consistent with developed country findings (Power et al. 2003; Power et al. 2005; Sweeting 2008; Ziol-Guest et al. 2009), this research suggests that the influence of childhood economic conditions on adult BMI depends on timing and gender. The results illustrated that multiple “critical periods” may exist when household income puts individuals on a path toward young adult abnormal weight status. The effects of income, however, are likely to differ by gender and the household's relative income level (high versus low). The findings further highlight that increasing household income is not always beneficial in the context of the

nutrition transition, and that efforts should be made to assist households in making better use of their income to prevent further growth in the overweight and obese populations in these settings.

Both the similarities and differences in findings between this study and those in developed countries suggest that this is an important area for further research. Future studies should focus on testing these ideas in other nutrition transition settings, as well as assessing family and household sources of unobserved heterogeneity, to better assess the causal relationship between household income and weight status. Empirical tests of potential causal mechanisms between childhood household income and adult weight status would also move this research forward and provide more insight into possible policy interventions.

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TABLE 1

Descriptive Statistics for Sample Children ($N = 2,011$)

Variable	$\bar{X}$	S.D.	Min.	Max.
<i>Logged per capita household income (in pesos)</i>				
All childhood (prenatal–age 19)	3.82	.59	1.52	5.82
Prenatal	3.51	.94	.00	6.21
Early childhood (age 2)	3.37	.96	.00	6.21
Mid-childhood (average age 9–12)	3.86	.71	.62	6.21
Late childhood (average age 16–19)	4.17	.64	1.30	6.21
<i>Controls</i>				
Male	.52	.50	0	1
Age BMI assessed	21.2	.72	18	22
Maternal age at birth	26.1	6.01	15	46
Mother indigenous	.03	.15	0	1
Maternal BMI at baseline	20.7	2.81	13	35
Maternal education > 7 years	.44	.49	0	1
Mom worked for pay	.83	.38	0	1
Number of siblings at age 2	2.28	1.95	0	10
First-born	.22	.42	0	1
Extended family household at birth	.39	.49	0	1
Mother ever remarried	.14	.35	0	1
Child ever not in mother's household	.19	.39	0	1
Urbanicity at birth ^a	29.1	12.9	5	49
Urbanicity at age 9 ^a	32.8	14.3	5	59

^aNot included in analyses due to high correlation with community dummy variables.

TABLE 2

Pearson Correlations of Household Income and Maternal Education Variables in Sample

	Prenatal		Early childhood	Mid-childhood		Late childhood	
	Low	High		Low	High	Low	High
Prenatal income – high	.38						
Early childhood income	.29	.45					
Mid-childhood income – low	.38	.25	.28				
Mid-childhood income – high	.20	.40	.36	.38			
Late childhood income – low	.25	.19	.22	.46	.29		
Late childhood income – high	.18	.31	.29	.29	.65	.39	
Maternal education > 7 years	.17	.33	.24	.21	.37	.16	.35

TABLE 3

Multinomial Logistic Regression Results —Relative Risk Ratios of Underweight and Overweight Compared with Normal Weight ($N = 2,011$)

	Model 1		Model 2		Model 3		Model 4		Model 5	
	UW	OW	UW	OW	UW	OW	UW	OW	UW	OW
<i>Logged per capita household income</i>										
All childhood (prenatal – age 19)	.79 (.11)	2.09** (.48)								
Prenatal – low spline			.99 (.18)	.62 (.17)						
Prenatal – high spline			.78* (.09)	1.09 (.14)						
Early childhood					1.01 (.07)	1.36** (.15)				
Mid-childhood – low spline							.86 (.14)	3.08* (1.72)		
Mid-childhood – high spline							.79 (.13)	1.66** (.33)		
Late childhood – low spline									.81 (.16)	.87 (.36)
Late childhood – high spline									.95 (.15)	2.10** (.46)
<i>Controls</i>										
Male	.39** (.05)	1.11 (.20)	.39** (.05)	1.13 (.20)	.39** (.04)	1.11 (.19)	.39** (.05)	1.14 (.21)	.40** (.05)	1.12 (.20)
Age when BMI assessed	1.04 (.06)	1.00 (.11)	1.04 (.06)	1.01 (.11)	1.04 (.06)	1.01 (.11)	1.04 (.06)	1.01 (.11)	1.05 (.06)	.99 (.11)
Maternal age at birth	1.00 (.01)	1.01 (.02)	1.00 (.01)	1.03 (.02)	1.00 (.01)	1.03 (.02)	1.00 (.01)	1.01 (.02)	1.00 (.01)	1.01 (.02)
Mother indigenous	1.85 (.62)	.73 (.40)	1.85 (.62)	.73 (.38)	1.85 (.63)	.72 (.38)	1.86 (.63)	.74 (.40)	1.86 (.62)	.68 (.36)
Maternal BMI at baseline	.92** (.02)	1.12** (.04)	.92** (.02)	1.13** (.04)	.92** (.02)	1.13** (.04)	.92** (.02)	1.12** (.04)	.92** (.02)	1.12** (.03)
Maternal education > 7 years	1.17 (.14)	.84 (.16)	1.16 (.14)	1.06 (.18)	1.09 (.13)	.96 (.17)	1.17 (.14)	.87 (.16)	1.12 (.13)	.90 (.17)
Mom worked for pay	1.26 (.19)	.92 (.25)	1.30 (.19)	.89 (.24)	1.25 (.18)	.91 (.25)	1.25 (.19)	.94 (.25)	1.24 (.18)	.92 (.25)
Number of siblings at age 2	1.00 (.04)	.91 (.07)	.99 (.04)	.85* (.06)	1.02 (.04)	.88 (.06)	1.00 (.04)	.89 (.06)	1.01 (.04)	.88 (.06)
First-born	.87 (.15)	1.06 (.27)	.89 (.16)	1.10 (.27)	.86 (.15)	1.04 (.26)	.87 (.15)	1.09 (.27)	.83 (.15)	1.09 (.28)
Extended family household at birth	.99 (.13)	.95 (.15)	.98 (.13)	.97 (.15)	.99 (.12)	1.07 (.16)	1.01 (.13)	.88 (.15)	1.01 (.13)	.92 (.15)
Mother ever remarried	.70* (.12)	1.25 (.25)	.71* (.12)	1.19 (.24)	.71* (.12)	1.21 (.24)	.70* (.12)	1.25 (.25)	.72* (.12)	1.24 (.24)
Child ever not in mother's household	.75 (.14)	.49* (.14)	.74 (.13)	.48* (.14)	.75 (.13)	.49* (.14)	.75 (.14)	.50* (.14)	.75 (.13)	.48** (.13)
Constant	1.63 (2.36)	.00** (.00)	.84 (1.22)	.02 (.06)	.78 (1.14)	0.00* (.01)	1.27 (1.97)	.00** (.00)	1.31 (2.11)	.03 (.09)
Log Likelihood			–1,464		–1,470		–1,470		–1,461	
										–1,462

Note: 32 community dummy variables included but not reported for brevity. Robust standard errors are in parentheses.

* $p < .05$
** $p < .01$.

TABLE 4

Multinomial Logistic Regression Results —Relative Risk Ratios with Household Income at All Stages ($N = 2,011$)

	Model 1		Model 2	
	UW	OW	UW	OW
<i>Logged per capita household income</i>				
Prenatal—low spline	.95 (.17)	.51* (.15)	.95 (.18)	.50* (.15)
Prenatal—high spline	.78* (.10)	.83 (.13)	.77* (.09)	.83 (.12)
Early childhood	1.11 (.08)	1.34* (.15)	1.11 (.08)	1.33* (.15)
Mid-childhood—low spline	.87 (.14)	3.55* (2.04)	.91 (.15)	4.62** (2.56)
Mid-childhood—high spline	.82 (.13)	1.54* (.32)	.81 (.12)	1.24 (.29)
Late childhood—low spline			.86 (.17)	.59 (.22)
Late childhood—high spline			1.13 (.17)	1.72* (.41)
<i>Controls</i>				
Male	.39** (.05)	1.14 (.20)	.39** (.05)	1.14 (.20)
Age when BMI assessed	1.05 (.06)	1.02 (.11)	1.06 (.07)	1.01 (.11)
Maternal age at birth	1.00 (.01)	1.01 (.02)	1.00 (.01)	1.01 (.02)
Mother indigenous	1.85 (.63)	.68 (.39)	1.85 (.62)	.63 (.36)
Maternal BMI at baseline	.92** (.02)	1.13** (.04)	.92** (.02)	1.12** (.04)
Maternal education > 7 years	1.20 (.14)	.88 (.16)	1.19 (.14)	.83 (.16)
Mom worked for pay	1.30 (.19)	.95 (.26)	1.30 (.19)	.97 (.26)
Number of siblings at age 2	.99 (.04)	.89 (.06)	.99 (.04)	.89 (.07)
First-born	.88 (.16)	1.04 (.26)	.86 (.15)	1.02 (.26)
Extended family households at birth	1.04 (.13)	.99 (.16)	1.06 (.14)	1.00 (.16)
Mother ever remarried	.70* (.12)	1.24 (.25)	.72* (.12)	1.27 (.26)
Child ever not in mother's household	.74 (.13)	.50* (.14)	.73 (.13)	.49* (.14)
Constant	.96 (1.57)	.00** (.00)	1.27 (2.23)	.00* (.00)
Log Likelihood	-1,452		-1,445	

Note: 32 community dummy variables included but not reported for brevity. Robust standard errors are in parentheses. Income effects that are significantly different across stages at $p < .05$: prenatal (high and low) and early childhood, early and mid-childhood low, mid- and late childhood low income. Mid-childhood high and late childhood low-income splines are significantly different at $p < .10$.

*
 $p < .05$

**
 $p < .01$.

TABLE 5

Summary of Relative Risk Ratios from Multinomial Logit Models with All Income Variables and Gender-by-Income Interactions

	Relative Risk Ratios for early adult weight status			
	<i>Underweight vs. normal</i>		<i>Overweight vs. normal</i>	
	Boys	Girls	Boys	Girls
Prenatal income				
Low		n.s.	.89	.30**
High		n.s.	.98	.53*
Early childhood income		n.s.	1.62**	1.01
Mid childhood income				
Low		n.s.		n.s.
High		n.s.		n.s.
Late childhood income				
Low		n.s.		n.s.
High	.72	1.23	2.22**	1.02

Note: Significance of gender differences assessed at $p < .05$.

Significantly different from normal weight:

**
 $p < .05$

*
 $p < .01$.