



California Center for Population Research
University of California - Los Angeles

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CCPR-036-07

December 2007

***California Center for Population Research
On-Line Working Paper Series***

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Paper presented at the 29th Annual APPAM Research Conference, Washington DC, November 8-10, 2007. This research was supported by US Department of Agriculture, CSREES Grant #2005-35215-16075. Acknowledgements: Patricia Crawford, Judy Gomez, Nelly Mallo, November McGarvey, Anthony Ramirez, Eva Saul, Shannon Whaley.

Conference draft: Please do not cite or distribute.

Abstract

Overweight and obesity constitute a growing and significant public health problem; increasing incidence and prevalence of overweight in young children is of particular concern. This study examines the question of whether participation in the Special Supplemental Nutrition Program for Women, Infants and Children (WIC) may play a role in risk for early childhood overweight. We conducted a case-control study including 555 WIC participant children ages 3-5 years who were either overweight (BMI >95th percentile of reference standard) or normal weight (BMI 25-75th percentile). The hypothesis was two-sided, since there are logical reasons why WIC participation might be either preventive or promotive of overweight in young children. The population is large majority (95%) Hispanic, a group that has been documented to have the highest rates of overweight and obesity in adults and children. The independent variable of interest (“Family Dose of WIC”) was constructed as cumulative history of WIC program participation for the entire family, adjusted for reported breaks in participation, and then expressed as person-years. Family dose of WIC did not differ between cases and controls, and had a median of 12.6 person-years. In multivariate logistic regression analyses controlled for a number of variables, “family dose of WIC” had no predictive power. Only mother’s BMI and child height were significantly predictive of child overweight; number of hours of television watching showed a slight but non-significant relationship to overweight risk and number of hours of sleep at night a slight but non-significant negative relationship. There is no indication that cumulative time of WIC program participation influences risk of early childhood overweight.

Keywords: WIC, overweight, Hispanic, children

Introduction

Overweight in young children

Obesity is the most prevalent and pressing nutrition problem in the US, and is rapidly becoming a global epidemic. Because obesity predisposes to several chronic and costly illnesses including diabetes, heart disease, and several types of cancer¹, there are substantial human and economic costs consequent to the recent rapid rise in prevalence of obesity. Almost two-thirds of the US adult population is now overweight or obese². Children are also affected, and the health risks to children include early predisposition to diabetes and high blood pressure as well as important social and emotional disadvantages³. Overweight in children is defined³ as relative weight above the 95th percentile of the standard reference population – based on weight-for-height ratio prior to release in 2000 of the current CDC guidelines for Body Mass Index* (BMI) percentiles, and based on BMI since that time^{4**}. Between 1971 and 2004, prevalence rates for overweight among children rose from 5.0 to 13.9% among children aged two to five years and proportionately as much or more for older children, with 18.8% of 6-11-year olds and 17.4% of 12-19-year olds estimated to be overweight in 2004.^{4,5} NHANES data from 1971 to 2000 show that the extent of overweight among children (i.e., the degree of overweight among those who are overweight) has increased even more rapidly than the prevalence of overweight among US children and adolescents⁶.

*Body mass index is calculated as weight in kilograms divided by height in meters, squared (kg/m²).

**We are aware of the American Obesity Association recommendation for terminology for children, in which BMI between the 85th and 95th percentiles is termed “overweight” and >95th percentile “obese”. In this paper we utilize the CDC-recommended terms.

Hispanic children are particularly at risk. A recent analysis of national data from the Fragile Families and Child Wellbeing Survey, which focuses on urban, low-income children, showed that among three-year-olds, 35% were above the 85th percentile of the reference BMI distribution (“at risk of overweight” by CDC definition); Hispanic children more than twice as likely as either non-Hispanic white or black children to meet this criterion.⁷

The major established risk factors for overweight in children include parental and sibling overweight⁸ and low levels of physical activity^{9, 10}. There is some indication that not having been breast-fed is also an independent but weaker risk factor¹¹. All of these risk factors are extremely prevalent in the US population.

The data addressing dietary influences on overweight risk for young children are not generally as conclusive as for other risk factors, probably due to the difficulty of accurately measuring usual diet in a precise and quantitative manner; but dietary behavior clearly plays a role. The Feeding Infants and Toddlers Study, of 3022 American children 4 to 24 months of age in 2002, showed that fruit and vegetable consumption was low or non-existent among 20 to 33 percent of children, and French fried potatoes were the most commonly consumed vegetable by age 18 months (25 percent of all children). Presweetened cereals were consumed by 18 percent of 12-month-old toddlers. Desserts, sweets or sweetened beverages were included in the diets of 46 percent of 7- to 12-month infants. By two years of age, 62 percent ate desserts, 20 percent consumed candy, and 44 percent drank sweetened beverages¹².

At any age, treatment options for overweight are generally unsatisfactory. Prevention, beginning early in childhood through careful attention to both diet and physical activity, is the only viable public health option.

The role and potential of the WIC program

The Special Supplemental Nutrition Program for Women, Infants and Children (WIC) provides targeted food and nutrition assistance to low-income pregnant, breastfeeding and postpartum women, infants and children up to five years of age. The program has three major components in terms of benefits: supplemental food of high nutrient content, nutrition education, and referrals to health and social services. WIC has grown rapidly over the last 25 years, and now serves more than eight million women, infants and children/year nationally at a cost of about five billion dollars.¹³

Because of its rapid expansion and cost, the program has come under critical scrutiny^{14, 15} and suggestions have been made in the popular press that food assistance programs in general, WIC among them, may be contributing to the obesity epidemic. The available published evidence does not support such an assertion. A CDC analysis of data from 1988-91 showed that low-income children enrolled in WIC did not have higher weight-for-height than those low-income children not enrolled in WIC¹⁶. A recent analysis of NHANES data for 2-4 year-old children showed no differences in weight status between WIC participants and eligible non-participants^{17, 18}.

While various aspects of the WIC program have been evaluated, most of this work has focused on the benefits for pregnant women. Improved pregnancy outcomes and reduced medical expenditures have been well demonstrated. The most recent is an

elegant analysis by Bitler and Currie¹⁹ utilizing data from the national Pregnancy Risk Assessment Monitoring System and showing that among Medicaid mothers, all of whom are income-eligible for WIC, WIC participants are negatively selected on a wide variety of observed variables and yet WIC participation is associated with more favorable pregnancy outcomes, utilizing a set of state-year interactions to capture unobservable variables at the state level.

Fewer studies have focused on child participants, but the analyses that are available point to significant benefits. The National WIC Evaluation, based on WIC data from the early 80s, found significant improvements in dietary quality for children in WIC²⁰. More recently, Basiotis et al. analyzed data from the 1989-91 CSFII and showed that participation in the WIC program by at least one family member raised the aggregate Healthy Eating Index score for the household significantly, compared to households that did not participate in the WIC program²¹. The role of the WIC program in the ongoing decline in the prevalence of anemia in low-income children is well documented²². An important recent analysis²³ showed that Medicaid-enrolled children participating in WIC had greater use of all types of health services, including preventive services and effective care of common illnesses, than Medicaid-enrolled children who were not WIC participants. We have shown a favorable impact of the program on household food insecurity²⁴; and given the demonstrated association of household food insecurity for both physical and mental health of children^{25, 26} this is likely to be a major positive contribution of the program.

With regard to risk of childhood overweight, we can conceptualize a role for the WIC program in either direction – promoting or preventing the development of

overweight in young children. It is logical that the nutrition education provided is helpful, and also that the increased participation in the health care system now well demonstrated for children has a beneficial effect. The California Health Interview Survey data from 2001²⁷ show substantially higher prevalence of overweight in children under five who had no usual source of health care versus those who usually received care in either a physician's office or a community clinic (21.8% vs. 15.0% and 13.7% respectively). The fact that overweight is a risk criterion for WIC eligibility implies that program policy assumes that the interventions through WIC can benefit overweight children.

If we hypothesize the opposite -- that WIC participation might actually promote risk of overweight -- then it is necessary to consider the effect of the WIC food package on the family food system and on the child's and family's dietary intake. The WIC food package was originally designed to focus on foods that are concentrated sources of the nutrients believed to be limiting in the diets of low-income women and children when the program began -- namely calcium, iron, protein, vitamin A and vitamin C; with the exception of the addition in 1992 of carrots and canned tuna to create an enhanced package for exclusively breastfeeding women, the food packages have not changed. Newer knowledge of the relationship of diet to chronic disease risk would argue for an emphasis on nonfat and low-fat milk and a food package designed to maximize fruit and vegetable consumption, among other goals. The current proposed changes in the food package, based on an Institute of Medicine recommendation²⁸, will bring the supplemental packages into congruence with current dietary guidance²⁹ and stand to contribute positively to the health of WIC participant women, infants and children.

However, up to this time one could conceptualize that the amount of whole-fat milk, cheese, and eggs included in the food packages, particularly for families with multiple participants, might adversely impact dietary quality in terms of relatively large contributions of fat, saturated fat and dietary energy.

Studies of the effect of WIC participation on any outcome have been plagued by problems of selection bias, since it is not possible to randomly assign individuals to participant or non-participant status. Since WIC has grown to serve a very large portion of the low-income population of women, infants and children (91% of low-income infants in Los Angeles County are served by the program, for example), it has become increasingly impossible to conceptualize, let alone to find, comparable control groups to study program impact. One way to circumvent this problem is to focus within the universe of program participants, quantifying their exposure in terms of duration and/or intensity of participation. Very little work has been published that has attempted to quantify WIC participation. An important paper by Devaney and others²³, investigating the effect of WIC participation on Medicaid costs and use of health services, derived a four-level intensity-of-participation variable defined as the percentage of months from birth to current age of the index child in which food vouchers were redeemed (>66% high, 34-66% medium, <34% low, and none). We are aware of no work to date that has attempted to look at participation as a total family exposure rather than for an individual child.

Data and Methods

We conducted a case-control study of overweight vs. normal-weight three and four year old WIC participant children in Los Angeles County. The study population was drawn from a single large WIC clinic east of Los Angeles. We defined “overweight” as a BMI greater than the 95th percentile of the CDC reference population, and “normal weight” as a BMI between the 25th and 75th percentile.

Over a 14-month period in 2006-2007, on three days/week, the mother of the first presenting child age 36-59 months who met the overweight criterion was invited to participate; if she agreed and enrolled in the study, then the mother of the next presenting child of the appropriate age but within the “normal weight” range was invited. Altogether 555 children and their mothers participated, 259 overweight children and 296 of normal weight.

After informed consent, height and weight were measured for the mother (the child’s measurements had already been taken as part of standard protocol) and an appointment was made for the study interview by telephone. The interview was conducted in English or Spanish, according to the participant’s preference, and took an average of almost an hour. If the participant had to break off the interview, an appointment was made for another call to complete it. Interviewers were WIC paraprofessional staff who worked overtime to do the telephone interviews; they were bilingual in English and Spanish and blind to the weight status of the child with whose mother they were speaking on the phone. Altogether, 83 mothers invited to participate declined; eight who had consented could not be reached (7 disconnected phones and 1

moved out of the area), and only one interview had to be stopped partway when the respondent declined to continue.

The first part of the interview collected detailed information for a complete roster of household composition, including nativity, gender, relationship, and birthdates or age. This was followed by in-depth questioning about the family's history of WIC participation, for all relevant members and in any place in the country. Additionally, an extensive battery of questions was asked about health, feeding patterns and activity variables for the index child, food security, and home environment. The study was approved by the Institutional Review Boards at Public Health Foundation Enterprises and UCLA.

Most data were entered in a bilingual computer-assisted system during the interview; the family roster and history of WIC participation data were recorded on paper, and later entered into the database.

We constructed the "family dose of WIC" variable as total person-years rather than chronological time with any family member participating (there is overlap between a breastfeeding or postpartum mother and her infant, and often may be overlap of one or both with another child or children in the family). For example, if a mother participated for six months during her pregnancy and six months postpartum, and the infant born of that pregnancy was enrolled in WIC for one year after birth and then again for one year from age three to four, the total family exposure is three person-years. The rationale for using total person-years rather than total chronological time is that the former more accurately reflects the totality of supplemental food and its influence on the family food

supply. We counted WIC participation in any WIC program for families who had participated elsewhere before moving into the area.

Statistical analyses were completed using SAS version 9.1 (2005, SAS Institute, Inc, Cary, NC). We used descriptive statistics, t tests and Chi-square tests to describe and assess the statistical significance of differences in characteristics of overweight children and normal weight children.

We used multivariate logistic regression to identify independent predictors of overweight/normal weight.. Overweight status was the dependent variable. Independent variables included square root of family WIC history adjusted for breaks in participation, gender, ethnicity, interview language, maternal age, log (base 10) of maternal body mass index (BMI), whether the mother was born or not in the US, household size, child height (as a Z-score relative to norms), whether the child was ever breastfed or given breast milk, hours of sleep per night, hours of TV watching per day and perceived weight status of biological father.

Male, Hispanic, Spanish language of interview, born in the US, ever breastfed, television viewing on a usual day none/one hour or less, and normal weight/thin were used as the reference groups for gender, ethnicity, interview language preference, whether the mother was born or not in the US, hours of TV watching per day and perceived weight status of the child's biological father respectively.

Independent variables were considered to be significant predictors of the child's overweight status if p value was $<.05$. Odds ratios and their 95% confidence intervals were calculated.

The best subset of independent variables was found using the subset selection method. The goal of this method is to find the subset with the largest “Pseudo Cp”. Pseudo Cp is computed using the following formula: $\text{Score statistic} - 2*(P+1)$, where score is the output given by SAS and P is the number of independent variables³⁰. The best subset of independent variables obtained included ethnicity, hours of TV watching, the mother’s BMI, child height, and hours of sleep per night.

Results

Descriptive Statistics

Just over half (50.2%) of study children were girls. The ethnic distribution was 95.7% Hispanic, with only 22 children of other ethnic groups (Table 1).

Table 1. Ethnic Identification of Study Participants

Ethnic Identification	Percent
Latina or Hispanic	95.7%
Non-Hispanic White	1.8%
Non-Hispanic Black	1.1%
Asian-American	0.4%
American Indian	0.2%

Basic household and maternal characteristics are presented in Table 2. There was no difference between cases and controls with regard to maternal age, household size, whether the mother was born in the US, or language of the interview. More than three-

quarters of the interviews were conducted in Spanish, and almost 80% of mothers were first-generation immigrants.

Average maternal body mass index met the criterion for obesity, or nearly so, for both groups but was significantly higher for mothers of overweight children (Table 2). Most mothers were obese (BMI \geq 30) and the vast majority were overweight or obese (BMI \geq 25). Only 13 percent of mothers of overweight children and 26% of mothers of normal-weight children were of normal weight themselves,

Table 2. Household and Maternal Characteristics
(mean + sd or %)

	Overweight Children	Normal-weight Children
Household size, # persons	5.1 \pm 1.7	5.0 \pm 1.7
Mother's age, yrs	31.2 \pm 6.6	30.0 \pm 6.6
Mother's BMI, kg/m ² ***	32.7 \pm 7.1	29.5 \pm 6.3
Mother obese	61%	41%
Mother overweight or obese	87%	74%
Mother born in the US	22.0%	21.0%
Interview conducted in Spanish	76.8%	75.1%

*** p<.0001

There were no significant differences between cases and controls for the following variables, so they are described for the sample as a whole: Almost three-quarters (72%) of mothers were not employed outside the home; most fathers (71%

worked full-time. Almost all (89%) had either public or private health insurance. More than one-third of households (37%) were food-insecure utilizing the full USDA food security assessment instrument.

Most children (75%) had some history of breastfeeding but most (87%) also or exclusively had history of formula feeding as infants. Forty-one percent of mothers perceived their child to be “more active than other children” and only three percent thought their child was less active than others. Twenty-six percent of the children were reported to be in “excellent” health and only 5% in “fair” or “poor” health. The average number of hours sleep/night was just under eleven (10.8 ± 1.5) and 45% of the children were reported to still take one or more naps/day. More than three-quarters (76%) reported having a television set in the room where the child sleeps. Almost two-thirds (64%) of children were reported to eat in front of the television one or more times on a typical day. These combinations of activities were generally accompanied by crowded housing, requiring eating, sleeping and entertainment often in the same room. In response to a question about how many times in the previous week the child had eaten “fast food”, the average was less than one time ($0.8 +0.7$) and not different for overweight children vs. normal weight children.

Cumulative Family History of WIC Participation

Figure 1 shows the distribution of cumulative family history of WIC participation, in person-months, and Table 3 summarizes the data in person-years. The median exposure to the program for these families was 12.6 person years, and there was no

difference between cases and controls. Due to the shape of these histograms, this variable was square-root transformed in the multivariate analyses.

Figure 1. Cumulative Family WIC Participation History in Person-Months*

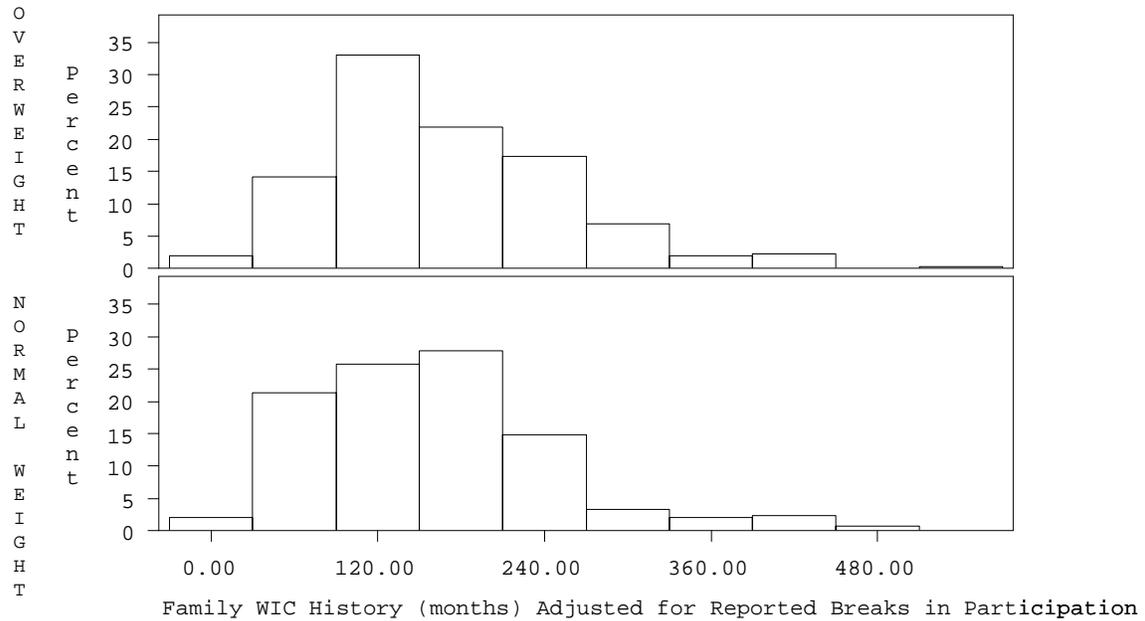


Table 3. Cumulative Family WIC Participation History in Person-Years*

	Overweight Children	Normal-weight children
Mean \pm sd	13.9 \pm 7.3	13.4 \pm 7.1
Median	12.7	12.6
10 th -90 th percentiles	5.7 - 23.3	5.2 - 21.8

*Adjusted for reported breaks in participation

Does cumulative family history of WIC participation predict overweight status when controlled for other potentially relevant variables?

Logistic regression models confirmed no effect of cumulative “family dose of WIC participation” in predicting overweight (Table 4). Maternal BMI was by far the strongest predictor of childhood overweight, even within this group of mothers most of whom were obese. Child height was also significant, with overweight children being about 0.5 Z-score taller on average than normal-weight children. There is a suggestion of an effect of hours of television watching ($p=.06$) and a possible negative relationship with hours of sleep/night ($p=.08$).

Table 4. Effects of Cumulative Family WIC History on Childhood Overweight
Multivariate Logistic Regression

Variable	Odds Ratio	P value	95% Confidence Interval
Square-root of family WIC history adjusted for breaks in participation	0.995	0.8805	0.928 - 1.067
Characteristics of the Child			
Gender	1.113	0.5822	0.760 - 1.629
Whether the child was ever breastfed or fed breast milk	1.068	0.7743	0.680 - 1.680
Hours of TV watching per day	1.608	0.0677	0.966 - 2.676
Hours of sleep per night	0.893	0.0806	0.787 - 1.014
Height for age Z score	1.729	<.0001	1.428 - 2.094
Maternal Characteristics			
Ethnicity	0.445	0.1293	0.157 - 1.267
Language of the Interview	1.041	0.9065	0.534 - 2.028
Mother born or not in the US	1.313	0.4521	0.646 - 2.671
Log of Body Mass Index	10.023	<.0001	3.771 - 26.643
Age	1.003	0.8629	0.970 - 1.037
Perceived weight status of biological father	1.024	0.9177	0.656 - 1.599
Household Characteristics			
Household size	0.979	0.9536	0.480 - 1.998

Male, Hispanic, Spanish language of interview, born in the US, ever breastfed, television viewing on a usual day none/one hour or less, and normal weight/thin were used as the reference groups for gender, ethnicity, interview language preference, whether the mother was born or not in the US, hours of TV watching per day and perceived weight status of the child's biological father respectively.

The best subset of independent variables was found using the subset selection method. The goal of this method is to find the subset with the largest "Pseudo Cp". Pseudo Cp is computed using the following formula: $\text{Score} - 2*(P+1)$, where score is the output given by SAS and P is the number of independent variables³⁰. The best subset of independent variables obtained included ethnicity, hours of TV watching, the mother's BMI, child height, and hours of sleep per night.

Discussion

This study utilized a “dose” variable, defined as cumulative person-years of WIC program participation for a family, in order to explore whether WIC exposure was related either positively or negatively to overweight in three- and four-year-old children. So far as we are aware, this is the first study to conceptualize WIC participation in terms of total family exposure.

Total family history of program participation averaged more than 13 person-years, indicating that the influence of the supplemental food package and other program benefits had been significant for most of these families. WIC “dose” did not differ significantly between overweight and normal-weight children and had no predictive power in multivariate analyses.

Overweight children were slightly taller, on average, than normal-weight children, consistent with many other studies. Overweight children spent slightly more time watching television than normal-weight children, consistent with other studies^{9, 10}, although this relationship did not quite reach statistical significance in multivariate models. Overweight children also appeared to spend slightly less time sleeping at night than normal-weight children (again not quite statistically significant); this interesting finding is consistent with a recent study of overweight in preschool children in urban Vietnam³¹.

Maternal BMI was an extremely strong predictor of childhood overweight, even within this sample in which most mothers were overweight and a majority obese. The adjusted odds ratio of 10 corresponds to a change of one unit on the log₁₀ scale of

maternal BMI. Therefore, for example, the OR is 1.2 for a change of 20% and is 1.5 for a change of 50% in maternal BMI.

We asked mothers whether they remembered their own childhood weight status as thin, average or overweight. Eighteen percent of mothers of overweight children remembered themselves as overweight in childhood, compared to only 8% for mothers of normal-weight children. Forty-two percent of mothers of normal-weight children remembered themselves as “thin” children, as did 32% of mothers of overweight children.

The population for this study was almost entirely Hispanic and the children’s mothers were mostly first-generation immigrants. These characteristics limit generalizability to the overall US population, but have the advantage of focusing on the ethnic group at highest risk for overweight.

Based on the analyses presented here, we conclude that there is no reason to temper enthusiasm for the many demonstrated positive benefits of WIC participation for low-income mothers and their children in light of the recent epidemic of pediatric overweight. Rather, attention should focus on utilizing the very wide coverage and reach of the WIC program to empower parents with regard to providing healthy eating and activity patterns with a view to reversing the trend toward overweight in young children.

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