Food Preparation for the School Lunch Program and Body Weight of Elementary School Children in Taiwan

Hung-Hao Chang

Associate Professor, Department of Agricultural Economics, National Taiwan University, No 1, Roosevelt Rd, Sec 4, Taipei 10617, Taiwan

Abstract

In investigating the association between the school lunch programs and children's body weight, this study focuses on the school lunch programs in Taiwan. Using a national representative dataset of elementary schoolchildren, we estimate a mixed multinomial logit model to cope with the potential endogeneity issue, and examine how different types of food preparations for school meal programs may affect children's weight in different ways. The results indicate that children who go to schools which serve lunch meals prepared by school kitchens tend to have lower weight on average. In contrast, children who go to schools offering lunch boxes purchased from outside restaurants tend to have higher weight on average. From a policy standard point of view, our findings could shed some light on how school lunch policy can be designed to help prevent children's obesity.

Keywords: school lunch program, elementary schoolchildren, body weight, mixed multinomial logit model, Taiwan

Corresponding author: Tel: + 886.2.33662656
Email: H. H. Chang: hunghaochang@ntu.edu.tw

Introduction

Childhood obesity has become a global epidemic problem and this alarming trend of obesity rates among children continues to generate serious concern. Obesity during childhood is highly correlated with being overweight throughout adulthood, and obese children are substantially more likely to develop health problems such as high blood pressure as early as adolescence, coronary problems, diabetes, etc (Whitaker et al. 1997). Moreover, childhood obesity would influence long-term psychological problems and labor market results (Daniels 2006; Dietz 1998). Many of these problems impose a substantial burden on healthcare systems. In Taiwan, one in every four children is considered overweight or obese and the prevention of childhood obesity has become one of the primary government policy objectives (Chen et al. 2006; Hsieh and FitzGerald 2005).

Precluding genetic and medical conditions among all of the factors that are associated with children's obesity, the school environment has been shown to be one of the most significant determinants, because schoolchildren normally spend more than half a day in school and school lunch meals are an important source of their daily food consumption (Mirtcheva and Powell 2009; Schanzenbach 2009). From a policy standard point of view, understanding the association between school lunch programs and children's body weight could shed some light on how school lunch policies can be designed to prevent children's obesity.

In Taiwan, the school lunch program was introduced back in 1973, and it was implemented in elementary schools for schoolchildren under 12 years old. The policy goal of the program is to ensure that every young student can have lunch at school to maintain a healthy lifestyle. Hungry and malnourished children are at a great disadvantage in succeeding in a learning environment. However, due to the limited financial budget of each county government, this program was not implemented across the entire nation. To ensure that every school child can eat lunch at school, the government is proposing to enforce that each elementary school provide lunch meals starting in 2015. Therefore, a better understanding of the relationship between school lunch programs and children's health is of particular interest in Taiwan, especially at this point in time.

According to the Hygiene Law of the school lunch program, school lunches have to include rice, at least two kinds of vegetables, one type of meat and a bowl of soup. With respect to the dietary requirement, there is no specific regulation of nutrient intakes that should be implemented in each lunch meal (Ministry of Education 2002). Prices for these lunches are set by the school board's lunch program in each school. The school board generally consists of school teachers, local government officials, and parent representatives. On average, the prices of school lunches are NT$30–55 per meal. Parents have to pay money every month for these school lunches. However, students with disability, or from low or middle-income families, can receive their school lunches free of charge because the government will cover the cost (Ministry of Education 2002).

In general, there are two different methods for preparing school lunch meals in Taiwan. Some schools prepare the meals in their on-site kitchens, while some schools do not have a kitchen or do not have the capacity to provide cooking facilities. For those schools without food facilities on campus, hot lunch boxes are ordered from large food serving companies or restaurants nearby

according to the assessment and planning of the school. In this case, the school simply plays a supervisory role in monitoring the contents of the lunch boxes provided by the food companies to ensure that they satisfy the minimum requirement of food servings. That is, the school just makes sure that each meal contains rice, at least two kinds of vegetables, one serving of meat and a bowl of soup, but with little information on how these meals are prepared. Because the preparation/provision of school meals differs in various schools, it would be interesting to investigate whether schoolchildren's health also differs in relation to these lunch programs. Given the high public health priority to address the epidemic of childhood obesity, it seems worthwhile to investigate whether these two different types of food preparation of school lunch meals may have different influences on children's body weight.

In light of the importance of the school lunch program, empirical evidence has been provided, with most of it generated in the U.S. Among these studies, much attention had been paid to understanding the roles of socioeconomic characteristics, lifestyle behaviors of children, as well as parental and family conditions which may determine the likelihood of participation in the school lunch program (e.g., Akin et al. 1983; Fox et al. 2009; Gleason 1995; Hofferth and Curtin 2005; Maurer 1984; Mirtcheva and Powell 2009). Until very recently, a few studies examined the influence of school lunch programs on children's body weight; however, their findings are at best inconclusive. For instance, using data from the 1997 child development supplement conducted by the University of Michigan and controlling for self-selection bias, Hofferth and Curtin (2005) found no significant relationship between participation in the school lunch program and body weight of schoolchildren. In contrast, using data of 17,656 children in 994 schools drawn from the early childhood longitudinal study of kindergarten classes in 1998-1999 in the U.S., Millimet, Tchernis, and Husain (2008) found a positive effect of the school lunch program on children's body weight. Using similar data, Schanzenbach (2009) also found a positive relationship between school lunch programs and children's body weight. There are many possible reasons for the inconclusive findings of the previous studies, such as different samples or methodologies. However, no study so far has examined the role of food preparation in the school lunch program.

This study assesses the relationship between the school lunch program and children's body weight in Taiwan.[1] The primary objectives of this study are to answer the following questions: 1) What are the roles of children's socio-demographic characteristics, family factors and school environment in regard to children's participation in the school lunch program? 2) Given that there are three different types of school meal programs for elementary schoolchildren in Taiwan: (a) no school lunch programs, (b) school lunch programs with meals from restaurants outside of school and (c) school lunch programs with meals prepared in on-site kitchens at school, which is associated with the highest probability of childhood obesity?

Using a nationwide survey dataset of the elementary schoolchildren in Taiwan, a mixed multinomial logit model is estimated to investigate the effects of the school lunch programs on

---

[1] To the best of our knowledge, there was only one study in Taiwan on school lunch programs. Chen et al. (2009) examined the association between food insecurity and disease as well as mental health of schoolchildren in Taiwan. Their study did not find any significant effects of school lunch programs on alleviating the harmful health effects of food insecurity for poor children.

children's body weight. Several interesting findings are revealed. In accordance with the findings of previous studies, socio-demographic characteristics of children and their parents significantly determine both the likelihood of children receiving school lunch programs, and their body weight. In regard to the effects of the school lunch programs, we found that lunch meals prepared in on-site kitchens at school are significantly related to a lower likelihood of being overweight of schoolchild. In contrast, lunch meals ordered from outside restaurants appear to lead to a higher chance to be overweight of schoolchildren. Moreover, a positive self-selection bias between the school lunch program and children's body weight is evident, i.e. the school lunch programs are correlated with children's weight due to some unobserved common factors.

The remainder of this paper is organized as follows. The data used in this study are introduced in the next section. A theoretical framework for the empirical analysis and econometric strategy is then discussed. After presenting the empirical results, we conclude this paper with a brief summary.

Data

Our data were drawn from the Nutrition and Health Survey in Taiwan for Elementary School Children (NAHSITC), conducted by the Bureau of Foods and Hygiene of the Department of Health in Taiwan in 2002. The NAHSITC survey was specifically designed for elementary schoolchildren aged from 6 to 12 years. A multistage stratified sampling scheme was used. In the first stage, 359 townships of Taiwan were divided into thirteen regions according to their ethnicity and geographic location. Within each region, eight schools were selected using probability proportional to their population. Therefore, NAHSITC is representative of the population of the elementary schoolchildren population in Taiwan.[2]

The primary purpose of this survey was to develop and implement appropriate public health and educational measures to promote health through proper nutrition. The detailed information on nutrition, diet and health was well documented. Not only children's but also parents' profiles were included. Information at both the individual and aggregate level, such as school environment and resources, were recorded as well. In total, 2,419 elementary schoolchildren were chosen for the designated survey. After deleting some observations with missing values, the final sample consists of 2,017 elementary schoolchildren.[3]

The dependent variable of interest was whether each child was provided with a school lunch. As indicated earlier, schoolchildren were separated into three subgroups, due to the different types of the school lunch programs: children without school lunch, children who are served school lunch prepared by the on-site school kitchen and children with lunch meals ordered from restaurants outside their schools. The other dependent variable was the overweight status of each child. In this dataset, body mass index (BMI) measured as the ratio of weight (in kilogram) to

---

[2] Detailed information on survey designs can be found in Fu et al. (2007).

[3] In the NAHSITC dataset, approximately 12% of the schoolchildren (i.e. 298 students) have missing values on body weight. Unlike self-reported measures, weight and height of each school child were measured by the school clinics. These students may have missed the scheduled body checking either because they had classes or for other reasons. For the remaining missing values in our sample, the detailed information on the parents was not reported.

height squared (in meters) is documented. Unlike the self-reported values, children's BMI were measured by the health department staff in each school. It has been documented that examining the association between school lunch programs and student's overweight is more important for policy makers than using the continuous measure of body mass index. Therefore, we define a binary variable to indicate whether or not each schoolchild is overweight, based on the official cutoffs determined by the Department of Health in Taiwan. The cutoff differs by student's age and gender.[4]

Built upon the findings of previous studies on school food programs (e.g., Akin et al. 1983; Fox et al. 2009; Gleason 1995; Hofferth and Curtin 2005; Li and Hooker 2010; Maurer 1984; Mirtcheva and Powell 2009), several variables of the socio- demographic and lifestyle behaviors of schoolchildren, parental characteristics, family structure and school environmental conditions are specified. Children's characteristics are represented by age and gender (the variables Age and Male). Since hours of watching television has been shown to be significantly correlated with children's diet and weight (e.g., Anderson et al. 1998; Chang and Nayga 2009; Li and Hooker 2010), three dummy variables are specified to indicate if the average hours of television viewing of children at home are less than 1 hour (the reference group), between 1-2 (the variable TV12), 3-4 (the variable TV34) or more than 5 hours per day (the variable TV56), respectively. Based on the findings in Chang and Nayga (2009), eating breakfast is significantly associated with the body weight of children. Therefore, a dummy variable is also specified, indicating whether the schoolchildren eat breakfast every day at home.[5]

In addition to the socio-demographic factors, some variables reflecting parental behaviors and family characteristics are included. Because the mother's education and employment status reflect the opportunity costs on time use that can be devoted to food preparation in the family (Akin et al. 1983; Chang and Nayga 2009), several dummy variables are specified to capture the effects of parental characteristics on children's body weight and the school lunch programs. With respect to the household characteristics, a variable indicating the number of siblings of each child is defined because it has been documented that the number of siblings is a significant factor of family structure concerning children's obesity in general (Formisano et al. 2013). Also, monthly family income is included to reflect the wealth and income of the household, and a variable reflecting the physical house size is specified to capture the physical home environment of each child.

The school environment also matters in regard to children's food consumption due to the fact that children usually spend at least 6 hours at school every day, and the school lunch programs provide the major food sources obtained at school (Li 2010; Story, Kaphingst, and French 2006). In recognition of the importance of the school environmental effects, we specify a continuous variable of the physical area of the school (Size_M), a variable which measures the average hours of physical education classes per week (Physical_S) and a dummy variable indicating whether the specific school is located in a metropolitan area (City_M). In the section offering our

---

[4] We thank anonymous reviewers for this thoughtful suggestion. The official cutoffs used to determine students' weight status can be found in the website of the Department of Health in Taiwan.
http://www.vghtpe.gov.tw/~nutr/forum/forum02/bmi2.htm.
[5] In contrast to the case in the U.S, no school breakfast program is available in Taiwan.

empirical results, we first present the distribution of the body weight of schoolchildren in Table 1 according to the different school lunch programs. Detailed definitions follow, and the sample statistics of the selected explanatory variables are listed in Table 2 (see Appendix).

Methodology

One important issue related to the empirical analysis of school lunch program has to be addressed, i.e. in addition to the observed children's, parents' and school characteristics, the school lunch program and students' body weight can still be correlated due to some unobserved common factors. In the case of Taiwan, each school can decide whether the school lunch given to the students is to be provided by the on-site kitchen of the school or ordered from outside restaurants. In addition, the parents can decide whether their schoolchildren will participate in the school lunch program or if they prefer to pack a lunch for them. Evidence of previous studies has indicated the existence of the endogeneity issue on the topic of school lunch programs. A common wisdom of these studies is that failing to cope with the endogeneity issue will result in inconsistent estimations.

To investigate the effects of the school lunch program on children's weight and accommodate the potential endogeneity problem indicated above, a mixed multinomial logit model proposed by Deb and Trivedi (2006) and Deb et al. (2006) was configured.[6] To represent this concept, suppose child i has j different choices of the school lunch program. The indirect utility of child i associated with the j_{th} school lunch program ($V_{ij}*$) can be defined as:

$$(1) \quad V_{ij}^{*} = z_i ' \alpha_j + \beta_j h_{ij} + \varsigma_{ij}$$

where the vector z_i contains exogenous determinants, and h_{ij} represents the latent unobserved characteristics commonly associated with a child's participation in the school lunch program and his/her body weight; α_j, β_j are parameters to be estimated, and ς_{ij} is the error term. If we further assume the choice structure follows a multinomial logit model, then the probability of the i_{th} child's choice of the j_{th} program j can be shown as:

$$(2) \quad \Pr(d_{ij} \mid z_i, h_{ij}) = \frac{\exp(z'_i \alpha_j + \beta_j h_{ij})}{1 + \sum_{m=1}^{J} \exp(z'_i \alpha_m + \beta_m h_{im})}$$

where d_{ij} is the indicator of the school lunch program. Given the outcome y_i (i.e. if the child is overweight) being a binary variable, the expected body weight status of the i_{th} child can be formulated as:

$$(3) \quad \Pr(y_i = 1 \mid d_{ij}, x_i, h_{ij}) = m(x_i ' g + \sum_{j=1}^{J-1} \gamma_j d_{ij} + \sum_{j=1}^{J-1} \lambda_j h_j)$$

---

[6] Deb and Trivedi (2006) and Deb et al. (2006) used the mixed multinomial logit model to study the effects of different health insurance programs on healthcare utilization in the U.S.

where x_i is a set of exogenous variables that determines if a child is overweight, and g, γ_j, λ_j are the parameters to be estimated. As a result, the expected weight status equation of children is a function of the exogenous determinants (x_i), the indicator of the school lunch program (d_{ij}) and the unobserved common factors that are correlated with the school lunch programs (h_j); $m(.)$ is the link function. Therefore, parameter γ_j captures the effects of the j_{th} lunch program on the children's weight. In addition, λ_j captures the endogeneity (i.e. self-selection effect) between the j_{th} program and child's body weight.

If we further assume that the marginal density function of the weight status equation follows a logistic distribution, the joint distribution of the participation decisions of school lunch programs and the body weight status equations can be written as the product of the marginal density function, as (see Deb and Trivedi 2006):

$$(4) \ \Pr(y_i, d_{ij} \mid x_i, z_i, h_i) = f(y_i \mid d_{ij}, x_i, h_j) * \Pr(d_{ij} \mid z_i, h_j)$$

Using Eq. (4), the consistent estimators of the parameters $\alpha_j, \beta_j, g, \gamma_j, \lambda_j$ can be estimated by the maximum likelihood estimation method. As indicated by Deb et al. (2006), Eq. (4) does not have a closed form; therefore, we use the Halton sequences random draw method suggested by Deb et al. (2006) for the empirical estimation.

Regarding the condition of model identification, Deb and Trivedi (2006) noted that the model is econometrically identified due to the non-linear functional form of the maximum likelihood function. However, to avoid the overburden of the identification relying on the functional form, some exclusion variables (i.e. the instrumental variables) can be used; they are helpful in deriving the empirical estimation. In the case of the school lunch program in Taiwan, the types of school lunch programs are jointly determined by schools and the board of parents. Therefore, both the school characteristics and socio-democratic characteristics of the parents of the schoolchildren are expected to have direct effects on the types of school lunch programs as well as the children's body weight. In this case, finding an appropriate exclusion variable (or the instrumental variable) is not obvious. In the empirical specification, we specify the same set of explanatory variables in the equation of the school lunch program and children's body weight. In so doing, the model identification condition can still be reached by relying on the non-linear functional form of the maximum likelihood function.[7]

Empirical Results

Sample Statistics of the Body Weight Status of Schoolchildren

Table 1 presents the sample statistics of the weight status of schoolchildren by different types of school lunch programs. In total, 102 elementary schools and 2,017 schoolchildren were selected in our sample. The sample distribution shows that 60 out of 102 schools purchased lunch boxes

---

[7] We thank anonymous reviewers for this observation.

from outside school restaurants, while 31 of them made lunch in food facilities at school. With respect to the sample distribution of the body weight of children, it is evident that schoolchildren who were offered lunch boxes from restaurant orders exhibited higher values of BMI (19.29) compared to those who were offered lunch boxes from school facilities (16.18), on average. The corresponding rates of schoolchildren who are overweight or obese for these two groups are 28.6% and 24.2%, respectively. The differences in body weight of schoolchildren are found to correlate to different school lunch programs; however, this can only be regarded as a snapshot because the differences in school and parental characteristics among children in different school lunch program groups are not controlled.

Table 1. Sample distribution of students weight by different types of school lunch programs

Types of school lunch programs	Total number of schools	Total number of students	Body mass index (kg/m^2)	Overweight (%)[#]
No school lunch program	11	204	17.92 (3.27)	26.1%
Prepared by school kitchen	31	626	16.18 (3.00)	24.2%
Purchased from outside-school restaurants	60	1,187	19.29 (3.75)	28.6%

In total, 102 elementary schools and 2,017 schoolchildren were included in our sample.
(.) is the standard deviation of the continuous variable.
[#]The official cutoffs of the body mass index into overweight status are defined by the Department of Health in Taiwan.

Effects of the School Lunch Programs on Schoolchildren's Overweight

The estimations of the mixed multinomial logit model are presented in Table 3. We begin our discussion of the empirical results by looking at the association between school lunch programs and children's body weight status. Because children's weight status is specified as a binary variable to indicate whether they are overweight, the coefficient directly estimated from the model does not capture the magnitude of the association of the explanatory variables. To provide a more intuitive interpretation of our finding, the marginal effect which captures the change in the likelihood of being overweight of schoolchildren resulting from the change in the explanatory variables is also reported. As exhibited in Table 3, a significant relationship between the school lunch programs and children's weight status is evident.[8] Moreover, the associations do differ according to the lunch meal preparations at school. Compared to the children who go to schools which provide no school lunch programs (the reference group), children who are served

---

[8] The interpretation of our findings calls for caution. Due to the confidentiality concern, sampling weights used in the NAHSITC survey are unavailable to us. Therefore, the standard errors of the estimates are calculated using the bootstrap method with 500 replications, rather than the weighted standard errors. As pointed out by an anonymous reviewer, ignoring the survey design may result in downward biased standard errors of the parameters and overstating statistical significant findings.

lunch meals provided by schools' on-site kitchens have a lower likelihood of being overweight by 9.6 percentage points (the marginal effect of the variable *School kitchen*). In contrast, students who go to schools serving lunch meals of restaurant orders have a higher propensity to be overweight by 12.5 percentage points (the marginal effect of the variable *Outside-school restaurants*). Both are statistically significant at the 5% level or higher. Several explanations are possible in regard to interpreting these findings. First, a positive association between ordered lunch meals and children's chances of being overweight may reflect the intense business competition between restaurants. Restaurants have to make their food attractive to schoolchildren in order to maintain their business ties to the schools. Therefore, their lunch boxes are usually more likely to be oily and to contain more saturated fat to cater to the appetite of the children (Tong Foundation 2007). For instance, fried chicken and red meat are more commonly seen in lunch boxes prepared by the outside restaurants (Tong Foundation 2007). Given the fact that schools who order lunch boxes from food companies or restaurants outside the school usually only monitor the quantities of food servings to satisfy the requirement of the School Hygiene Law, the nutrients or food quality can more easily fail to match the standards of a healthy diet. In contrast, lunch meals prepared by school kitchens are handled by nutritionists on campus; therefore, these lunch meals are more concerned with health than with taste. In addition, more vegetables and fruits are likely to be offered by the school kitchen. Our findings may also reflect the fact that children usually do not finish all of the served food prepared by the school kitchen, especially dishes with more fruits and vegetables instead of fried meat, compared to the restaurant ordered lunch boxes.[9]

Our findings may also help to explain the inconclusive findings in previous studies on the effects of school lunch programs on childhood obesity. The positive effect of lunch meals ordered from the restaurants on children's overweight is in accordance with Schanzenbach (2009). On the other hand, the negative effect of lunch meals prepared by school kitchens on a child's overweight is not inconsistent with the findings in Hofferth and Curtin (2005) and Millimet, Tchernis, and Husain (2008).

Our results are supportive of the endogeneity problem linking school lunch programs and children's overweight. The estimated self-selection parameter $\lambda\_kitchen$ is significant at the 10% level, which supports the existence of selection bias. More specifically, the school lunch programs and children's overweight may be correlated due to some unobserved common factors. For instance, parents who are more knowledgeable about nutrition may pay more attention to their children's wellbeing and may take better actions to improve their children's health, such as packing a healthy lunch, restricting TV viewing, signing up their children for sports, etc. These children may have a lower likelihood of being overweight or obese. Since the information regarding this factor is not observed in our dataset, it is likely to simultaneously affect children's body weight and the type of schools that children attend, so that the endogeneity problem can occur. Our finding of the significant selection bias is not consistent with evidence in the U.S. (Millimet, Tchernis, and Husain 2008; Schanzenbach 2009).

---

[9] The information can be found at http://www.epochtimes.com/gb/7/4/4/n1668075.htm

Table 3. Estimation of the mixed multinomial logit model

	School Lunch Program				If child is overweight		
	School kitchen		Outside-school restaurants				
Variable	**Coefficient**	**SE**	**Coefficient**	**SE**	**Coefficient**	**SE**	**Marginal Effect**
School kitchen					-1.010 **	0.422	-0.096
Outside-school restaurants					1.631 ***	0.384	0.125
Age	-0.074 **	0.040	-0.012 ***	0.004	-0.031	0.035	-0.008
Male	-0.211	0.191	-0.136	0.170	0.265 **	0.109	0.060
Sibling	-0.028	0.106	0.140	0.092	-0.022	0.062	-0.006
House size	0.001	0.007	0.005	0.007	-0.002	0.002	-0.001
Income	0.013	0.027	-0.044 *	0.026	0.010 *	0.005	0.002
Senior_M	-0.566	0.384	-0.471	0.371	0.189	0.193	0.048
Junior_M	-0.239	0.370	-0.103	0.347	0.170	0.218	0.047
Breakfast	-0.505 **	0.245	-0.327 ***	0.135	-0.243 *	0.137	-0.056
TV56	0.126	0.414	-0.075	0.383	0.132	0.177	0.025
TV34	0.181	0.277	0.019	0.241	-0.050	0.181	-0.018
Job_M	0.038	0.314	0.020	0.308	-0.064	0.107	-0.012
City_S	1.341 *	1.016	0.446	0.982	-0.069	0.151	-0.002
Size_S	0.176 ***	0.045	0.243 **	0.094	0.093	0.067	0.021
Physical_S	0.664 **	0.309	0.140	0.768	0.033	0.093	0.012
Constant	0.804	1.141	2.025 *	1.131	-0.977 *	0.582	
λ_kitchen					-0.348 *	0.264	
λ_restaurant					0.020	0.403	
Log-likelihood	-2,998						

The reference group of the school lunch program is the non-participants.
***, **, * indicate the significance at the 1%, 5%, and 10% level, respectively.

Other Determinants of the School Lunch Programs

Although it is not the primary focus of this study, we briefly discuss the associations between other exogenous determinants and the school lunch programs. As exhibited in Table 3, children's characteristics and lifestyle behaviors, family characteristics, and mother's behaviors and school environmental conditions significantly determine the likelihood of children receiving school lunches. Age is negatively associated with these two kinds of lunch programs, and the association is more pronounced for the lunch meals prepared by school kitchens. Also, in accordance with the findings of Chang and Nayga (2009), children who eat breakfast every day are less likely to have school lunches. This finding may reflect the fact that meal planners (parents) for this group of children may have greater nutritional knowledge regarding their children's health and food consumption; therefore, they may spend more time in preparing their

own lunch boxes for their children. Compared to the school-served lunch meals, the self-prepared lunch meals by parents are expected to be much healthier.

Family characteristics also matter. Results indicate that children living in households with higher income are less likely to go to schools which serve lunch meals by outside restaurants. This result is in agreement with the policy objective whereby children of poor families are subsidized for their lunch meals; therefore, they are more likely to have school lunch. Consistent with the findings of previous studies (e.g., Akin et al. 1983), the mother's employment status is significantly correlated with children's school lunch programs. Compared to the children of unemployed mothers, children with working mothers are more likely go to a school serving lunch meals. This finding may reflect the substitution effect of time between work and preparing meals for their children. Finally, school conditions significantly determine the likelihood of children having school meals. Children who study at large elementary schools, or with more hours per week of physical education classes, or located in large cities are more likely to obtain school-served meals.

Other Determinants of Schoolchildren's Overweight

In addition to the school lunch programs, some other variables also significantly determine a child's weight status. Gender difference in body weight status is evident; the results show that boys have a higher chance of being overweight compared to girls. Although the finding is statistically insignificant, in accordance with Li and Hooker (2010), compared to the children who spend less than 1 hour in viewing television per day, children who spend at least 5 hours viewing television have a higher chance of being overweight by 2.5 percentage points. This result is supportive of the belief that TV watching usually correlates to poor diet quality, and thus affects the energy balance of the children. Eating breakfast is also important. Compared to their counterparts, children who eat breakfast have a lower chance of being overweight by 5.6 percentage points. Socio-demographic characteristics of the mothers and the family are also crucial factors. Children who live in households with higher income are more likely to be overweight. The results show that an additional $10,000 in monthly family income increases children's chance of being overweight by 0.2 percentage points.

Conclusions

Childhood obesity is a global epidemic associated with lifestyle, dietary patterns, and living environment, especially regarding food and the school environment. A better understanding of the relationship between children's overweight and lunches eaten at school will help policymakers to identify strategies to effectively combat childhood obesity. A considerable body of literature has addressed the issues of school lunch programs; however, most of them emphasize the extent to which socio-demographic factors, family condition and parental behaviors are associated with the likelihood of school lunch participation. Only a few studies conducted in the U.S. have investigated the extent to which school food programs are correlated with children's health; studies from Asian countries are generally silent on this topic. This study contributes to previous studies by assessing the association between school lunch programs and the body weight status of the elementary schoolchildren in Taiwan. In contrast to the case in the

U.S., a unique system of school lunch programs is implemented in Taiwan, i.e. each school has the option to conduct food programs using their on-site kitchen, or to simply order from food companies or restaurants nearby. This study makes distinctions of the extent to which these different types of food preparations of the school lunch programs may have different associations with children being overweight.

Using a nationwide dataset of elementary schoolchildren in Taiwan, we estimated a mixed multinomial logit model to capture the potential endogeneity between school lunch programs and children's weight status. Several interesting findings were revealed: parental characteristics, family conditions and school environmental conditions are significantly associated with the choice of school lunch programs. Most importantly, different school lunch programs have different associations with children's body weight. Compared to children who go to schools without school lunch meals, children who go to schools serving lunch meals prepared in on-site kitchens at schools have a lower likelihood of being overweight. In contrast, children who go to schools serving restaurant-ordered lunch boxes have a higher chance of being overweight.

Policy implications that can be inferred from our study are straightforward. Providing school lunch is not necessary to alleviate the increasing overweight problem of schoolchildren. Moreover, since the effectiveness of the policy depends on the way that the food is prepared, the government should manage the way food is prepared in schools. In addition, more information on healthy nutrition could be provided to the parents of schoolchildren.

Some caution is required in interpreting our findings. First, we explain the associations between different types of school lunch programs and children's overweight by the fact that restaurant-ordered lunch boxes are oilier and less healthy than lunch meals prepared at on-site kitchens (Tong Foundation 2007). Comparing the lunch menu or food list between restaurant-ordered and self-prepared lunch meals will be useful to further confirm our hypothesis. Due to the lack of detailed information on what is actually provided to schoolchildren, we are unable to further address this issue. In addition, it is likely that private and public schools may have different ways of preparing their lunch meals to students (Tsu 2005). If more detailed information of school characteristics becomes available, further research can investigate this interesting issue. Finally, despite our control over potential endogeneity between school lunch programs and children's obesity, with the empirical results supporting self-selection, using more sophisticated panel data can further attest to the robustness of our findings.

Acknowledgements

References

Akin, J., D. Guilkey, B. Popkin and J. Wyckoff. 1983. The demand for school lunches - an analysis of individual participation in the school lunch program. *Journal of Human Resources* 18: 213–230.

Andersen, R., C. Crespo, S. Bartlett, L. Cheskin and M. Pratt. 1998. Relationship of physical activity and television watching with body weight and level of fatness among children: results from the third National Health and Nutrition Examination Survey. *Journal of American Medicine Association* 279: 938–942.

Chang, H. and R. Nayga. 2009. Television viewing, fast food consumption and children's obesity. *Contemporary Economic Policy* 27: 293–307.

Chen, L., M. Wahlqvist, N. Teng and H. Lu. 2009. Imputed food insecurity as a predictor of disease and mental health in Taiwanese elementary school children. *Asia Pacific Journal of Clinical Nutrition* 18: 605–619.

Chen, L., K. Fox, A. Haase and J. Wang. 2006. Obesity, fitness, and health in Taiwanese children and adolescents. *European Journal of Clinical Nutrition* 60: 1367–1375.

Daniels, S. 2006. The consequence of childhood overweight and obesity. *The Future of Children* 16: 47–68.

Deb, P. and Trivedi, P. 2006. Specification and simulated likelihood estimation of a non-normal treatment-outcome model with selection: application to health care utilization. *Econometric Journal* 9: 307–331.

Deb, P., C. Li, P. Trivedi and D. Zimmer. 2006. The effect of managed care on use of health care services: results from two contemporaneous household surveys. *Health Economics* 15: 743–760.

Dietz, W. 1998. Health consequences of obesity in youth: childhood predictors of adult disease. *Pediatrics* 101: 518–525.

Formisano, A., M. Hunsberger, K. Bammann, B. Vanaelst, D. Molnar, L. Moreno, M. Tornaritis, T. Veidebaum, L. Lissner, G. Barba and A. Siani. 2013. Family structure and childhood obesity: results of the IDEFICS Project. *Public Health Nutrition* 20: 1–9.

Fox, M., A. Dodd, A. Wilson and P. Gleason. 2009. Association between school food environment and practices and body mass index of US public school children. *Journal of American Dietetic Association* 109: S108–S117.

Fu, M., L. Cheng, S. Tu and W. Pan. 2007. Association between unhealthful eating patterns and unfavorable overall school performance in children. *Journal of American Dietetic Association* 107: 1935–1943.

Gleason, P. 1995. Participation in the national school lunch program and the school breakfast program. *American Journal of Clinical Nutrition* 61: 213S–220S.

Hsieh, P. and M. FitzGerald. 2005. Childhood obesity in Taiwan: review of the Taiwanese literature. *Nursing & Health Sciences* 7: 134–142.

Hofferth, S. and S. Curtin. 2005. Poverty, food programs, and childhood obesity. *Journal of Policy Analysis and Management* 24: 703–726.

Li, J. and N. Hooker. 2010. Childhood obesity and schools: evidence from the national survey of children's health. *Journal of School Health* 80: 96–103.

Maurer, K. 1984. The national evaluation of school nutrition programs: factors affecting student participation. *American Journal of Clinical Nutrition* 40: 425–447.

Millimet, D., R. Tchernis and M. Husain. 2008. School nutrition programs and the incidence of childhood obesity. *IZA Discussion Papers* No. 3664. Bonn, Germany.

Ministry of Education. 2002. *School hygiene law: laws & regulations databases of the Republic of China*. Taipei, Taiwan.

Mirtcheva, D. and L. Powell. 2009. Participation in the national school lunch program: importance of school-level and neighborhood contextual factors. *Journal of School Health* 79: 485–494.

Schanzenbach, D. 2009. Do school lunches contribute to childhood obesity? *Journal of Human Resource* 44: 684–709.

Staiger, D. and J. Stock. 1997. Instrumental variables regression with weak instruments. *Econometrica* 65: 557–586.

Story, M., K. Kaphingst and S. French. 2006. The role of schools in obesity prevention. *Future Children* 16: 109–142.

Tong Foundation. 2007. *Survey on status and quality of school lunch in Taiwan*. Taipei, Taiwan (in Chinese).

Tsu, J. 2005. The study of the difference between the nutritional lunch provided by private management of public school and public-owned and public-management school. *School Administration Bimonthly Magazine* 35: 170–188 (in Chinese).

Whitaker, R., J. Wright, M. Pepe, K. Seidel and W. Dietz. 1997. Predicting obesity in young adulthood from childhood and parental obesity. *New England Journal of Medicine* 37: 869–873.

Appendix

Table 2. Sample statistics of the selected variables

Type of the school lunch program		No school lunch		Prepared by school kitchen		Purchased from restaurants	
Variable	Definition	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Child's characteristics							
Age	Age of the child (years)	8.53	1.72	8.45	1.71	8.49	1.71
Male	If male (=1).	0.58	0.50	0.53	0.50	0.53	0.50
TV12	If watch TV less than 2 hours per day (=1).	0.12	0.32	0.12	0.32	0.12	0.32
TV34	If watch TV 3-4 hours per day (=1).	0.42	0.49	0.42	0.49	0.42	0.49
TV56	If watch TV at least 5 hours per day (=1).	0.47	0.50	0.46	0.50	0.46	0.50
Breakfast	If eats breakfast everyday (=1).	0.84	0.36	0.78	0.42	0.80	0.40
Household characteristics							
Sibling	Number of sibling	1.53	0.90	1.48	0.90	1.65	1.00
House	House size (100 m²)	0.44	0.26	0.44	0.29	0.46	0.35
Income	Monthly household income (NT$ 10,000)	5.97	3.21	6.20	3.49	5.50	3.34
Mother's characteristics							
Senior_M	If mother finished senior high school or higher (=1).	0.71	0.45	0.70	0.46	0.64	0.48
Junior_M	If mother finished junior high school (=1).	0.20	0.40	0.21	0.41	0.25	0.43
Primal_M	If mother didn't finished junior high school (=1).	0.09	0.29	0.10	0.29	0.11	0.31
Job_M	If mother is employed for a full time job (=1).	0.66	0.47	0.66	0.47	0.63	0.48
School variables							
Size_S	School size (10,000 m²)	2.05	0.49	2.27	0.80	2.21	1.32
Physical_S	Average hours of physical class per week (hrs)	1.86	0.93	2.03	0.62	1.92	0.56
City_S	If the school is located in a large city (=1)	0.20	0.40	0.35	0.48	0.22	0.41