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Young Adult Obesity and Household Income: Effects of Unconditional Cash Transfers†

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We investigate the effect of household cash transfers during childhood on young adult body mass indexes (BMI). The effects of extra income differ depending on the household's initial socioeconomic status (SES). Children from the initially poorest households have a larger increase in BMI relative to children from initially wealthier households. Several alternative mechanisms are examined. Initial SES holds up as the most likely channel behind the heterogeneous effects of extra income on young adult BMI. (*JEL* D14, H23, H75, I12, J13, J15)

The global obesity epidemic is anticipated to become one of the most significant noncommunicable disease threats to global public health in the near future (*Lancet* 2011). Leading public health experts around the world have called for coordinated government action to help turn the tide of obesity and the twin threats of cardiovascular disease and diabetes (Wang et al. 2011; *Lancet* 2011). There is significant concern that the rise in obesity worldwide will slow or even reverse the significant mortality reductions experienced by high-income countries in the past several decades (Swinburn et al. 2011) and that obesity has become a bigger threat to public health than smoking.

Current trends are particularly alarming among children and adolescents. Globally in 2004, there were 170 million overweight (inclusive of obese) children (Lobstein, Baur, and Uauy 2004). The United States has experienced a drastic increase in the prevalence of childhood and adolescent obesity since the 1980s. According to the most recent National Health and Nutrition Examination Survey (United States

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Department of Health and Human Services 2008), 11.9 percent of children aged 2–19 were at or above the ninety-seventh percentile of the Body Mass Index (BMI)-for-age growth charts, and 17 percent were at or above the ninety-fifth percentile (Ogden et al. 2010). Being overweight in young adulthood is a predictor of later-life obesity and chronic conditions such as diabetes and heart disease. The recent rise in poverty in the Unitec States is particularly alarming given the connection between household socioeconomic status and children's BMI and later-life health. There is a strong correlation between poverty and obesity and other health ailments. We know relatively little about the mechanisms behind these relationships. A good understanding of the link between poverty and obesity is particularly pressing today, when the poverty rate in the United States stands at its highest since 1993.[1]

Theory predicts an inverted U-shape relationship between unearned income and weight (Lakdawalla and Philipson 2009). As income increases, households and individuals increase their consumption of food, and consequently we see an increase in weight. Beyond a certain threshold, the wealthiest households are either able to purchase higher quality foods that are more nutritious or pursue health-related activities, so the income-BMI curve starts sloping downward. Without exogenous variation in either children's body mass or household income, the direction of causality between the two is unclear. To our knowledge, there is no experimental evidence testing this prediction. This study uses exogenous cash transfers to identify the effects of positive household income shocks on adolescent BMI.

Our research shows that exogenous unearned household income transfers have heterogeneous effects on adolescent and young adult health depending on pre-intervention family socioeconomic background. Consistent with theory, we find evidence that extra unearned household income increases BMI among youths from poorer households relative to their wealthier peers.

We study the effect of exogenous household income transfers for American Indian households in North Carolina. These transfers are provided to all enrolled adult Eastern Cherokee tribal members regardless of their economic characteristics.[2] Included in our data are non-Indian children who reside in the same 11 counties who are untreated by the transfer program. An equal proportion of profits from the tribal casino operations is provided to the entire distribution of tribal member household types. Both wealthy and poor individuals received the same-sized transfers. Our findings suggest that the income transfers generated by the casino operations increased BMI among adolescents from families with average incomes below $30,000, but not among their better off peers. Further investigation reveals that this is primarily due to differential changes in weight among youths from different economic backgrounds. Children from the initially poorer households tend to increase their relative BMI over time.

[1] The Census Bureau, announcement from September 13, 2011.

[2] The income transfers are provided only to enrolled members of the Eastern Band of Cherokee Indians (EBCI) over the age of 18. Membership in the Eastern Cherokee tribe is determined by genealogical ties to existing tribal membership rolls from 1924. The minimum blood quantum required is 1/16 for tribal membership; therefore, ethnically individual tribal members may be mixed race, but they may still be politically tribally enrolled members. The enrollment requirements are for tribal citizenship, not ethnicity or race. Only tribally enrolled citizens are eligible for the casino transfer payments. We use Native American, American Indian, and tribal member interchangeably through the rest of the text.

In addition to initial household income, we examine several other channels that may contribute to heterogeneous effects of extra household income on adolescent health. For example, we study the effects of pre-intervention maternal labor force participation, mother's education, subject's own education, and the child's birth weight, which is a proxy for the child's health endowment. We find that the differences in outcomes induced by differences in initial household income are robust to the inclusion of these additional potential mechanisms.

This research contributes to two major strands of the existing empirical literature. First, we offer the first assessment of the medium-term effects of quasi-experimental household income transfers on adolescent BMI. We add to the literature examining the health effects of public policy interventions in childhood. We show that interventions that start as late as adolescence could benefit children's long-term well-being. Further, it is demonstrated that the effects of these income interventions vary with initial family socioeconomic status.

Second, we contribute to the growing economics literature on the impact of Native American-run casinos on the well-being of neighboring communities (Evans and Topoleski 2002; Wolfe et al. 2012). Native Americans are a population that has received relatively little attention in the economics literature, especially considering the dire socioeconomic and health conditions on many Native American reservations. The Indian Gaming Regulatory Act (IGRA) of 1988 provided an avenue for Native American tribes to pursue potentially lucrative gaming ventures on their reservations in order to combat poor economic conditions. The express purpose of IGRA was to increase tribal incomes and to lift tribal members out of poverty and alleviate social problems related to poverty and deprivation, including poor health outcomes. We show that the effects of casino-generated cash transfers on children from tribal communities are not unambiguous. To our knowledge this is the first study of the effects of casino transfers on tribal members' health that uses individual panel data.

I. Background

A consensus has emerged that early life conditions and shocks to health affect long-term economic and social outcomes (Currie, Stabile, Manivong, and Roos 2010), and that children from poor families experience worse health conditions (Currie 2009). With particular reference to weight and obesity, Baum and Ruhm (2009) show that weight changes over the life cycle are inversely related to SES and that differences in obesity across SES groups widen with age. They also show that family SES affects individuals' weight over their lifespans.

Public policy could work to counterbalance any such adverse initial conditions by providing extra resources to poor families. Some work has been done to identify the long-term effects of welfare programs such as Food Stamps (Almond, Hoynes, and Schanzenbach 2010) and Head Start (Currie and Thomas 1995; Carneiro and Ginja 2012; Frisvold 2006). However, a recent review of the literature identifies few studies that have tested how pure income transfers to families affect the short- and long-term well-being of their children (Almond and Currie 2009). The existing literature has focused on studying the short-term effects of income transfers (Dahl and Lochner

2005; Milligan and Stabile forthcoming) and on relatively young ages at intervention (infancy and early childhood). These studies do not investigate whether the effects persist into adulthood and whether and to what extent the age at intervention matters.

A separate literature has emerged studying the effects of Head Start on childhood obesity. Participation in Head Start has been found to reduce obesity (Frisvold 2006; Carneiro and Ginja 2012) and a recent contribution by Frisvold and Lumeng demonstrates that even the "dosage" of Head Start received (half-day or full-day) matters (Frisvold and Lumeng 2011). The children participating in Head Start were affected by the program at very young ages, so we still do not know whether interventions at later stages of child development could be beneficial. Moreover, we have little evidence of the effects of interventions targeted at the household level, rather than at the preschool class.

When studying the determinants of childhood obesity outside specific policy interventions, economists have concentrated primarily on the effects of the supply and quality of food consumed by children. For example, it has been shown that fast food restaurants close to school grounds increase the prevalence of obesity among ninth graders (Currie, Della Vigna, Moretti, and Pathania 2010) and higher prices of fruit and vegetables in the neighborhood are associated with higher BMI, especially among economically disadvantaged children (Powell and Chaloupka 2009). Increased supply of fast food or "bad" food potentially available to children contributes to a higher incidence of childhood obesity.

Studies investigating the effects of changing access to different types of food assume that the demand-side effects are negligible. This paper asks the opposite question: holding access and availability of foods constant, would higher household incomes result in changes in obesity rates among the children of these households? Due to the panel nature of our data, we can control for unobserved area characteristics, such as the kinds of restaurants and supermarkets in a particular area that affect all children residing there in the same way.

One way to assess the contribution of increased incomes on adolescents' BMI is to consider exogenous changes in the affordability of different types of food. Affordability can increase in two ways: by providing extra funds that can be spent on food only (such as food stamps and other coupons) and by changes in expendable income. Previous studies have found mixed results on the effect of receiving food stamps on adult obesity rates (Townsend et al. 2001; Chen, Yen, and Eastwood 2005; Kaushal 2007). Two recent studies examine the causal effects of extra expendable income on BMI. Schmeiser (2009) considers low-income women while Cawley, Moran, and Simon (2010) study Social Security recipients. Both utilize instrumental variable (IV) strategies to estimate changes in BMI and obesity rates attributable to changes in income. Our study differs from previous studies by focusing on children and using a quasi-experimental framework. We are not aware of any previous economics research on the effects of exogenously increased household income on adolescents' BMI in the United States.[3]

[3] In a study examining obesity rates for adults over 30 years old, Chang and Lauderdale (2005) find that there has been an increase at all levels. Their study differs from ours in that they are looking at an association between income and obesity (they do not have an exogenous change to income) and they are looking at adults only.

Empirically, the relationship between income and obesity is hard to identify. Among studies using data on adult populations, the main problem is identifying the direction of causation—higher incomes make food more accessible, but obesity and the associated health problems make it harder to earn high incomes. People with higher incomes can afford better food, and they are also less likely to be obese.[4] There is a separate literature estimating the effect of BMI on earnings (Kline and Tobias 2008; Cawley 2004; Mocan and Tekin 2011), and at least one study shows that overweight and obese adults are likely to suffer from low self-esteem which may be underlying their lower earnings (Mocan and Tekin 2011). To plausibly capture the empirical relationship between income and weight, one has to exogenously increase the amount of dispensable income available to the household without affecting the extent of physical activity or physical attractiveness needed to earn that income.

Assessing the effect of exogenous income transfers on the BMI of children and adolescents is attractive for two reasons. First, the transfers we consider come from an exogenous source and their size is not affected by the initial financial situation of the household. Second, the transfer affects children while they are teenagers—a time when most children earn little on their own.[5] The children in our study are subjected to the income effect, but unlikely to be affected by a substitution effect away from labor.[6]

II. Data and Basic Analysis

The Great Smoky Mountains Study of Youth (GSMS) is a longitudinal survey of 1,420 children aged 9, 11, and 13 years at the survey intake that were recruited from 11 counties in western North Carolina. The children were selected from a population of approximately 20,000 school-aged children using an accelerated cohort design.[7] Children from the Eastern Band of Cherokee Indians were over sampled for this data collection effort. Survey weights are used in the child outcome regressions that follow. The federal reservation is situated in two of the 11 counties within the study. The initial survey contained 350 Indian children and 1,070 non-Indian children. Proportional weights were assigned according to the probability of selection into the study; therefore, the data is representative of the school-aged population of children in this region. Attrition and nonresponse rates were found to be equal across ethnic and income groups.

The survey began in 1993 and has followed these three cohorts of children annually up to the age of 16 and then reinterviewed them at ages 19 and 21.[8] Both

[4] Behrman and Deolalikar (1987) have shown that changes in income in a developing country are not necessarily associated with changes in food consumption—they find that it depends on the income elasticity of food.

[5] Child labor laws and mandatory schooling requirements in the United States prevent children from working full time until age 18.

[6] In developing countries, the case would be quite different in that the additional household income would allow children to work less and enter school which may have separate effects on the child's BMI. See, for instance, the literature on child labor in developing countries. Edmonds (2008) provides a useful overview of the findings.

[7] See Costello et al. (1996) for a thorough description of the original survey methodology.

[8] Individuals are interviewed regardless of where they are living (whether on their own, in college, or still living with their parents). No child is dropped from the survey because they moved out of their parent's home. We find no statistically significant difference in attrition between the treatment and control groups or selective attrition on

parents and children were interviewed separately up until the child was 16 years old. Interviews after that were only conducted with the child alone.

After the fourth wave of the study, a casino was opened on the Eastern Cherokee reservation; the survey children were approximately 13, 15, and 17 years of age at that time. The casino is owned and operated by the tribal government. A portion of the profits are distributed on a per capita basis to all adult tribal members.[9] Disbursements are made every six months and have occurred since 1996. The average annual amount per person has been approximately $4,000. This income is subject to the federal income tax requirements. However, as the transfers are not part of earned income, they do not directly affect EITC for eligible individuals.

The outcome variables of interest are BMI, height, weight, and obesity. The first three measures are recorded at each survey wave. Interviewers measured survey respondents using rulers and scales. According to the Centers for Disease Control (CDC), recommended levels of BMI are between 20 and 25 (Centers for Disease Control and Prevention 2007). Individuals with BMI levels of 25–29 are considered overweight in adults; those with BMI 30 or higher are considered obese.[10] The obesity variable in the dataset is based on the CDC's obesity tables for different ages and sexes, until adulthood. The obesity index for adulthood equals one for BMI ≥ 30, and zero otherwise. We employ these designations in the tables that follow.

Table 1 provides descriptive statistics. The sample is balanced on conditions at intake such as age, sex, and maternal labor force participation between tribal members and the rest. American Indian mothers are significantly less likely to have been to college, and more likely to have completed only high school. However, maternal education in the Eastern Cherokee subsample does not significantly differ from average educational attainment among comparable Native American women with children (see Table A1 in the online Appendix). The incidence of obesity and being overweight is substantially higher among American Indian youth. A large proportion of these adolescents are obese (36 percent) as compared to 19 percent of the rest of the sample. The difference comes from an eight kilogram difference in weight, while average height is very similar between the two groups.

Tribal members come from poorer families—their households received, on average, $10,000 less in annual income in the three survey waves before the casino opened. In the original data, the variable for household income is provided in categories that are $5,000 in size each. A value of 6, for instance, corresponds to

health outcomes. American Indians comprise 24 percent of the sample in the very first survey wave and comprise approximately 27 percent of the sample at age 21.

[9] All adult tribal members received these per capita disbursements. If there were any noncompliers (parents that either did not receive or refused the additional income), then any estimates found here would be an underestimate of the true effects of additional income. Children listed as tribal members were eligible for the casino disbursements themselves at age 18 if they completed high school; even if they did not complete high school they would receive the casino transfers at age 21. While they initially did not know exactly how much the transfers would amount to, tribal members had every reason to believe that this was a permanent positive change in their incomes. Casino operations are authorized under the Indian Gaming Regulatory Act of 1988 which allowed the development of economic activities related to gaming on US Federally recognized American Indian reservations. By the time the Eastern Cherokee tribal casino began operation, other tribal casinos had been operating in places such as Florida and the midwest for almost a decade.

[10] In the analysis, we drop extreme outliers (which we attribute to either recording error or measurement error) for recorded BMI levels that exceed 100 or are below 10. This results in omitting five observations in total.

Table 1—Means and Standard Deviations of Main Outcomes and Control Variables at First Survey Wave

	Non-Indians			American Indian		
	Observations	Mean	SD	Observations	Mean	SD
Obese	909	0.190	0.393	304	0.362	0.481
Body Mass Index (BMI)	909	20.048	4.703	304	22.990	6.069
Weight in kgs	909	43.951	14.790	304	51.876	18.141
Height in cm	909	146.531	12.390	304	148.735	11.951
Age	909	10.870	1.625	304	10.895	1.605
Sex (1=male)	909	0.567	0.496	304	0.536	0.500
Number of American Indian parents	909	0.017	0.127	304	1.217	0.634
Mother with high school education	909	0.290	0.454	304	0.342	0.475
Mother with college education	909	0.498	0.500	304	0.352	0.478
Mother participates in the labor force	791	0.861	0.346	255	0.863	0.345
Average pre-casino household income	899	29,104.56	17,111.64	299	18,754.18	14,231.39
Birth weight	822	7.485	1.333	281	7.516	1.274

Note: Average pre-casino household income categories taken at midpoints.

approximately $30,000 (the average for non-Indians); while a value of 4 corresponds to an annual income of approximately $20,000 (the average for American Indian households). These amounts correspond closely to data for the region from the 1990 US Census. In online Appendix Table A1, we use Census data from 1990 to show that the average household SES characteristics of the Eastern Cherokee are similar to the characteristics of other rural Native American households and to rural African American households.

The casino disbursements (approximately $4,000) represent more than a 20 percent increase in the average household income of parent couples of mixed heritage, and more than a 40 percent increase in households of two tribal members. The casino transfers alone would be enough to close the income gap between an average family with two nonmember parents and families composed of two tribal members. Online Appendix Table A2 reports the results from a "first-stage" ordered probit regression confirming that the casino transfers indeed resulted in increased income for the Native American households in subsequent survey years. We use an ordered probit because income is coded in $5,000 categories. The results suggest that eligibility for casino transfers resulted in an average annual household income increase of about $3,900 per eligible parent.

This amount is very similar to the average extra cash income provided by large government assistance programs such as the Supplemental Nutrition Assistance Program (SNAP) and Temporary Assistance for Needy Families (TANF) program. For example, in 1998 the maximum yearly cash assistance in North Carolina through the TANF program was $3,264 annually (French 2009). In 2000, the average poor household received $3,420 supplementary income from the SNAP (formerly Food Stamps) program (for a household of three as classified by the US Department of Agriculture). Thus, redistributing the extra tribal income from gaming among tribal members augmented poor families' incomes by similar (or lower) absolute amounts than what we would expect in terms of state and federal government support. An important difference is that contrary to government cash support, the tribal income redistribution was done equally across initial income levels.

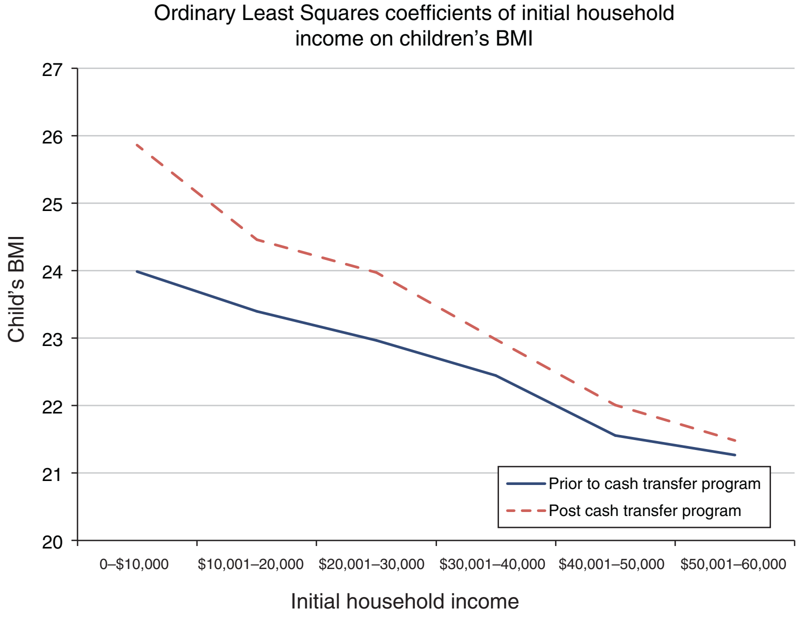

Figure 1. Conditional Means Plot of BMI as a Function of Income Before and After the Casino Transfers

Notes: Ordinary Least Squares regressions of children's BMI on dummies indicating six different initial (pre-casino) household income categories before and after the casino transfers. The highest income category (over $60,000 in annual income) is the reference category.

In Figure 1, we plot conditional means obtained from a linear regression estimating the relationship between household income in the last survey wave before the initiation of the income transfers and children's body mass (solid line). The dashed line represents the same relationship after the initiation of the income transfers. The graph confirms that prior to the casino transfer there was a negative relationship between initial household income and children's BMI, and that the extra unearned income transfers actually intensify this negative relationship with BMI.[11] For instance, prior to the transfers, children who come from households with an initial income of between $10–20,000, on average, will have BMIs that are two index points higher than children from households with the highest initial annual income of $60,000 or more. The slope of the household income-BMI relationship in the after-transfer period is steeper than the before-transfer period, so that after the transfers are in place, a child from a household with initial income of between $10–20,000 will have, on average, a BMI that is three index points higher than a child from a household with the highest initial

[11] In this US-based sample we do not observe children in the left part of the inverted U-shape relationship predicted by Lakdawalla and Philipson (2009). Very few households in the United States interviewed during the late 1990s report food insecurity for children and even fewer report children going without a meal sometimes during the year. In the National Health and Nutrition Examination Survey (NHANES III) from 1997, less than 5 percent of *poor* households with children under the age of 18 reported having experienced *any* food insecurity in the previous year. Only about one-quarter of the households that report food insecurity also report that children sometimes skip meals. The number of severely impoverished households in our sample is low. Specifically, we do not have a significant amount of observations in the very poorest income categories. Of the 83 observations with initial household incomes of $10,001 or less, only three have initial incomes of $5,001 or less.

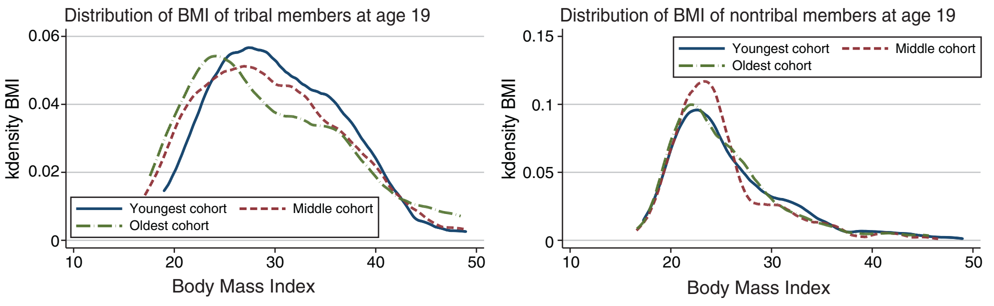

Figure 2. Distribution of BMI by Age Cohorts and Tribal Status at Age 19

Notes: Density plots of the distribution of BMI across tribal member children and nonmembers at age 19 by age cohort. The youngest age cohort was initially age 9 at survey intake, the middle age cohort was age 11 at intake, and the oldest cohort was 13 at intake.

income level. Rather than reducing children's BMI differences by income level, the extra income transfers increased them.

In Figure 2, we provide a simple graph of the distribution of BMI at age 19 by age cohort for American Indians on the left and for non-Indians on the right. The idea is to compare the distribution of BMI at the same age for cohorts of tribal members who were treated to extra cash transfers for different amounts of time in addition to comparing it to the distribution of BMI for a sample of youths of the same cohorts who did not get the transfers. The graph shows that the BMI distribution at age 19 for the youngest age cohort of American Indians is to the right of the BMI distributions of the other two Native American cohorts. The middle age cohort distribution is to the right of the oldest age cohort. No clear corresponding relationship is visible in the distribution plots for nonnative BMI across the three cohorts. We interpret these plots as suggestive evidence that longer exposure to casino transfers may have increased adolescent BMI.

While we compared BMI distributions across cohorts and ethnicities at the same age in Figure 2, we take an individual-level approach in Figure 3. We plot the distribution of changes in BMI *for the same individual* between the ages of 13 and 19. We construct a density plot of these individual changes separately for tribal members and nonmembers of the three cohorts.[12] This is intended to overcome potential inherent differences in BMI across the cohorts, which would likely be apparent by age 13. Regardless of initial body weight, on average, Native American children in the youngest cohort tend to gain more weight relative to non-Indians of the same cohort. This is apparent in the top left panel of Figure 3 comparing the differential gains across tribal members and nonmembers of the youngest cohort. But we also observe higher variance in the relative gains among this group—a nontrivial proportion of tribal members gain less than the comparable group of whites. On average, the youngest cohort of Native Americans gained more in BMI than the middle cohort, who in turn gained more than the oldest cohort. Thus, the between-cohort

[12] For the youngest age cohort, we restrict analysis to age 12 as there were no observations at age 13 for this cohort. It is important to note that none of the three cohorts were treated with the increase in household income at these ages.

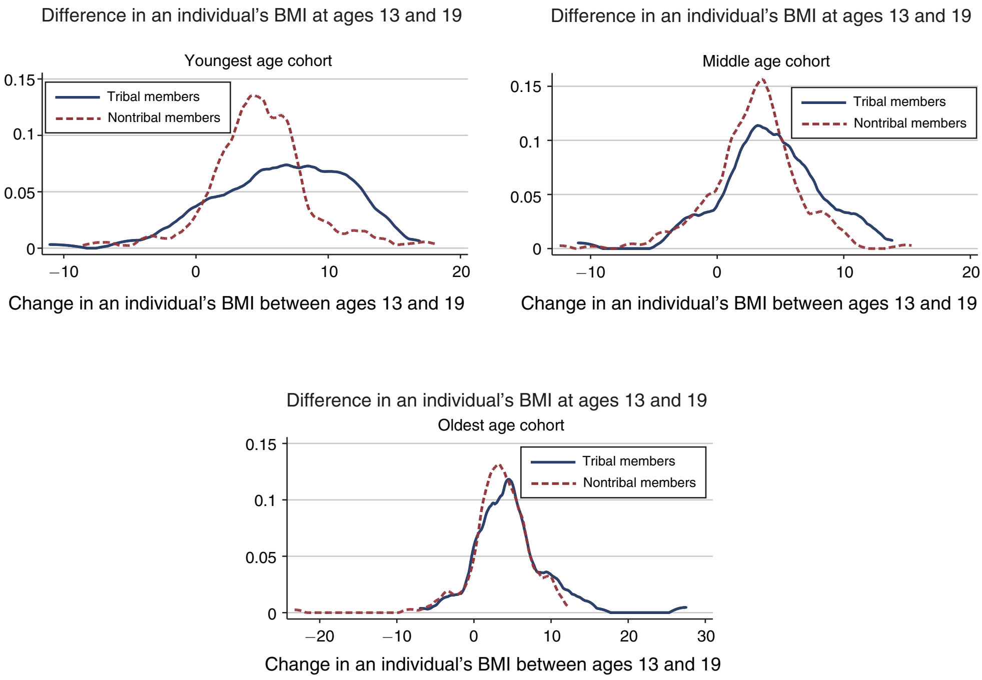

Figure 3. Distribution of Individual Changes in BMI by Cohort between Ages 13 and 19 among Tribal Members and Nonmembers

Notes: The plots show the distribution of changes in children's BMI between ages 13 and 19 by cohort and by tribal affiliation. The youngest cohort was aged 13 when the transfers started, the middle cohort was 15, and the oldest cohort was 17. The solid line shows the distribution of BMI changes among tribal members. The dashed line shows the distribution of changes in BMI for nonmembers.

differences already noted in Figure 2 are due to differential changes in BMI across Native American cohorts between the ages of 13 and 19. Finally, comparing across panels, we see that the differences between tribal members and nonmembers are most apparent in the youngest and least obvious in the oldest cohorts.

A. *Cohort-Level Analysis: Obesity and BMI at Ages* 19 *and* 21

As a first cut of the data we use a difference-in-differences regression strategy to examine the effects of varying duration of treatment using differences among cohorts measured at ages 19 and 21. Our analysis in Section IV will focus explicitly on the panel aspect of the data and utilize fixed-effects panel regressions in the analysis. The duration of treatment differs across the age cohorts as they were affected by the casino transfer payments at different points in their childhood. The youngest group was first treated at age 13, the middle group at age 15, and the oldest group at age 17. We include several other variables which have the potential to explain changes in child obesity and BMI, such as maternal labor force participation and education, distance between the household's residential location and the casino, as well as the child's own education at age 19.

We compare young adult outcomes for adolescents who resided for a total of six years as minors in households with extra income (four years for the middle age cohort) to adolescents who resided for two years as minors in households with exogenously increased incomes. The two youngest age cohorts (age 9 and age 11 at survey intake; ages 13 and 15 at first treatment) function as the "after-treatment" cases and the oldest age cohort (age 13 at survey intake; age 17 at first treatment) is the "before-treatment" case. We focus explicitly on the effect of the income transfer on BMI and the incidence of obesity at ages 19 and 21. Nontribal members serve as the pure control group.

The size of the exogenous increase in household incomes can take on two different values depending upon the number of American Indian parents in each household.[13] It is possible for there to be zero, one, or two American Indian parents in each household. Clearly households with two tribal member parents will have double the amount of exogenous income than households with only a single American Indian parent. The equation below details the empirical specification:

$$(1) \qquad Y_i = \alpha + \beta_1 \times Age9_i + \beta_2 \times Age11_i + \delta_1 \times NumParents + \gamma_1 \times Age9 \times NumParents_i + \gamma_2 \times Age11_i \times NumParents_i + \mathbf{X}_i'\theta + \varepsilon_i.$$

In the equation above, Y is BMI or obesity status for the survey children measured at ages 19 or 21; $Age9$ and $Age11$ variables indicate whether or not the child is drawn from the youngest or middle age cohorts—the age 13 cohort (oldest) is the omitted category in this regression. The variable *NumParents* indicates the number of parents who are tribal members in that child's household. The two coefficients of interest are γ_1 and γ_2, which measure the effect of receiving the casino disbursements and being in either the age 9 or age 11 cohorts relative to the 13-year-old cohort. The vector **X** controls household conditions prior to the opening of the casino and includes average household income over the four pretreatment years, the sex of the child, the race of the child, the mother's pre-intervention labor force participation, and education level.

Identification of equation 1 relies on the fact that the different age cohorts of children were randomly sampled within American Indian and non-Indian groupings.[14] We also show that the pre-intervention trends between the treatment and control groups move in a similar direction. These graphs are provided in online Appendix Figures 1–3 for pretreatment BMI, weight, and height. The trends for BMI, weight, and height move in tandem across the two groups for the first three survey waves, which predate the initiation of the transfer payments.

[13] We find that the effect of the treatment (household eligibility for the casino per capita transfer) results in approximately \$3,900 additional household income at each survey wave. The average amount distributed per person has been about \$4,000 per year. This also suggests that households do not alter their labor participation in response to this additional household income.

[14] See Akee et al. (2010) for evidence of the comparability of respondents across age cohorts.

Table 2—Marginal Effect of Casino Transfers on Obesity and Overweight Status at Ages 19 and 21: Ordinary Least Squares and Probit Regressions

Variables	OLS BMI at age 19 (1)	OLS BMI at age 19 (2)	OLS BMI at age 21 (3)	OLS BMI at age 21 (4)	Probit obese at age 19? (5)	Probit obese at age 19? (6)	Probit obese at age 21? (7)	Probit obese at age 21? (8)
Age cohort 1 × number of AI parents × average HH income		−0.637**		−0.635*		−0.0284**		−0.0444***
		(0.269)		(0.327)		(0.0125)		(0.0167)
Age cohort 2 × number of AI parents × average HH income		−0.0254		0.0446		0.00513		0.00295
		(0.233)		(0.277)		(0.0117)		(0.0169)
Age cohort 1 × number of American Indian parents	−0.624	3.033*	−1.105	2.813	−0.0244	0.119	−0.0525	0.175*
	(1.000)	(1.777)	(1.196)	(2.092)	(0.0411)	(0.0755)	(0.0513)	(0.102)
Age cohort 2 × number of American Indian parents	0.168	0.248	1.042	0.888	0.0100	−0.0225	0.0157	−0.0126
	(0.981)	(1.797)	(1.144)	(2.078)	(0.0426)	(0.0753)	(0.0543)	(0.104)
Age cohort 1 × average HH income		0.219		0.520***		0.0125		0.0258*
		(0.172)		(0.184)		(0.0103)		(0.0138)
Age cohort 2 × average HH income		−0.0401		0.178		−0.0121		−0.00725
		(0.153)		(0.178)		(0.0102)		(0.0142)
AI parents and average HH income		−0.0694		−0.132		0.00450		0.00147
		(0.181)		(0.232)		(0.00865)		(0.0123)
Average HH income	−0.157**	−0.179	−0.0543	−0.276**	−0.0120***	−0.0118	−0.00818	−0.0166
	(0.0682)	(0.113)	(0.0786)	(0.128)	(0.00437)	(0.00775)	(0.00564)	(0.0111)
Age cohort 1 (13 yo)	1.461**	0.0300	1.239*	−2.287	0.0380	−0.0422	0.0596	−0.102
	(0.705)	(1.488)	(0.744)	(1.571)	(0.0470)	(0.0708)	(0.0540)	(0.0926)
Age cohort 2 (15 yo)	0.278	0.569	0.687	−0.583	−0.0102	0.0657	0.0189	0.0743
	(0.649)	(1.524)	(0.728)	(1.708)	(0.0428)	(0.0890)	(0.0570)	(0.120)
Number of AI parents	−0.748	0.547	−1.228	0.562	−0.0379	−0.0488	−0.0952*	−0.0673
	(0.825)	(1.415)	(1.106)	(1.666)	(0.0379)	(0.0614)	(0.0498)	(0.0824)
American Indian race	5.729***	3.906***	6.050***	3.754***	0.331***	0.283***	0.424***	0.311***
	(0.983)	(0.863)	(1.190)	(1.035)	(0.0803)	(0.0795)	(0.0842)	(0.0797)
Sex	0.630	0.566	0.571	0.493	0.0145	0.0130	0.0508	0.0492
	(0.554)	(0.560)	(0.610)	(0.614)	(0.0329)	(0.0317)	(0.0399)	(0.0395)
Mother has a high school diploma	0.374	0.261	0.505	0.297	0.00266	−0.00236	−0.00105	−0.00869
	(1.453)	(1.442)	(1.550)	(1.552)	(0.0574)	(0.0553)	(0.0692)	(0.0676)
Mother has some college or more	−0.661	−0.848	−1.785	−2.019	−0.0346	−0.0451	−0.135*	−0.140*
	(1.420)	(1.414)	(1.519)	(1.534)	(0.0596)	(0.0590)	(0.0770)	(0.0777)
Average labor force participation of mother	−0.358	−0.338	0.655	0.566	−0.0285	−0.0315	0.0693	0.0643
	(0.882)	(0.879)	(0.934)	(0.885)	(0.0544)	(0.0521)	(0.0697)	(0.0660)
Constant	25.65***	25.99***	25.48***	27.42***				
	(1.602)	(1.829)	(1.685)	(2.001)				
Observations	921	921	913	913	920	920	912	912

Notes: Robust standard errors in parentheses. Household income is a categorical variable where each bin is $5,000 in size. The lowest category, for instance, goes from 0 to $5,000. The second bin goes from $5,001 to $10,000, etc. The first four regressions are ordinary least squares. The final four regressions are probit regressions with marginal effects presented in the table above.

*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.

B. *Difference-in-Differences Regression Results for BMI and Obesity at Ages* 19 *and* 21

We present several specifications of the difference-in-differences regression in Table 2. In all of these regressions, the omitted category of children is the oldest age cohort (age 13 at survey intake; age 17 at beginning of treatment). Thus all coefficients are interpretable as differences with the oldest cohort.

The first four columns in Table 2 report coefficients obtained from an OLS regression of BMI on a number of controls specified in equation (1). Columns 5–8 report marginal effects after probit regression coefficients of obesity at ages 19 and 21.[15] Columns 1, 3, 5, and 7 show the difference-in-differences regressions based on the model in equation (1). The coefficients of interest, while not statistically significant, indicate that adolescents who reside in households with at least one tribal member parent and are in the youngest age cohort have lower BMI and are less likely to be obese by ages 19 and 21.[16] Based on the conditional means plotted in Figure 1, we expect that the effects of exogenous income transfers on BMI will vary depending on initial household income. In columns 2 and 4, we test this hypothesis. In these regressions we interact initial household income (prior to the casino payments) with the original difference-in-differences term from columns 1 and 3. Our results confirm the theoretical prediction that the marginal effect of extra income varies across the initial income distribution.[17] The results demonstrate that relative to the oldest cohort, the exogenous income transfers reduced BMI by 0.6 index points and also decreased the probability of obesity by 3 percent at age 19 with each $5,000 increase in *initial* household income for the youngest cohort of adolescents. We find similar effects at age 21. There is a reduction of between 2 and 4 percentage points in the probability of being obese with each $5,000 increase in the initial household income at ages 19 and 21.

We show graphically that poverty matters for BMI using a simple poverty/non-poverty distinction. In Figure 4, we separate the tribal and nontribal populations along poverty lines and plot the distributions of BMI at ages 13 and 21 aggregating across all cohorts. The younger age is effectively pretreatment for all age cohorts and age 21 is after treatment for all cohorts. Figure 4 indicates that American Indians tend to have higher BMI than non-Indians even at a relatively young age. By age 21, this difference becomes more pronounced with a proportionately higher increase in BMI for American Indians. Figure 4 is illustrative of the results reported in Table 2, that poor American Indians are relatively heavier at age 21 compared to their relatively wealthier counterparts. This figure also shows that the average gain between ages 13 and 21 is largest for poor tribal members than any other group. We revisit this finding using an individual panel approach in Section IV.

The other covariates reported in Table 2 are also informative. We find that American Indian adolescents are 4–6 body mass index points heavier and between 33 and 42 percentage points more likely to be obese than non-Indians. We also find

[15] We report marginal effects for ease of exposition. Linear probability regressions yield the same results. The tables are available from the authors. In a series of papers, Ai and Norton (2003) and Norton, Wang, and Ai (2004) have shown that interaction terms in binary regressions are not properly calculated by standard statistical analysis software output (e.g., STATA). We have used their suggested estimator (inteff) and report interaction coefficients evaluated at the mean.

[16] Even though the coefficient of the youngest Native American cohort is not significant, it is negative, which appears at odds with the raw data evidence we presented in Figure 2. However, in addition to showing a higher prevalence of BMI in the 30–40 range and a larger variance in BMI in the youngest cohort, Figure 2 shows lower prevalence of extreme obesity (over 40 BMI) in the youngest group. When we exclude these observations from the sample, the coefficient becomes positive, even though still not statistically significant. The interaction coefficients with income are not affected by restricting the sample in this way.

[17] Behrman and Hoddinott (2005) find for Mexican children enrolled in the PROGRESSA program that the effects on growth are more pronounced for individuals from poorer households.

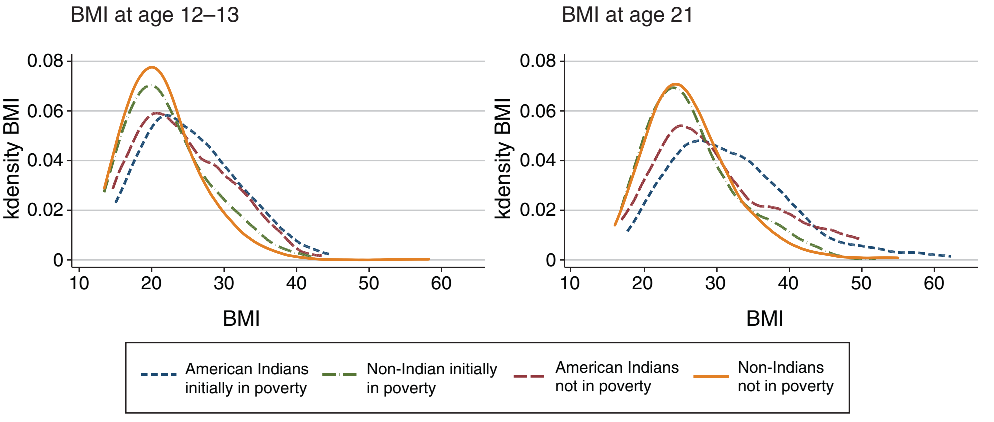

Figure 4. Density Plots of the Distribution of BMI at Ages 13 and 21 by Tribal Membership and Poverty Status; All Age Cohorts Included

Note: Poverty status is determined for household income in years prior to the income intervention and follows US poverty guidelines.

that the average of childhood household income (in the three years prior to the government transfer program) negatively affects BMI and obesity at age 19.

We conduct several placebo and robustness tests for this difference-in-differences analysis in online Appendix Table A3. We test whether differences in parental labor force participation, the gender of the parent receiving the transfer, the distance from the household to the casino, or own education can explain the results reported in Table 2. The analysis is presented in online Appendix Tables A3–A5 and indicates that our initial results are robust to alternative hypotheses about the cause of the heterogenous effects of extra household income on adolescent BMI. We explore the effect of the gender of the parent receiving the transfer on changes in adolescent BMI and obesity in online Appendix Table A3. In online Appendix Table A4 we include interactions of the subject's own birth weight, education, and country fixed-effects in the regression analysis. Finally, we include interactions with the distance to the casino in online Appendix Table A5. Our results are robust to the inclusion of these alternative variables.

III. Individual Panel Data Estimates

A potential concern about the results from our basic analysis is that children of Native American ancestry might grow at differential rates than non-Indian children. In order to account for this possibility, we take advantage of the panel nature of our data and examine the effect of the casino transfer payments on BMI and obesity outcomes at each survey wave. Because the panel data contain information on the same individuals at multiple points in time (survey measures of height and weight), we are able to include individual fixed-effects as well as age-by-race fixed effects and a Native American-specific time trend.

A. *Empirical Strategy*

We examine changes in the body mass index as well as weight and height. We use all available data for each individual from ages 9, 11, and 13, respectively, onward, interviewed every year until age 16, and then again at ages 19 and 21. The empirical specification is

$$Y_{it} = \alpha_i + \mathbf{X}'_{it}\beta + \gamma \times Transfer_{it} + \varepsilon_{it}, \tag{2}$$

where, α_i is the individual fixed effect and **X** is a vector of control variables, including the presence of children younger than six in the household and dummy variables controlling for the child's age interacted with Native American race. The indicator variable *Transfer* varies within individual across survey waves and is equal to one in survey waves after the casino disbursements started. This indicator variable is always zero for households that are not receiving the casino transfers; for households that are receiving the casino transfers, the variable is zero for the first four survey waves and then takes the value of one thereafter. Identification of the casino effect is driven by differences between Native American treated and untreated children of the same age; this is possible because the Native American children in our panel data are treated to casino payments at different ages. For instance, we can compare 16 year olds who were treated (the two youngest age cohorts) to 16 year olds who were not treated (the oldest age cohort).We emphasize that vector **X** also includes a set of age by race fixed effects, to control for potentially different growth paths between tribal members and others. In our preferred specifications we also include a Native American-specific time trend, but we note that this does not significantly affect any of the main results. Taken together these two different types of race-cohort controls (time invariant and time variant) should account for any meaningful differences across the two groups.[18] The main outcomes of interest are BMI and obesity, but we also test for other (self-reported) health conditions in additional analyses.

To exploit the additional variation in extra income coming from the presence of one or two transfer-eligible parents we disaggregate the *Transfer* variable above into two separate variables. The main specification in (2) is modified as follows:

$$Y_{it} = \alpha_i + \mathbf{X}'_{it}\beta + \gamma_1 \times One\_Transfer_{it} + \gamma_2 \times Two\_Transfers_{it} + \varepsilon_{it}, \tag{2.1}$$

where *One_Transfer* is an indicator variable equal to one for children who have only a single American Indian parent and receive the casino payments. The *Two_Transfers* is an indicator variable that is equal to one for children who have two American Indian parents and receive the casino payments. The coefficient on this variable would thus capture the change in outcomes due to the doubling of the transfer. There is no variation in the number of Native American parents over time, and we find that the casino transfers did not affect marital arrangements between the parents. Native American children have only one of these indicators turned on after the transfers

[18] In results not reported here, we include a squared Native American-specific time trend and find no differences in our results.

begin. The coefficient γ_1 captures the effect of having one source of exogenous income transfers and the coefficient γ_2 the effect of twice the transfer. The control variables are identical to the ones used in (2), but here we include separate linear trends controlling for potentially different growth trajectories between youth with one and two Native American parents.

It is important to note that there were no health or educational programs created immediately after the advent of casino disbursements by the tribal government. In later years new programs have been developed, but for the crucial period in which these children were minors in their parents' households, there is little evidence of new programs. Anecdotal evidence suggests that the revenues from the casino operations were, at least in the short run, spent only on per capita disbursements to the tribally-enrolled membership. Spending on large-scale construction was not completed until well after the youngest age cohorts were over 18 years old. Therefore, the children in this study were not exposed to new tribal programs or tribal facilities funded by the casino revenues.[19]

B. *Panel Level BMI Regression Analysis*

The basic difference-in-differences analysis implied differential effect on BMI and obesity rates at ages 19 and 21 depending upon initial household income. Figure 3 shows that children residing in treated households for the longest periods increased their BMI relative to others, but it also shows that they have higher variance in the gains. In this section, we investigate whether the data support similar heterogeneity in the effect of extra income once we account for fixed individual characteristics and race-specific trends, and exploit only variation coming from different survey waves within individuals. We also test for heterogeneous effects across maternal characteristics and children's initial health endowments.

The panel estimations, based on the model in equations (2) and (2.1), are reported in Tables 3–5. In addition to individual specific fixed-effects, all reported models include age-by-race dummies and a Native American-specific linear time trend. We cluster standard errors at the individual level. We also include an indicator for the presence of children in the household who are less than six years old. Consistent with previous results in the development literature, the effect of young siblings in the household is negative and significant. These results are robust to controlling for the total number of siblings in the family.

In column 1 of Table 3, we include a binary variable for casino payments that is equal to one in years when households are eligible (have at least one Native American parent) to receive transfers, and zero otherwise. The coefficient is small and not statistically different from zero. In column 2, we add an interaction term with initial household income, defined as the average household income reported by the parents in the first three survey waves before the casino transfers began. This specification is testing the hypothesis that the effects of casino transfers differ across pretreatment income groups. Adolescents residing in households eligible for casino

[19] Additionally, any new health-related facilities or programs would have been equally available to both poor and nonpoor individuals enrolled in the tribe, see Costello (2010).

Table 3—The Effect of Transfers on Children's BMI: Separating Out One- and Two-Native American Parent Households

					Native American only	
Variables	BMI (1)	BMI (2)	BMI (3)	BMI (4)	BMI (5)	BMI (6)
BMI panel						
Household eligible for casino disbursement	−0.211 (0.379)	0.673 (0.467)				
Interaction of casino × average household income		−0.184*** (0.0513)				
Household eligible for casino disbursement: One NA parent			−0.280 (0.389)	0.309 (0.500)		
Household eligible for casino disbursement: Two NA parents			−0.0780 (0.608)	1.763** (0.811)	0.487 (0.485)	2.095*** (0.778)
Interaction of casino one NA parent × average household income				−0.120** (0.0582)		−0.0940* (0.0496)
Interaction of casino two NA parents × average household income				−0.378*** (0.106)		−0.390*** (0.108)
Constant	22.44*** (1.120)	22.45*** (1.118)	22.58*** (1.119)	22.64*** (1.116)	27.37*** (0.850)	27.35*** (0.847)
Native American-specific time trend	Yes	Yes	No	No	No	No
Native American by number of American parents trend	No	No	Yes	Yes	No	No
Observations	4,585	4,585	4,585	4,585	1,219	1,219
R^2	0.319	0.321	0.320	0.322	0.346	0.353
Number of gsms	1,268	1,268	1,268	1,268	326	326
					Native American only	
Variables	Obesity (1)	Obesity (2)	Obesity (3)	Obesity (4)	Obesity (5)	Obesity (6)
Obesity panel						
Household eligible for casino disbursement	0.0525 (0.0320)	0.0816* (0.0427)				
Interaction of casino × average household income		−0.00607 (0.00647)				
Household eligible for casino disbursement: One NA parent			0.0352 (0.0353)	0.0344 (0.0481)		
Household eligible for casino disbursement: Two NA parents			0.0818* (0.0480)	0.212*** (0.0813)	0.0333 (0.0434)	0.173** (0.0829)
Interaction of casino one NA parent × average household income				0.000777 (0.00815)		0.00612 (0.00697)
Interaction of casino two NA parents × average household income				−0.0270** (0.0107)		−0.0265** (0.0108)
Constant	0.693*** (0.0976)	0.693*** (0.0978)	0.695*** (0.0984)	0.701*** (0.0986)	0.220*** (0.0767)	0.219*** (0.0764)
Native American-specific time trend	Yes	Yes	No	No	No	No
Native American by number of American parents trend	No	No	Yes	Yes	No	No
Observations	4,583	4,583	4,583	4,583	1,219	1,219
R^2	0.019	0.020	0.020	0.021	0.020	0.026
Number of individuals	1,268	1,268	1,268	1,268	326	326

Notes: Note in columns 5 and 6, the omitted category is having a single Native American parent as the reference group. Included in all specifications but not reported are: separate trend variables for one- and two-Native American parent households, number of children less than six years of age, age by race dummy variables, and a Native American-specific time trend. Household income is a categorical variable where each bin is $5,000 in size. The lowest category, for instance, goes from 0 to $5,000. The second bin goes from $5,001 to $10,000, etc. Clustered standard errors at the individual level in parentheses.

***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

transfer payments with no pre-transfer income have, on average, two-thirds of a unit increase in BMI, which is equal to 10 percent of the standard deviation of BMI for adolescent tribal members, but the coefficient is not statistically significant at conventional levels. The interaction effect is negative and statistically significant. As a result of the transfers, an adolescent from a household with $5,000 more in initial household income will have a BMI that is 0.18 BMI units lower than a comparable individual from a poorer household.[20]

In columns 3 and 4 of Table 3, we exploit the variation in the amount of casino payments to one- and two-Native American parent households. The model in column 3 is specified exactly following (2.1). The coefficient on the first transfer is negative and similar in size to the coefficient on the single transfer binary variable in column 1, but not statistically significant at conventional levels. Doubling the amount of the transfer due to a second eligible parent does not significantly affect the BMI of the household children.

The next specification in column 4 includes interaction terms of the one- and two-extra income indicators with initial household income. Both of the coefficients on the interaction terms are negative and statistically significant. Moreover, children from the initially poorest households with close to zero initial income with two Native American parents have the largest increases in initial BMI after the transfers began. Overall, these results confirm the findings already reported from the more restrictive specification in column 2—the effects of exogenous income transfers vary depending on the households' position in the initial income distribution. From the specification in column 4 we learn that the bigger the transfers, the larger the effects.

In online Appendix Table A6, we report the results from robustness checks on the specifications based on model (2.1). A potential concern is that the estimates are capturing the effect of coming from a two-parent Native American household (as compared to a one-parent household), rather than the effects of doubling the income transfers. In the robustness table, we restrict the sample to children coming from two-parent households and obtain the same results.

Finally, in columns 5 and 6 of Table 3, we restrict the sample to Native American children only and compare those who received double transfers to those who only received a single transfer. The results are essentially the same as estimated in columns 3 and 4.

An important issue to consider is whether the effect of extra unearned household income is similar across the children's initial BMI distribution. To that end, we first test for significant income effects on the incidence of obesity. The lower panel of Table 3 repeats the estimation with obesity, rather than BMI, as the outcome variable. The caveat here is that "obese" is an indicator variable and exhibits much less variation within an individual child. Moreover, once a child is obese, it is very hard to return to normal weight quickly.

[20] In unreported results, we also decompose the interaction variable using dummy variable interactions for the different household income categories. We find that the heterogeneity of effects by income also holds up—the coefficients on the interaction terms with the lowest income category dummies are much larger than the interaction terms with the highest income category dummy.

The empirical findings imply that the average effect of the income transfers was to increase obesity. The coefficient on the main transfers variable increases in magnitude and attains marginal statistical significance once we control for the interaction with initial income in column 2. At first glance these results could be interpreted to mean that the effect of casino income was to increase obesity across the initial distribution of both BMI and income. However, these results may simply mask heterogeneous extra income effects across the initial BMI distribution. We probe further by estimating fixed-effects models (Model (2)) in which the transfer variable is interacted with the quintile of the child's BMI at age 13. Online Appendix Table A7 presents the results. The income transfers increased BMI for children in the first four quintiles of the BMI distribution at age 13. The largest gain was among children initially in the middle of the BMI distribution—between the twentieth and the eightieth percentiles. Children who were initially in the fourth quintile (BMI $>$ 22.6 and BMI $<$ 26.4) could easily tip over the obesity threshold given the estimated average increase in BMI. At the same time, the income transfers decreased the BMI of children in the top quintile of the BMI distribution at 13. These children were already obese by age 13 (initial BMI $>$ 26) and the average loss was not sufficient to bring them back below the obesity threshold.

In the second column of online Appendix Table A7, we include the interaction term with initial income. The coefficient on the interaction term is negative and statistically significant and is similar in magnitude to the main estimates in Table 3. Thus, differential income effects across the BMI distribution are not the driving force behind our findings about effect heterogeneities depending on initial household income.

The additional specifications in Table 3 columns 3–6 exploit differences in size of the extra income transfer. The presence of a second income transfer appears to be driving both the main effect on obesity and the interaction term with initial household income.

C. *Panel-Level Weight and Height Regressions*

BMI has two components: weight and height. These components could be affected differently by extra household income during adolescence.[21] We investigate whether the differences in BMI between adolescents residing in households from different parts of the income distribution could be caused by the differential impact of extra income on these two components. Table 4 reports the effect on the government transfer on adolescent weight. We find in column 1 that there is a negative effect of receiving casino payments on gaining weight. However, this coefficient is not statistically significant, and when we include an interaction variable with the initial level of household income, the main effect becomes positive in sign (but not statistically significant). The interaction term is statistically significant implying

[21] There are several growth spurts in children's physical development during which they gain significantly in height. For example, boys in the United States gain up to 10 cm/year at age 13, and up to 5 cm/year at ages 14–16 (see, e.g., Figure 1 in Case and Paxson 2008). In our study, the youngest treated cohort were aged 13 at the time that the income transfers were first received by the parents. On average, these children would have gained around 25 cm (girls) and 28 cm (boys) in height between their thirteenth and twentieth year.

Table 4—Effect of Casino Transfers on Weight in Kilograms: Individual Fixed-Effects Panel Regression

Variables	Weight in kilograms (1)	Weight in kilograms (2)
Household eligible for casino disbursement	−0.667	1.384
	(1.083)	(1.413)
Interaction of casino × average household income		−0.428**
		(0.187)
Number of children in household less than six years old	−0.840*	−0.817*
	(0.458)	(0.458)
Constant	66.41***	66.43***
	(3.024)	(3.021)
Observations	4,585	4,585
R^2	0.549	0.550
Number of individuals	1,268	1,268

Notes: Clustered standard errors at the individual level in parentheses. Included in all specifications but not reported are: age-by-race fixed effects and a Native American-specific time trend. Household income is a categorical variable where each bin is $5,000 in size. The lowest category, for instance, goes from 0 to $5,000. The second bin goes from $5,001 to $10,000, etc.
***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

Table 5—Effect of Casino Transfers on Height in Centimeters: Individual Fixed-Effects Panel Regression

Variables	Height in centimeters (1)	Height in centimeters (2)
Household eligible for casino disbursement	0.191	−0.910
	(0.404)	(0.688)
Interaction of casino × average household income		0.230*
		(0.129)
Number of children in household less than six years old	−0.123	−0.135
	(0.231)	(0.231)
Constant	170.6***	170.6***
	(1.413)	(1.409)
Observations	4,585	4,585
R^2	0.568	0.568
Number of individuals	1,268	1,268

Notes: Clustered standard errors at the individual level in parentheses. Included in all specifications but not reported are: age-by-race fixed effects and a Native American-specific time trend. Household income is a categorical variable where each bin is $5,000 in size. The lowest category, for instance, goes from 0 to $5,000. The second bin goes from $5,001 to $10,000, etc.
***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

that there is a nonlinearity in the effect of additional household income on weight. A child coming from a household with an additional $5,000 in initial income would experience a 0.4 kg reduction in weight as a result of the extra income compared to a child coming from a household that was $5,000 poorer before the intervention.

We repeat this analysis for the adolescents' height at each survey wave. These results are presented in Table 5. In column 1, the casino disbursement dummy is positive but not significant. We find that the coefficient on the interaction term with initial household income in column 2 is positive and marginally statistically significant at the 10 percent level, implying that an adolescent from a household with $5,000 more in initial income will experience a 0.23 cm increase in height if they also receive the casino payments. It is possible that extra income transfers might result in height increases for children coming from better off families compared to poorer children.[22] This result should however be interpreted with caution as it is only marginally statistically significant. Further, the effect of increasing initial household income by $5,000 is very small in size—less than one-hundredth of the average increase in height for children between their thirteenth and twentieth year (see footnote 20).

Taken together these results show strong evidence for nonlinearity in the effects of extra unearned income on weight and some indication that children's height might be affected, even though the latter is much smaller and imprecisely estimated. Overall, the effects on weight are the dominant force that drives our findings on BMI.

D. *Potential Mechanisms*

Our findings thus far indicate that there is a heterogeneous effect of additional household income on the BMI of household children. The effect differs according to where the household resided in the initial (pre-transfer) distribution of incomes. In this section, we investigate whether our observed results are diminished or otherwise changed by interacting the casino transfer payment variable with other initial household conditions. The empirical specification in Table 6 is the same as presented in Table 3 columns 1 and 2, with the addition of other casino interaction variables.

In the first two columns, we include casino interaction variables with mother's initial labor force status and education levels. For simplicity of interpretation, we construct a dummy equal to one if the mother has a high school degree or more. Having less than a high school education is the omitted category. The coefficient on this variable is not statistically significant. Additionally, the main coefficient of interest, the interaction of casino payments and initial average household income, does not diminish greatly in magnitude or statistical significance.

The specifications in columns 3 and 4 in Table 6 include the casino transfer payment interaction with the child's birth weight and average weight in the first three survey waves (prior to the opening of the casino). Birth weight is coded in three categories: i) if birth weight is less than 2,500 grams; ii) if birth weight is greater than or equal to 2,500 grams but less than 4,500 grams; and iii) if birth weight is greater than or equal to 4,500 grams. Children who were born with low birth weight gain more relative to their peers. This may be due to two mechanisms. On the one hand, lower birth weight infants might maintain lower weight in adolescence, so they have more to gain. On the other hand, low birth weight may proxy for more fragile health or SES, which in itself may be related to larger gains in BMI. We test which hypothesis is more likely by including an interaction term with the individual's average

[22] In results not shown, after dividing the sample by males and females, we find that the effect is larger for males; the difference in coefficients by gender is not statistically significant.

Table 6—Potential Alternative Mechanisms of Casino Transfers on BMI: Individual Fixed-Effects Panel Regression

Variables	BMI (1)	BMI (2)	BMI (3)	BMI (4)	BMI (5)	BMI (6)
Household eligible for casino disbursement	0.133	0.963*	3.298**	2.804***	4.902***	4.082***
	(0.717)	(0.553)	(1.376)	(0.904)	(1.498)	(1.580)
Interaction of casino × average household income	−0.173***	−0.166***	−0.188***	−0.204***	−0.206***	−0.199***
	(0.0551)	(0.0543)	(0.0513)	(0.0499)	(0.0497)	(0.0545)
Number of children in household less than six years old	−0.293*	−0.219	−0.218	−0.221	−0.218	−0.289*
	(0.152)	(0.144)	(0.145)	(0.145)	(0.145)	(0.152)
Interaction of casino × mother's labor force participation	0.414					0.906
	(0.673)					(0.644)
Interaction of casino × mother has high school or more education		−0.484				−0.149
		(0.526)				(0.580)
Interaction of casino × child's birthweight			−1.290**		−1.109*	−1.093
			(0.644)		(0.639)	(0.670)
Interaction of casino × child's average weight prior to casino intervention				−0.0307**	−0.0284**	−0.0291**
				(0.0130)	(0.0130)	(0.0137)
Constant	20.95***	22.42***	22.41***	22.42***	22.39***	20.85***
	(1.558)	(1.124)	(1.113)	(1.115)	(1.112)	(1.557)
Observations	4,126	4,585	4,585	4,574	4,574	4,120
R^2	0.319	0.321	0.322	0.322	0.323	0.322
Number of individuals	1,131	1,268	1,268	1,262	1,262	1,128

Notes: Clustered standard errors at the individual level in parentheses. Included in all specifications but not reported are: age-by-race fixed effects and a Native American-specific time trend. Household income is a categorical variable where each bin is $5,000 in size. The lowest category, for instance, goes from 0 to $5,000. The second bin goes from $5,001 to $10,000, etc. Birth weight is coded in three categories: i) if birth weight is $<$ 2,500 grams; ii) if birth weight is $>$ 2,500 grams but less than 4,500 grams; iii) if birth weight is $>$ 4,500 grams.

***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

pre-casino weight (in kilograms averaged over the first three survey waves). Initially heavier children gain less. Once both interactions are included in the specification in column 5, the marginal effect of pre-casino weight is significant at the 5 percent level and birth weight is significant at the 10 percent level. We conclude that low birth weight proxies for more than simply genetic body mass differences.

In the specification reported in column 6 of Table 6, we include all of these additional interactions with our variable of interest, casino payment interaction with average initial household income. In this specification and in all of the previous ones, the negative interaction between initial household income and casino-generated cash remains economically and statistically significant. Changes in household income have a nonlinear effect on BMI for adolescents depending upon the level of the household's initial income, and initial income appears to matter more than any other channel that we consider in the analysis.

While birth weight, mother's education, and the child's BMI pre-intervention are predetermined variables, mother's labor force participation might have been directly affected by the casino operations. In turn, changes in mothers' (or fathers') employment may be the mechanism behind the observed effects of the transfers

Table 7—Parental Employment Before and After Casino Operations: Indiviudal Fixed-Effects Panel Regressions

	Mother			Father		
Variables	Employed (1)	Employed in the home (2)	Unemployed (3)	Employed (4)	Employed in the home (5)	Unemployed (6)
Household eligible for casino disbursement	0.109	−0.0521	−0.0638	−0.00652	−0.0171	−0.0372
	(0.102)	(0.0778)	(0.0853)	(0.0936)	(0.0124)	(0.0500)
Interaction of casino × average household income	−0.00737	0.00310	0.00483	−0.0179	0.00386	−0.00355
	(0.0112)	(0.00880)	(0.00587)	(0.0110)	(0.00325)	(0.00659)
Constant	1.212***	−0.0374	0.0257	0.931***	−0.0472	−0.0130
	(0.221)	(0.156)	(0.159)	(0.166)	(0.0475)	(0.0813)
Observations	2,084	2,084	2,084	2,083	2,083	2,083
R^2	0.012	0.035	0.010	0.020	0.018	0.009
Number of individuals	1,079	1,079	1,079	1,080	1,080	1,080

Notes: Included in all specifications but not reported are: separate trend variables for one- and two-Native American parent households, number of children less than six years of age, age by race dummy variables, and a Native American-specific time trend. Household income is a categorical variable where each bin is $5,000 in size. The lowest category, for instance, goes from 0 to $5,000. The second bin goes from $5,001 to $10,000, etc. Clustered standard errors at the individual level in parentheses.

***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

on children's health. Using data from the National Longitudinal Study of Youth (NLSY) Anderson, Butcher, and Levine (2003) show that more hours of work for employed mothers at the top end of the income distribution have a positive effect on children's BMI. Even though the children they consider are younger (aged 3–11) and the effect is driven by white, relatively well-off mothers, we test whether maternal employment differentially reacts to the extra income transfers in our sample. We explore this hypothesis in a series of regressions reported in Table 7. We use parents' self-reported employment status and test for differences before and after the transfers commence using the same specification utilized in Table 3 column 2. Neither the mother nor the father appear to have been affected in their employment decisions by the casino transfers. [23] Moreover, the size of the coefficients on the interaction variable between pre-transfer income and casino is very small in five out of the six regressions, in addition to not being statistically significant in any specification.

There is no conclusive evidence that Native American parents reacted to the exogenous income transfers by either increasing or decreasing their employment. We also found no evidence that survey participants' parents changed their industry of employment to the gaming, entertainment, or hospitality sector. In the entire panel data we only identify one individual who was employed in these industries.

We utilize several additional survey questions to investigate other potential mechanisms for the adolescent weight loss or gain due to the income transfers.

[23] Cawley (2010) offers a nice summary of the current state of the economics literature on children's obesity and in particular the role of maternal labor force participation. Skoufias and di Maro (2006) find no evidence for changes in parental labor force participation for households receiving payments from the PROGRESA program in Mexico.

Table 8—Potential Mechanisms Used in Weight Loss: Individual Fixed-Effects Panel Regressions

Variables	Reduced appetite (1)	Weight loss in last 3 mos. (2)	Bulimic (3)	Exercise to lose weight? (4)	Using appetite suppressants? (5)	Dieting to lose weight? (6)
Household eligible for casino disbursement	−0.025 (0.109)	−0.150 (0.13)	−0.055 (0.059)	−0.145 (0.112)	−0.105 (0.089)	−0.013 (0.045)
Interaction of casino × average household income	0.004 (0.015)	0.016 (0.018)	0.005 (0.008)	0.015 (0.014)	0.009 (0.009)	0.000 (0.006)
Constant	0.095 (0.246)	0.940** (0.365)	0.241*** (0.023)	0.220*** (0.040)	0.042** (0.018)	0.068*** (0.012)
Observations	4,574	4,565	4,579	4,578	2,827	4,581
R^2	0.0107	0.00930	0.00880	0.00800	0.00974	0.00431
Number of individuals	1,266	1,266	1,268	1,267	1,215	1,268

Notes: Included in all specifications but not reported are: separate trend variables for one- and two-Native American parent households, number of children less than six years of age, age by race dummy variables, and a Native American-specific time trend. Household income is a categorical variable where each bin is $5,000 in size. The lowest category, for instance, goes from 0 to $5,000. The second bin goes from $5,001 to $10,000, etc. Clustered standard errors at the individual level in parentheses.

***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

In Table 8, we report the results from linear regressions using our main estimation model that tests for differential transfer effects on self-reported weight-related health behaviors and conditions. These variables indicate whether the person is bulimic, has lost weight in the past three months, exercises to lose weight, or uses dieting to lose weight. We do not find clear evidence in favor of any particular channel of weight loss, nor do we find any differences in the propensity to lose weight or suffer from reduced appetite. While we cannot draw strong conclusions since we do not have information on food consumption and nutrition choices, the estimates in Table 8 suggest that nutrition choices, rather than exercise or dieting, are more likely to be the driving force behind the estimated effects in Table 3.

E. *Other Health Outcomes*

We have shown that exogenous income transfers affect children's body mass differently depending on the households' standing in the pre-transfer income distribution. These effects persist several years after the initiation of the transfers, implying a medium-term effect of increasing household income on children's future health. In light of the extensive literature on the family income gradient on the long-term health of children, it is instructive to consider other (self-reported) measures of children's health.

Table 9 reports the estimates from linear panel regressions of the transfers' effect on a number of common health conditions. A priori it is not clear how extra income transfers would affect the probability of suffering from hay fever, headaches, or respiratory allergies, and so we consider these tests as a falsification exercise. However, there is some prior evidence that children coming from lower SES backgrounds are more likely to suffer accidents and experience asthma

Table 9—The Effect of Transfers on Alternative Health Outcomes: Fixed-Effects Panel Regressions

Variables	Accidents (1)	Asthma (2)	Hay fever allergies (3)	Respiratory allergies (4)	Allergies total (5)	Headaches (6)	Eczema (7)
Household eligible for casino disbursement	0.063	−0.101	0.059	−0.089	−0.087	−0.042	0.028
	(0.126)	(0.071)	(0.057)	(0.083)	(0.087)	(0.091)	(0.029)
Interaction of casino × average household income	−0.010	0.005	−0.007	−0.001	−0.001	0.006	0.002
	(0.016)	(0.007)	(0.010)	(0.014)	(0.015)	(0.008)	(0.002)
Constant	0.676	0.413	0.135	0.042	0.228	0.533	−0.016
	(0.622)	(0.336)	(0.120)	(0.278)	(0.288)	(0.439)	(0.150)
Observations	4,452	4,452	4,452	4,452	4,452	4,452	4,451
R^2	0.0230	0.00914	0.0236	0.00696	0.0196	0.0132	0.00562
Number of individuals	1,263	1,263	1,263	1,263	1,263	1,263	1,263

Notes: Included in all specifications but not reported are: separate trend variables for one- and two-Native American parent households, number of children less than six years of age, age by race dummy variables and a Native American-specific time trend. Household income is a categorical variable where each bin is $5,000 in size. The lowest category, for instance, goes from 0 to $5,000. The second bin goes from $5,001 to $10,000, etc. Clustered standard errors at the individual level in parentheses.

***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

attacks. We find no evidence that there is an initial income gradient in the effect of transfers on the incidence of either of the conditions. The coefficients on casino eligibility are also not statistically significant and point in different directions. We emphasize that contrary to body weight, height, and BMI, these current health status variables are reported by the parent up to age 16 and then self-reported by the individual thereafter. Therefore, the usual caveats should be applied in interpreting the results. In addition, the children in the sample are in their teens, and their initial health endowments have been determined prior to the income intervention. If we take the results at face value, they suggest that exogenous household income would likely affect children's body weight faster than any of the other health outcomes examined in Table 9.

IV. Concluding Remarks

Due to the quasi-experimental nature of our data, we are able to identify the effect of a permanent increase in unearned household income on weight gain and eventual obesity in adolescents and young adults. We trace out differential effects of extra income depending on the initial financial conditions of the household.

We find that individuals who come from the initially poorest households tend to gain more weight after the introduction of the transfer payments than their richer neighbors. These effects are not due to initial health conditions as proxied by birth weight. We also show that the heterogeneity remains, even after we include interactions with maternal characteristics and the child's initial health endowment and pre-transfer BMI. Investigation of several alternative mechanisms, such as maternal labor force participation, does not yield any plausible alternative candidate channel through which the effects could operate.

Taken as a whole, our findings support the notion that unearned extra household income has heterogeneous effects on adolescent body mass depending upon the child's household type. This has several implications for the design of welfare policies intended to address the family SES gradient in children's health and SES outcomes. First, pure cash transfers intended to close the initial SES gap between children will have unintended medium-term effects on these children's body mass in impoverished families. Second, exposure to poverty during childhood cannot be fully mediated through extra income interventions starting in early adolescence. Finally, children's body mass is likely to react to exogenous income transfers more quickly than other health outcomes, such as chronic conditions. Research on the long-term health effects of exogenous household income transfers should consider potential heterogeneities of the type revealed in this study.

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