The Effects of Sports Participation and Television Viewership on Adolescent Obesity: Evidence from the Panel Study of Income Dynamics

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INTRODUCTION

Childhood obesity has become a veritable pandemic in the Western world. The Center for Disease Control and Prevention (CDC) notes that childhood obesity rates have more than tripled in the past 30 years. Formerly 6.5 percent in 1980, the obesity rate for children aged 6 to 11 in the United States was just under 20 percent in 2008 (CDC, 2010). This represents a troubling prospect for policymakers and healthcare professionals for a number of reasons, but first and foremost, these trends have led to an overall decline in the health of America's youth. The CDC notes that "obese youth are more likely to have risk factors for cardiovascular disease…bone and joint problems, sleep apnea, and social and psychological problems such as stigmatization and poor self-esteem," (CDC, 2010). Aside from the obvious costs to public health, studies suggest that the total economic costs of childhood obesity amount to several hundred million dollars annually, and this figure rises yearly (Ludwig, D. S., 2007). These costs can take the form of lost productivity and rising medical costs, brought on by both increased prevalence of physical and psychological disabilities (Ludwig, D. S., 2007). Obese and inactive people have also been shown to command lower wages and achieve lower family incomes than their non-obese, more physically active counterparts (Lechner, 2009; Averett, S. and Korenman, S., 1996). In light of this information, it is clear that recent childhood obesity trends pose a vexing problem. With this in mind, the research presented herein sets out to explain the statistical relationship with patterns of sports participation, television viewership, and the onset of childhood obesity.

Should sports participation be shown to have a negative effect on obesity in adolescents, some policies should be pursued. At the state level, the subsidization of public schools' athletic departments or the creation of new parks and recreational facilities may increase sports activities amongst children. School systems can encourage participation in sports through rewards systems

for participation. Parents are perhaps the most pivotal, however, and can restrict children's access to screen-based media and television, opting instead to teach their children the value of sports and encouraging their participation.

Studies have shown that there are pronounced positive relationships between sports activity and self-image, the overall quality of one's peer relationships, and physical health status (Iannotti, Kogan, Janssen, and Boyce, 2009). Indeed, others have suggested that, above all else, adolescents engage in sports activities for the boosts in personal relationships they allow through team camaraderie (Webber and Mearman, 2009). Moreover, those active in sports are also more energetic and less prone to fatigue (Puetz, 2006). What this body of research suggests is that, overall, those participating in sports are generally more active, happy, and social, and these factors should overall decrease the probability of obesity.

Screen-based media use, on the other hand, is expected to have a negative effect on the probability of childhood obesity. In the same vein as before, screen-based media use has been shown to reduce self-image, physical fitness, and overall quality of life (Iannotti et al., 2009). Furthermore, screen-based media use like television viewership has demonstrated statistically significant, positive relationships with body mass index (BMI) (Crawford et al., 1999). If one accepts Puetz (2006)'s premise that children engaging in physical activity are more energetic as well, it seems highly plausible that those engaging in higher levels of screen-based media use may find themselves more fatigued and more inactive, which should lead to higher obesity probabilities. Furthermore, given the literature discussed, it may follow that these children are also less prone to at any point become physically active, because they already have reduced self-images, which have been shown to play a role in the decision to engage in physically rigorous activity (Webber and Mearman, 2009).

In any econometric study involving childhood obesity, it is intrinsically difficult to determine causal effects due to the potential for reverse causality amongst the variables involved. It is entirely possible that, contrary to earlier assumptions, obesity may lead to lower sports participation. Because obese children almost certainly have more sedentary lifestyles, sports participation may be negatively affected. The opposite effect could also occur - obese children's parents may encourage them to participate in sports to remedy the already developed obesity issue, which may conversely increase the child's sports participation. With these scenarios in mind, it is crucial to control for parental and family backgrounds in an effort to reduce reverse causality. The same logic applies to screen-based media – those children who are already obese may be more prone to engage in screen-based media use because of their already sedentary lifestyles. Obese children may also be more prone to fatigue, which can shift their entertainment prospects more toward screen-based media, as opposed to many more active alternatives.

Furthermore, it is entirely possible that there may be several sets of unobserved or less easily obtained variables (such as family background and neighborhood environment), that may affect obesity as well as sports participation and media use simultaneously. For example, wealthy neighborhoods may provide more sporting facilities to their children, which would undoubtedly affect sports participation. Simultaneously, wealthier neighborhoods may have higher capacities to provide for more nutritious foods, which could affect obesity as well. The child's genetic predisposition could also very well impact both their chances of becoming obese *and* their physical ability to perform well in sports. These omitted variables make these directions of causality just as probable as the ones discussed prior. A few measures have been taken to mitigate this problem.

First, a variety of parental characteristics are included. Since the majority of the omitted variable bias comes from family background, including parental background may reduce the bias. The PSID allows for a matching of child characteristics to those of their parents, so data on both can be analyzed with relative ease. Some of the variables include each parent's highest completed level of education, their weekly number of hours worked, their frequency of heavy physical activity, and their duration of unemployment, should any exist. The issue of reverse causality will be addressed by using lagged data to account for behavior in prior time periods. This practice ensures that obesity cannot influence the independent variables.

This research improves upon prior works by measuring the intensity of sports participation and media use to a much more precise degree. Prior studies have chosen to measure both sports participation and media use with dummy variables or simple intensity scales. The PSID and CDS allow for markedly higher degrees of precision. For each sports participation and media use classification, the exact number of minutes spent on each activity per week is recorded. This more precise measure is a significant improvement upon previous estimations. Furthermore, the periods included here (2002 and 2007) are more current than previous work, allowing for a more contemporary analysis of the subject. Changes in patterns of sports participation and media use have most definitely occurred since the dawn of the 21st century, so the research at hand is also more relevant in this sense.

LITERATURE REVIEW

Studies have confirmed that there exists a statistically robust relationship between patterns of sedentary behavior and childhood obesity rates. One of the most prominently studied sedentary pastimes is screen-based media use, or the time children spend watching television,

playing video games, and using the computer. Many have suggested that there are many negative health and human capital effects associated with elevated levels of screen-based media use. Iannotti et al. (2009) show that screen-based media use among adolescents actually has a negative relationship with positive health indicators like self-image, physical health status, and quality of life. The authors measure screen-based media by the number of hours spent on weekends and weekdays using a computer or watching television. Furthermore, Crawford, Jeffery, and French (1999) find that, amongst adults, television viewership is positively related to BMI.

Aside from screen-based media use, a great deal of focus has been given to physical activity in the form of team sports participation amongst adolescents in the childhood obesity literature. For obvious reasons, many have suggested that sports participation yields lower obesity rates, but it has also been shown to yield a great deal of other positive social and professional outcomes.

In the same study as before, Iannotti et al. (2009) confirm that sports participation leads to benefits in peer relationships, self-image, and overall health. The authors measure sports participation as the number of days the subject spends more than 60 minutes engaging in sports activities. Similarly, Webber and Mearman (2009) find that students primarily engage in sports activities for the benefit of social relationships, while the added benefit of physical activity also registers nominally. This may suggest that students engaging in sports activities are more active both physically and socially, and the latter shows through in terms of human capital and employment as well. Kosteas (2010) finds that regular exercise leads to higher earning potential. Similarly, Lechner (2009) shows that physical activity leads to higher wages for men and higher family income for both men and women. Children engaging in extracurricular activities like

sports are also typically higher academic achievers and less likely to engage in risky behavior (Eccles and Barber, 1999). Rees and Sabia (2010) also find that college aspirations run higher in high school athletes. Perhaps most important, however, is the nexus between sports activity and obesity itself. Hofferth and Curtin (2005) find that children who participate in sports are nearly 80 percent less likely to be overweight than those that do not. The authors utilize the CDS time diary in their study, measuring sports participation in the same fashion proposed here, but with older data. Goran, Reynolds, and Lindquist (1999) rationalize this finding by arguing that physical activity like sports participation increases energy expenditure and the resting metabolic rate, leading to the more favorable utilization of daily caloric intake than those who do not exercise at all. Indeed, the effects of physical activity in adolescents are widespread.

Aside from the two main independent variables, it is also important to call attention to the importance of family background. As discussed briefly prior, parental relationships, both genetic and personal, can have a significant influence on a child's probability of becoming obese. Anderson, Butcher, and Levine (2003) find that the greater number of hours worked by the child's mother, the greater that child's chance of becoming obese. The reasoning is intuitive – the higher number of hours worked by the mother on any given day, the less time she has to cook, shop, or regulate the child's eating habits. This can potentially lead to a lack of nutritional development. Lopoo (2007) reaches somewhat opposite conclusions and finds that increases in maternal employment yield higher sports participation in children. If one assumes that sports participation reduces obesity, then one would assume higher maternal employment levels would yield lower obesity. This discrepancy is interesting, and may suggest that there is some give-and-take in terms of maternal employment's effects on childhood obesity between the child's increased sports activity and seemingly simultaneous degradation of eating habits. Aside from

this, Whitaker et al. (1997) show that parental obesity is also an efficient predictor of obesity in very young children. The authors note a diminishing effect as the child grows older, but the relationship is significant nonetheless.

Each of these studies is useful in piecing together the originally posed research question, but many of them lack an accurate measure of sports participation and do not attempt to establish causality. Iannotti et al. (2009) do not attempt to answer the question of screen-based media or sports activity's effects on obesity. Furthermore, their measure of sports activity assumes that any activity taking place for under 60 minutes essentially never occurred. The authors use the number of days per week where more than 60 minutes of sports activity is undertaken, and this is relatively imprecise. Across each of these studies, no precautions are taken against reverse causality through the utilization of prior years' television viewership and sports participation. Hofferth and Curtin (2005) actually utilize the same methodology proposed herein, including the controls for reverse causality, but the PSID waves they use are older (1997 and 2002, to be precise). The analysis here differs because of the inclusion of the new data for 2007. Because obesity trends may have changed since the time periods studied by Hofferth and Curtin (2005), it is likely that different outcomes will be achieved. The methodology used herein corrects prior researchers' imprecise measurements by accounting directly for sports and television intensity, as well as utilizing prior CDS waves to account for reverse causality.

DATA AND METHODS

This study uses data taken from the University of Michigan's Panel Study of Income Dynamics (PSID). The PSID is a national survey that began in 1968 and was updated yearly until 1997, after which it has been updated every two years. The survey includes nearly 9,000

U.S. families and individuals and it includes several volumes of information on economic, health, and social indicators. Specifically, data is drawn from the Child Development Supplement (CDS), which tracks the progression of child subjects from childhood to young adulthood in the period between 1997 and 2007. During this period, the CDS records information on education, health, cognitive and behavioral development, and time use (PSID, 2010). For the purposes of this study, 2002 and 2007 waves are used. This way, temporal variation is considered, alongside a variety of cross-sectional variables. The advantage of using the PSID is that, for the two main explanatory variables, sports and media use, are broken down into individual activities (see **Appendix A**). This takes into account activities at all levels and locations, and allows for markedly more precision than other data.

The PSID derives the obesity variable by posing the question "has the child's doctor or health professional ever said that the child was obese, over-weight, or at risk of being over-weight?" (PSID, 2010). It is coded as a dichotomous variable with 1 indicating obese. Obesity rates for the children in the 2007 wave are shown broken down by age and gender in **Table 1**. Ages in the entire sample range from 10 to 19 for 2007 and the average obesity rate is 13.9 percent. For 2002, the age rage is of course much broader – from 5 to 19. The younger sample also means that a noticeably smaller percentage of the children are obese in 2002 – only 0.02 percent. The national obesity rate for children aged 12-19, as provided by the CDC, is 18.1 percent (CDC, 2010). The rate for ages 6-11 is 19.6 percent (CDC, 2010). The difference in the CDC estimates and those in the PSID sample for 2007 may be because the PSID is self-reported. A better measure for obesity should be based on the child's BMI.

The main independent variables are sports participation and television viewership. Previous studies have been vague with regard to their descriptions of sports participation, usually

quantifying the information as simply how often the subjects participate in sports as a blanket activity. In an effort to avoid vagueness, the sports activity variable utilized in this research is aggregated from 72 different sports activities taken from the CDS time diaries. The 72 variables are broken down into lessons, general sports, and meets and practices (see **Appendix A**). Each child included in the CDS gives a weekly response as to how much time they participate in each sport category on both weekdays and weekends, and this is then aggregated for sports in general,

Table 1 – Childhood Obesity Rates by Age and Gender, 2007

Age	% Obese	% Male Obese	% Female Obese
10 (n=60)	18.33 (n=11)	12.12 (n=4)	25.93 (n=7)
11 (n=193)	10.88 (n=21)	15.12 (n=13)	7.48 (n=8)
12 (n=187)	13.90 (n=26)	13.10 (n=11)	14.56 (n=15)
13 (n=207)	14.49 (n=30)	15.09 (n=16)	13.86 (n=14)
14 (n=209)	17.23 (n=36)	19.2 (n=24)	14.29 (n=12)
15 (n=203)	16.26 (n=33)	14.88 (n=18)	18.29 (n=15)
16 (n=201)	11.44 (n=23)	8.7 (n=8)	13.76 (n=15)
17 (n=163)	11.66 (n=19)	9.1 (n=7)	13.95 (n=12)
18-19 (n=68)	17.65 (n=12)	12.82 (n=5)	24.14 (n=7)

giving a much more precise measure. Television viewership is measured as the precise amount of time spent weekly on watching television. The values expressed for these variables are in minutes.

For 2002, the average amount of time spent on sports activities per week is 64.23 minutes. For 2007, the weekly average is 79.04 minutes. The difference is likely due to the subjects' ages – older children participate more in sports because of school team availability and greater developmental coordination. The average weekly television viewership for 2002 is 286.22 minutes and the average for 2007 is 267 minutes. Other screen-based media activities are also reported by the CDS time diaries, and of the aggregate number of minutes spent on all media for both weekends and weekdays, television accounts for 64.8 percent. As shown in **Figure 1**, the sample distributions for sports activity and television viewership for 2007 are both

Table 2 – Variable Descriptive Statistics (Mean and Standard Deviation)		
Variable	**2002**	**2007**
Television Viewership	286.22 (194.85)	267 (205.62)
Sports Participation	64.22 (109.09)	79.04 (123.93)
Child's Obesity Status	0.002 (0.05)	0.14 (0.35)
Child Age (Younger than 10)	0.33 (0.47)	0 (0)
Child Age (10-12)[1]	0.25 (0.43)	0.29 (0.46)
Child Age (13-15)	0.21 (0.41)	0.42 (0.49)
Child Age (16-19)	0.21 (0.41)	0.29 (0.45)
Gender	0.48 (0.50)	0.48 (0.50)
Child Race – Black	0.43 (0.50)	0.41 (0.49)
Child Race – White	0.44 (0.50)	0.45 (0.50)
Child Race – Hispanic	0.06 (0.23)	0.08 (0.27)
Child Race – Other	0.07 (0.25)	0.06 (0.25)
Good Self-Rated Health – Good	0.94 (0.23)	0.90 (0.29)
Chronic Illnesses	0.96 (1.21)	1.31 (1.48)
Family Income	62,125.71 (74,329.54)	70,715.42 (84,263.69)
Mother's Age	26.61 (19.01)	26.15 (21.89)
Mother Obese	0.23 (0.42)	0.28 (0.45)
Mother's Hours Worked per Week	17.50 (20.27)	16.85 (20.13)
Mother Completed High School	0.55 (0.50)	0.51 (0.50)
Father's Age	40.05 (9.37)	42.57 (11.44)
Father Obese	0.27 (0.45)	0.34 (0.47)

[1] Italicized variable means that it is used as the referent group.

Table 2 – Variable Descriptive Statistics (Mean and Standard Deviation) (cont.)		
Father's Hours Worked per Week	37.51 (18.86)	34.27 (20.44)
Father Completed High School	0.76 (0.43)	0.78 (0.41)
At Least One Parent Completed High School	0.80 (0.40)	0.82 (0.38)
At Least One Obese Parent	0.33 (0.47)	0.36 (0.48)
Parents' Hours Worked per Week Combined	54.67 (30.41)	50.65 (31.69)

noticeably right-skewed. Therefore, both variables are transformed on a logarithmic scale in the regression model.

Figure 1 – Television Viewership and Sports Participation Distribution, 2007

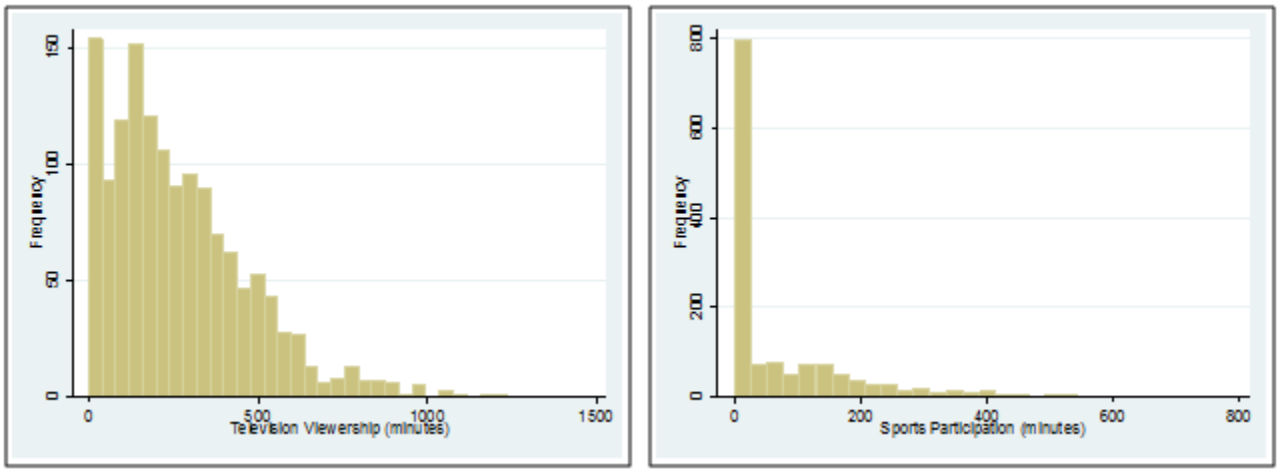


Table 3 provides more details on adolescent sports participation and television viewership. In particular, males that play sports do so for greater periods of time than females. Similarly, a greater percentage of males play sports than females. Roughly the same percentages of males and females watch television, but again males appear to do so for greater periods of time than females. These gender differentials exist for both 2002 and 2007.

Figure 2 describes the relationship between sports participation and television viewership and average obesity rates by gender in 2007. 18.4 percent of males who do not play any sports

are obese whereas 10.9 percent of males who play sports are obese. 17.7 percent of females who do not play sports are obese, while 9.8 percent of females who play sports are obese. 15.1

Table 3 – Weekly Sports Participation and Television Viewership by Gender, 2002 and 2007

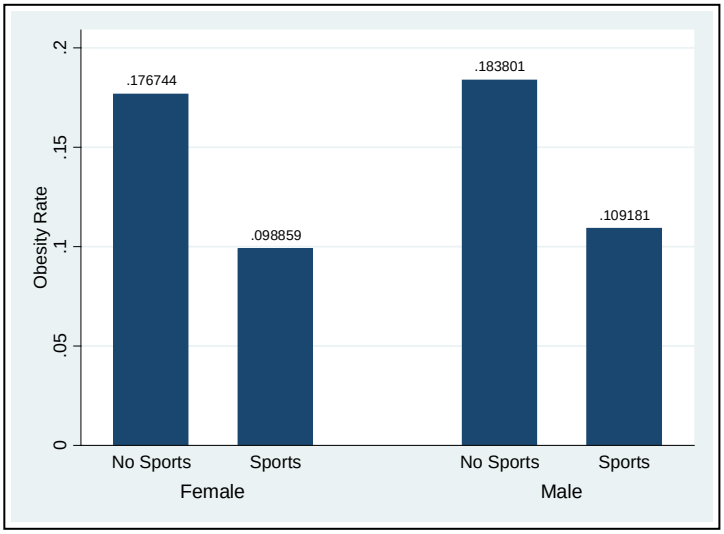
	Male			**Female**		
	% playing sports	% playing more than 2 hours per week	Mean for those who play sports (minutes)	% playing sports	% playing more than 2 hours per week	Mean for those who play sports (minutes)
All Sports Categories (2002)	49.13	35.36	165.5	35.29	13.51	133.41
All Sports Categories (2007)	55.57	32.19	180.79	38.02	17.65	149.09
	% watching TV	% watching more than 4 hours per week	Mean for those who watch TV (minutes)	% watching TV	% watching more than 4 hours per week	Mean for those who watch TV (minutes)
Television (2002)	96.2	53.96	308.09	94.83	50	291.08
Television (2007)	92.3	50.21	302.84	92.68	42.47	274.01

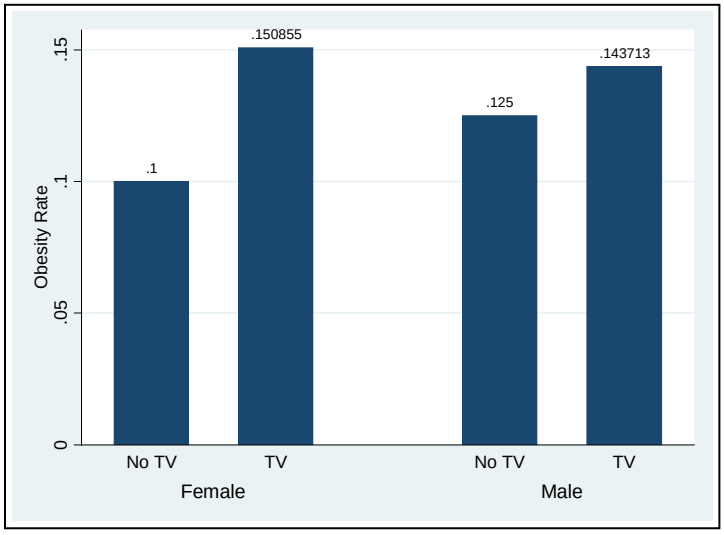
percent of females that watch television are obese whereas only 10 percent of females who do not watch television are obese. 14.4 percent of males who watch television are obese, while 12.5 percent of males who do not watch television are obese.

A variety of demographic control variables are included (see **Table 2**) including the child's age categories, gender, and racial background. Two measures of the child's overall health are also included – self-rated health status and the number of chronic illnesses. Self-rated health is a dichotomous variable that takes the value of 1 if the child reports their health to be in "good", "very good", or "excellent" condition and 0 if "fair" or "poor". 90.4 percent of the 2007 sample and 94.4 percent of the 2002 sample report their health in "good", "very good", or

"excellent" condition. The number of chronic conditions is an aggregate of several variables wherein the child is asked if the child's physician has ever indicated that the child suffers from a chronic condition such as allergies, autism, hyperactivity, or orthopedic impairment. There are 9 possible conditions – the average for 2007 is 1.31 and the average for 2002 is 0.96. It is assumed that higher levels of chronic conditions may impact the probability of obesity in a positive fashion.

Figure 2 – Obesity Rates for Sports Participators and Non-sports Participators and Television Viewers and Non-television Viewers by Gender, 2007





Finally, to again increase the model's predictive power and mitigate the potential for omitted variable bias, several of the subjects' parental and familial characteristics are also included. Family income is included in the model since low-income children are found to be more likely to be obese (Anderson and Butcher, 2006). The average family income for the 2002 wave is $62,125.71 and the average for the 2007 wave is $70,715.42. This variable is transformed to a logarithmic scale because of right-skewness.

Independent variables controlling for parental obesity, average number of hours worked per week, ages, and educational achievement are utilized. 69 percent of parents in the 2007 wave are high school graduates. 50.1 percent of mothers are high school graduates, while 78.1 percent of fathers are high school graduates. In the 2007 wave, 33.7 percent of fathers are obese versus 27.8 percent for mothers. 36 percent of the respondents had at least one obese parent. Fathers in 2007 worked on average 34.3 hours per week and mothers worked on average 16.9 hours per week. For 2002, both mothers and fathers worked slightly longer hours (17.5 and 37.5 hours, respectively). Obesity rates among parents in the 2002 wave are lower as well. Indeed, 27.4 percent of fathers are obese in 2002 and 22.6 percent of mothers are obese.

MODEL ESTIMATION

Because the dependent variable is dichotomous, a *probit* regression model is used, taking the following form:

$$P(y = 1|x) = \Phi(\beta_0 + x\beta),$$

where *P* denotes the probability of obesity and *x* includes characteristics of the child and his or her parents discussed prior. Φ is a cumulative distribution function of the normal distribution. The coefficient estimates reported in the results section are the marginal effects of the *probit* model, calculated at the mean with the following partial derivative:

$$\frac{\partial p(x)}{\partial x_j} = \phi(\beta_0 + x\beta)\beta_j,$$

where ϕ is a probability density function and:

$$\phi(z) \equiv \frac{d\Phi}{dz}(z).$$

Thus, using the above-referenced adjustment function, the coefficients of the regression model can be interpreted as obesity probabilities. To account for heteroskedasticity, robust standard errors are reported using Huber/White/sandwich estimates.

As noted prior, there is the potential for reverse causality in the above-referenced model. Children that are obese or chronically ill may be less likely to play sports, and are thus more likely to be obese. To avoid potential endogeneity, all children who are obese in 2002 (0.02 percent) are dropped from the regression. In separate models, lagged parental variables and lagged child health variables (observations from 2002) are used to predict the subjects' obesity in 2007. These precautions ensure the intended direction of causality – how sports participation, television viewership, parental characteristics, and child health affect their obesity, instead of the other way around.

In addition, it is important to control early child health status (number of chronic conditions and self-reported health) because sicker children are less likely to play sports and may be more likely to become obese as a side effect of the original illness. It could also be that these chronic diseases are in the causal pathway of sports and obesity. Those who are less likely to play sports are more likely to be obese and had more chronic conditions and rated their health poor. If this is the case, it may not be necessary to include these variables. Nevertheless, models including these variables and models excluding these variables are both presented.

The sample size for the 2007 wave, including all adults and children, is 11,482. For 2002, the sample size is 10,744. If the child or parent reports missing values for any of the pivotal variables, the observation is dropped from the regression. This limits the total sample size to between 1,028 and 1,162, depending on the model observed. The sample size is between 610 and

727 for children with both parents, again dependent upon which model is being observed. All statistical analyses are conducted in Stata.

RESULTS AND ANALYSIS

The main regression result is reported in **Table 4** for children who have at least one parent. Four model specifications are estimated including different combinations of independent variables from both 2002 and 2007. All four models have dropped the children who are reported as obese in 2002. **Models (1) through (3)** utilize 2007 variables to predict obesity. **Model (4)**, however, uses 2002 parental characteristics and child health variables as discussed in the section prior. **Model (4)**, therefore, is the preferred model, and the results reported below are based on **Model (4)** unless otherwise specified.

Across all four specifications, child sports participation is statistically significant at at least 5 percent. The magnitude of the relationship varies across each model. In the preferred model, however, children with 10 percent higher levels of sports participation are 14.4 percent less likely to be obese. Television viewership achieves statistical significance at the 10 percent level in only **Models (1), (2), and (4)**. Based on the preferred model, children with 10 percent higher levels of television viewership are 14.7 percent more likely to be obese.

Of the child demographic variables, only two of the race variables – black and Hispanic – are statistically significant at the 5 percent level. Black and Hispanic children are 4.92 and 10.8 percent more likely to be obese than white children, respectively. These findings are consistent with statistics released by Federal Interagency Forum on Child and Family Statistics (FIFCFS), which show that in 2007, Mexican-Americans and African Americans comprised 24.2 and 22.4 percent of the national population of obese children between the ages of 6 and 17, versus only

Table 4 – Probit Regression Results for Children with At Least One Parent (Marginal Effects)

VARIABLES	(1) Obesity	(2) Obesity	(3) Obesity	(4) Obesity
TV Viewership (Log)	0.0141*	0.0129*	0.0111	0.0147*
	(0.00732)	(0.00708)	(0.00681)	(0.00779)
Sports Participation (Log)	-0.0180***	-0.0178***	-0.00979**	-0.0144***
	(0.00429)	(0.00422)	(0.00384)	(0.00456)
Child Age (13-15)	0.0372	0.0323	0.0231	0.0269
	(0.0255)	(0.0249)	(0.0230)	(0.0267)
Child Age (16-19)	-0.00616	-0.00732	-0.00576	-0.0235
	(0.0267)	(0.0262)	(0.0240)	(0.0273)
Gender	0.0194	0.0230	-0.0130	0.0131
	(0.0205)	(0.0202)	(0.0187)	(0.0216)
Child Race – Black	0.0412*	0.0223	0.0496**	0.0492*
	(0.0226)	(0.0252)	(0.0247)	(0.0270)
Child Race – Hispanic	0.0762	0.0820	0.137**	0.108*
	(0.0469)	(0.0505)	(0.0580)	(0.0555)
Child Race – Other	-0.0470	-0.0534	0.00308	-0.0178
	(0.0365)	(0.0341)	(0.0435)	(0.0444)
Family Income (Log) (07)		0.0150	0.0231*	
		(0.0132)	(0.0129)	
At Least One Obese Parent (07)		0.0733***	0.0534***	
		(0.0209)	(0.0193)	
Parents' Hours Worked Combined (07)		-0.000837**	-0.000614*	
		(0.000404)	(0.000356)	
At Least One Parent Completed HS (07)		-0.0171	-0.0186	
		(0.0292)	(0.0258)	
Child Self-Rated Health – Good (07)			-0.112***	
			(0.0406)	
Child Chronic Conditions (07)			0.0703***	
			(0.00697)	
Family Income (Log) (02)				0.0287**
				(0.0143)
At Least One Obese Parent (02)				0.0878***
				(0.0242)
Parents' Hours Worked Combined (02)				-0.000529
				(0.000436)
At Least One Parent Completed HS (02)				0.00454
				(0.0295)
Child Self-Rated Health – Good (02)				-0.166***
				(0.0644)
Child Chronic Conditions (02)				0.0295***
				(0.00870)
Observations	1,162	1,162	1,137	1,028

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

17.4 percent for whites (FIFCFS 2007).

Parental obesity is the strongest predictor of obesity probability across all specifications. Children with at least one obese parent in the current year (2007) are between 5.34 and 7.33 percent more likely to be obese themselves. In the preferred model, which uses lagged parental variables, children with at least one obese parent are 8.78 percent more likely to be obese in 2007. More parental hours worked reduces obesity probabilities, but the relationship only exist when utilizing observations from 2007. Higher family income increases the probability of obesity by about 2-3 percent. Whether or not the child's parent has graduated from high school seems to have no bearing on the child's probability of becoming obese.

Chronic health conditions and self-rated health are both significant at the 1 percent level, regardless of which wave is used as predictors. In the preferred model, an increase of one chronic illness increases the probability of obesity by 2.95 percentage points. Children that reported their health to be "good" are significantly less likely to be obese. Specifically, in the preferred model, these children are 16.6 percent less likely to be obese.

Two-Parent Subsample Analysis

One of the more interesting questions involved with this study regards whether the mother and father have different effects on child obesity rates. To answer this question, a subsample is constructed that consists of children with both parents. Children with single parents are dropped. This yields a sample size between 610 and 727, depending on the model specification. Regressions are run in the same fashion as before, but because the existence of both parents is guaranteed, variables describing individual characteristics of the mother and father are included. Two separate regressions are run that separate father's characteristics

(**Model (3)**) from mother's characteristics (**Model (2)**). **Model (4)** includes both parents' individual characteristics. These separate measures have been undertaken to discern which characteristics matter more – the mothers' or the fathers'. Because the number of children who have both parents is understandably smaller than those with at least one, the sample size is reduced to between 600 and 700 depending on the specification. These results are posted in **Table 5**.

Again, sports participation is an extremely efficient predictor for obesity, achieving near-universal significance at the 1 percent level. The coefficient's sign again confirms the original expectation – higher sports participation yields a lower probability of obesity. Across all six models, a 10 percent increase in sports activity yields between a 9 and 20 percent lower obesity probability in children with both parents. Television viewership achieves 5 percent significance in both **Models (2) and (4)** and in both models the expected relationship holds. Across the two models, a 10 percent increase in television viewership yields between a 17.6 and 21.4 percent increase in the probability of obesity.

The parental characteristics included in the two-parent subsample are of particular interest to this study. Each of the individual variables' effects is localized to either the mother or the father; there is no overlap. For example, only maternal obesity appears to adequately predict the child's obesity probability in a statistically significant manner. At the same time, only paternal employment and paternal education (to a much lesser extent) are statistically significant predictors for the child's obesity. Indeed, children with obese mothers are between 11.1 and 12.5 percent more likely to be obese themselves. The mother's obesity status achieves 1 percent significance in both the middles in which it is included. Conversely, for every 10 hour increase in the father's work week, the child is roughly between 1.48 and 1.66 percent less likely to be

Table 5 – Probit Regression Results for Children with Both Parents (Marginal Effects)

VARIABLES	(1) Obesity	(2) Obesity	(3) Obesity	(4) Obesity
TV Viewership (Log)	0.0144*	0.0214**	0.0123	0.0176**
	(0.00849)	(0.00868)	(0.00875)	(0.00849)
Sports Participation (Log)	-0.0194***	-0.0176***	-0.0190***	-0.00854**
	(0.00498)	(0.00492)	(0.00520)	(0.00432)
Child Age (13-15)	0.0487	0.0571*	0.0523	0.0313
	(0.0321)	(0.0336)	(0.0348)	(0.0302)
Child Age (16-19)	0.0427	0.0510	0.0358	0.0350
	(0.0348)	(0.0385)	(0.0381)	(0.0344)
Gender	0.0561**	0.0469*	0.0513**	-0.00493
	(0.0239)	(0.0240)	(0.0249)	(0.0213)
Child Race – Black	0.0370	0.00287	0.0489	0.0168
	(0.0333)	(0.0311)	(0.0381)	(0.0319)
Child Race – Hispanic	0.0967*	0.0786	0.128**	0.123*
	(0.0502)	(0.0581)	(0.0630)	(0.0680)
Child Race – Other	-0.0493	-0.0235	-0.0673*	-0.00111
	(0.0380)	(0.0458)	(0.0352)	(0.0506)
Family Income (Log)		0.00507	0.0312	0.0378*
		(0.0205)	(0.0224)	(0.0209)
Mother's Age		0.00320*		0.00287
		(0.00179)		(0.00303)
Mother Obese		0.111***		0.125***
		(0.0362)		(0.0392)
Mother's Hours Worked		-0.000753		-0.000366
		(0.000659)		(0.000630)
Mother Completed HS		0.0182		0.0346
		(0.0356)		(0.0256)
Father's Age			0.00103	-0.000198
			(0.00166)	(0.00256)
Father Obese			0.0349	-0.00214
			(0.0273)	(0.0223)
Father's Hours Worked			-0.00166**	-0.00148**
			(0.000755)	(0.000667)
Father Completed HS			-0.0527	-0.0662*
			(0.0379)	(0.0375)
Child Self-Rated Health – Good				-0.126**
				(0.0556)
Child Chronic Conditions				0.0522***
				(0.00762)
Observations	726	667	663	609

Robust standard errors in parentheses; *** P<0.01, ** p<0.05, * p<0.1

obese. Paternal employment achieves 5 percent significance in both **Models (3) and (4)**. The paternal education variable, achieving only 10 percent significance in **Model (4)**, suggests that children whose fathers have completed high school are 6.62 percent less likely to be obese.

DISCUSSION AND CONCLUSION

First and foremost, the results of both the main regression and the two-parent subsample confirm that sports participation is a statistically and economically robust predictor of childhood obesity. Children engaging in regular sports activities are significantly less likely to be obese. The reasoning is intuitive – sports activity implies a more active lifestyle. Previous studies have shown that sedentary behavior can greatly increase any given child's chance of becoming obese, and the findings presented here essentially confirm this fact.

Television viewership fails to achieve as universal significance as sports participation, but it is a moderately efficient predictor for obesity. In the two-parent subsample analysis, the television viewership variable does achieve 5 percent significance, however, and higher levels of television viewership do lead to higher obesity probabilities. While this is a less consistent predictor, it nonetheless serves to confirm the notion that television viewership is contributing to adolescent obesity rates in the United States.

The results of this study also imply that black and Hispanic children of single parents are markedly more likely to be obese than those with both parents. If one accepts the premise that children falling under these minority categories already represent a higher percentage of the obesity population of 6-17 year olds, as reported by the FIFCFS, it makes sense that those children who only have one parent may be even more prone to obesity. Single parents are likely less able to actively monitor the quality and quantity of food their children consume simply

because they have less time. Two parents may find it easier to balance work and child-rearing, and thus have a greater ability to monitor their child's caloric intake. Single parents may not be afforded this luxury, and this sort of process may explain the higher obesity probability for minority children of single parents.

The results from the parental characteristic variables are also of particular interest to this study. First and foremost, in children with at least one or more parents, parents' obesity and employment are important. Likely due to genetics and eating habits, parents who are obese tend to have children who are much more likely to be obese themselves. This effect is more pronounced for children with at least one parent than for children with both parents. Consistent with Lopoo (2007)'s findings with regard to maternal employment, children with at least one parent are noticeably less likely to be obese at higher levels of parental employment. This can likely be attributed to, as Lopoo (2007) states, greater participation in after-school activities amongst children with working parents, which focus more on physical activity. The results of the two-parent subsample are slightly less intuitive.

When broken down into individual maternal and paternal characteristics, the effects of parental obesity, employment, and even education are localized to either the mother or the father. For children with two parents, the mother's obesity status is a very strong predictor (significant at the 1 percent level) for childhood obesity probabilities. Indeed, children with obese mothers are between 11.1 and 12.5 percent more likely to be obese. The father's obesity status seems to have no bearing on the child's chances of becoming obese, however. At the same time, only the father's employment seems to have any bearing on the child's probability of being obese – this result contradicts the findings in Lopoo (2007), where maternal employment is the focus.

To conclude, in terms of sports participation, the magnitude of the effects on obesity probabilities is roughly the same for children with at least one parent and children with two parents. What this implies is that active lifestyle choices, most readily available through all sorts of sports activities, are imperatives in the fight to lower childhood obesity rates in the United States. Parents and schools should continue to encourage sports activity in young children so as to establish healthy precedents early on that will persist into adolescence. Simultaneously, while the economic and statistical significance is lower, entertainment activities like television viewership should be avoided. Again, this responsibility falls upon the child's parents and school administrators.

With this established, parental characteristics are also extremely important to consider. Children with obese mothers are dramatically more likely to be obese themselves, suggesting that some of the lifestyle choices espoused by parents may affect those of their children. Because the mothers in the PSID sample seem to work fewer hours per week on average, it may follow that they spend more time with their children. Thus, the mother's obesity status should have a greater impact on the child than the father's. This again highlights the importance of parents' stressing healthy lifestyle choices including regular participation in sports and entertainment activity other than television. These choices are especially important for parents who are themselves obese. The father's hours worked, contrary to the findings in Lopoo (2007), seem to seem to reduce childhood obesity. This may have more to do with the fact that, on average, the sample's fathers worked significantly more than the mothers. Thus, changes in the father's hours worked may have a larger effect. The negative relationship may exist for reasons similar to those suggested in Lopoo (2007). Higher paternal employment hours may imply that the child participates in more afterschool activities while the father is away at work. These afterschool

activities are usually more active in nature, and this should have a negative effect on obesity probabilities.

Essentially, the results of this research add greater credence to the notion that the current childhood obesity epidemic can be attributed to a rise in sedentary lifestyle choices amongst America's youth. Further research, including waves closer than 5 years apart, may be warranted to observe this relationship as time goes on, as the childhood obesity issue is constantly changing. Ultimately, a model that controls for reverse causality through sports participation and television viewership observations from one or two years prior would be ideal, and perhaps future waves of PSID questionnaires will be able to provide this information. Either way, the importance of active lifestyle choices during childhood, especially with respect to sports participation, are paramount to culling the growth in childhood obesity in the coming years, and this trend seems to start from the household.

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APPENDIX A – Breakdown of Sports Participation Variable

The sports participation variable detailed in **Figure 1** is an aggregate of three separate CDS time diary activity categories: meets, lessons, and sports in general. The "meets" category details the time the child spends participating in sporting meets or games containing the following activities: unspecified team sports, football, baseball/softball, basketball, volleyball, soccer, hockey, swimming, track/running, gymnastics/dance, unspecified individual sports, tennis, squash, golf, ice skating, martial arts, boxing and wrestling, and bowling. The "lessons" category details the time the child spends participating in lessons containing the following activities: dance, swimming, golf, tennis, skating, gymnastics, yoga, martial arts, body movement, and aerobics. The "sports in general" category details the time the child spends participating in sports outside both meets and lessons, and contains the following activities: football, basketball, baseball, volleyball, hockey, soccer, field hockey, unspecified sports using racquets, tennis, squash, racquetball, paddleball, golf, swimming, water-skiing, skiing, sledding, snowboarding, ice skating, roller skating, unspecified recreational sports, bowling, pool, miniature golf, Frisbee/catch, unspecified gym exercises, judo/boxing, martial arts, wrestling, weight lifting, gymnastics, hunting, fishing, boating, extreme sports, bicycling, tricycling, horseback riding, walking for pleasure, hiking, jogging, and non-social dance/ballet. For each of these categories, participation is recorded for both weekdays and weekends.