경제학석사 학위논문

Effects of the School Lunch Program on the Nutrition Intake of School-Age Children and their Adult Height in South Korea

국내 학교급식사업이 아동기의 영양과
성인기의 키에 미치는 영향

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유 지 수

Abstract

Jisu Yu
Department of Economics
The Graduate School
Seoul National University

This paper examines the impact of the school lunch program of South Korea on the nutrient intakes of children in 1998 and 2001. Using regional variations in the provision of the school lunch program, I find the positive effect of the school lunch program on the total energy intake of school-age children for their lunch. Moreover, the effect persisted over 24 hours for protein, vitamins, and minerals. To evaluate the long-term effect of the school lunch program, I assess how the increased energy and nutrient intakes affect the height of the cohorts who are exposed to school meals in different degrees. The long-term effect on the height is positive and statistically significant for boys who are exposed to the school lunch program during their elementary school period. The expansion of the school lunch program leads to improved nutrition status of children.

Keywords: School Lunch Program; Nutrition; Health and Human Capital
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1. Introduction

The economics literature has focused on human capital improvement as a tool to develop and grow economies. As supplying sufficient nutrients is important for health, the school meal program became one of the effective methods to develop human capital. The relationship between physical growth and nutrition is clear. The nutritional status during childhood is critical for physical and cognitive development (Altindag et al., 2020; Frisvold, 2015; Glewwe et al., 2001; Strauss & Thomas, 1998). The adequate and balanced intake of nutrients is a prerequisite for body growth, such as bones and cells. Moreover, recent studies documented the positive correlation between nutrition intakes in school and cognitive development additional to physical growth. For example, Belot and James (2011) found that the improvement of school meals increases students' educational outcomes and decreases authorized absences.

The quantity and quality of food and nutrients that children take differ from their social and economic backgrounds. Children from households with lower socioeconomic status are more likely to get less attention and care in their diet. The school meal program can be a potential intervention to supply well-balanced and sufficient nutrients to every school-age child regardless of their background. The school meal is a planned diet that provides essential nutrients for growth while builds a safety net for low-income children.

Many countries use school meal programs to support sufficient nutritional intake of low-income children. The way of offering a meal or determining the eligibility to participate varies among countries. In the United States, the free or reduced-price meal is provided through the School Breakfast Program (SBP) and the National School Lunch Program (NSLP). Every student from a participating school can take a school meal and free lunches are eligible for children below 130 percent of poverty. The school meal in the United Kingdom is also complementary for eligible students if they request.

The decline in the paid meal participation rate is continually pointed out as a weakness of the current school meal programs in both countries. Some students from low-income families do not take a school meal due to the stigma effect (Ralston & Newman, 2015). From 2014, to expand the benefits, the UK started the provision of free meals to every youngest student from ages 4 to 7. Not only the UK but also many other countries debates on the expansion of universal school meal program. The cost of a school meal program is increasing worldwide. The impact of a school meal is, however, not fully examined.

This paper aims to investigate the impact of the school meal program on children's intake of nutrients and the long-term effect of school meal program on future health. Currently, every school in South Korea-henceforth, Korea-provides school lunches. The system of Korean school is difficult for students to choose other options and 99.9% of students are taking school lunches. In the case of elementary school students, students took 34% of their daily calories at lunch. For students, who get free school lunches, a portion of school lunches for daily calories was 40% (N.-Y. Park & Choi, 2008). Students take a large serving of their daily meals by school lunches. Therefore, the school lunch program is perceived as a great investment in the perspective of human resources, but the effectiveness of the school lunch program is still inconclusive.

Using the variations in the timing of the school lunch program expansions across regions, I estimate the difference between taking school lunch and non-school lunch. The estimation is also repeated by subgroups such as age and gender. The total energy intake for lunch is higher for school lunch takers than for non-school lunch takers. Also, taking school lunch increases student's intakes of micronutrients like vitamins and minerals. The positive effects on intakes of some nutrients are statistically significant for 24-hour.

Next, I assess the long-term effect of the school lunch program by following up on the cohorts exposed to school meals with a variation. To check the improvement in one's nutritional status, the relationship between probability to get benefit from the school lunch program, and the height at adulthood is analyzed. The increase in the implementation rate of the school lunch program at the location they went to schools is related to a rise in height.

The rest of the study is organized as follows. Section 2 reviewed the previous literatures and in section 3 the historical background and properties of the school lunch program in Korea are described. Section 4 presents the data employed. Section 5 describes the estimation strategy and results for the main analysis and subgroups. The long-term effect is discussed in Section 6. In conclusion, I discuss the valuation of the school meal program and nutrition policies.

2. Literature Review

Recent studies showed the evidence that childhood health effects on adult health, income, and social status (Almond et al., 2018; Bleakley, 2010; Case et al., 2005). Therefore, childhood illness or food insecurity has a negative impact on children's health outcomes. Gundersen and Kreider (2009) used nonparametric bounding methods to isolate the causal impact of food security on health and find that food security has a positive impact on general health status and healthy weight. They pointed out the intervention to alleviate food insecurity could enhance health outcomes by improving access to health care services by free up the household's budget from spending on food.

As a part of the food security policy, many researchers paid attention to the effectiveness of school meal programs in different countries. However, the literature has not reached a clear consensus. Gleason and Suitor (2003) used data from the Continuing Survey of Food Intakes by Individuals (CSFII) and estimated the effect of the National School Lunch Program (NSLP) of the U.S on the set of nutrients by using panel fixed effects model. They found that participating in the school lunch program increases 24-hour intakes of several key micronutrients such as six vitamins and minerals while increasing the intake of dietary fat. The results confirmed the finding of previous research that NSLP increased intakes of vitamins and minerals (Devaney et al., 1995).

Contrary to Gleason and Suitor (2003), Campbell et al. (2011) found that the school lunch program does not lead the participants to take a better-quality diet than those who decided not to participate in the programs. They used data from the National Health and Nutrition Examination Survey (NHANES) and calculated the Healthy Eating Index scores of students to examine whether the NSLP affects the quality of diet or not.

More recent studies tried to investigate heterogeneity in the impacts of school meal programs. For example, Howard and Prakash (2012) found that the NSLP has positive impacts on nutrient intakes when focusing on the subsample who takes free or reduced-price school meals in the Early Childhood Longitudinal Study-Kindergarten (ECLS-K). Moreover, Smith (2017) found that there are negative impacts on students at the upper quantile of the dietary-quality distribution by estimating with NHANES.

The selection bias and the difficulty of finding strong instrument variables have been pointed out (e.g. Bhattacharya et al., 2004). For example, in the U.S., the NSLP provides meals through school cafeterias and students can select to participate or not. Also, they can participate for only some days if they want while others can participate fully indicating that some students take school meals only for a day per week and others fully participate. Therefore, researchers face two empirical issues: i) defining the participation status of students, and thus constructing the participation variable are challenging, and ii) certain types of students opt into school meals program and likely to face biases in estimating the economic effects of school meals program.

The Korean case provides a unique opportunity to mitigate the empirical issues. In Korea, almost all of the students in the participating schools are in the program. The decisions to participate in the school lunch program in Korea is less selective than those in the U.S. As a student can benefit from the program when it is implemented to their school, variation between year and region can be used. This study contributes to the literature by estimating the effects of the school lunch program in Korea where the selection bias is less likely to occur. Also, long-term follow-up analyses are possible as most students get school lunches. The effect of the external intervention on nutrition intakes can be estimated more clearly than previous studies.

This paper draws out more clear ideas about the effect of the school lunch program on the nutrition intakes and adulthood health status. The high level of participation in the Korean school lunch program allows the evaluation without selection bias. Moreover, as almost every student participates in the program, we could assess whether this political intervention could relieve the food insecurity and nutritional imbalance of students from low-income families. Most of the welfare states aim onto sufficient provision of nutrition to their children. Beyond the purpose of supporting basic human rights, there is little literature about the impact of improving nutritional status in childhood within an economic perspective. Therefore, the paper evaluates the impact of school meal policy on the student's human capital in adulthood.

3. The School Lunch Program in South Korea

In Korea, similar to other countries, the school lunch program is designed to supply sufficient food and to develop the nutritional habits of students that maintain their adulthood. The Korean school lunch program provides adequate nutrients under nutritional standards. The nutritional standards are effective guidance to ensure the nutritional quality of school lunches (Meeyoung Kim et al., 2019). From 2007, every school that provides school lunches must have a nutrition teacher to be in charge of school food services (Enforcement Rules of School Meals Act, 2019). Therefore, the meals provided by schools satisfy a certain level of quality even though the quality can be different across schools.

The history of the school lunch program in Korea is not that long, but currently, almost all of the students participate in the school lunch program (Ministry of Education, 2019). The school lunch program is offered by all 11,818 schools in Korea and it serves an average of 561 million students on each school day, which is 99.9 percent of whole elementary, middle, high, and special education school students (Ministry of Education, 2019). The very first School Meal Act in Korea was enacted in 1981. After keep reforming the School Meal Act, the school lunch program in Korea started to expand from 1991 and was fully implemented in 2003. The program focused on quantitative growth until 2002 and moved on to quality improvement from 2003 until now (Won & Kim, 2011). The budgets on the school lunch program are also constantly increased and more than 6 trillion KRW are spent in 2018(Ministry of Education, 2019).

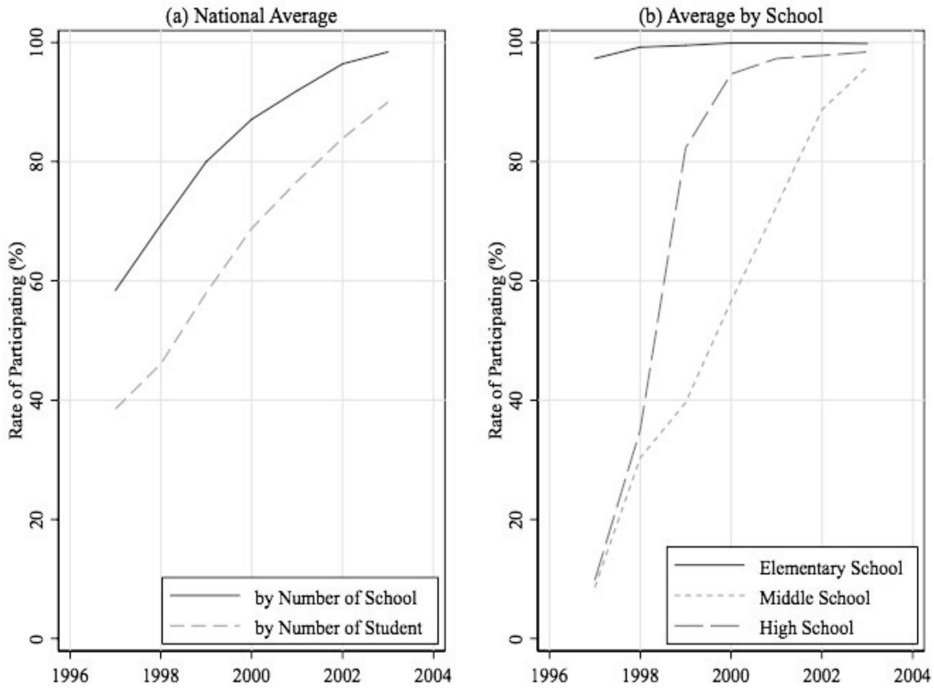

Figure 1. The Yearly Trend of School Lunch Program Expansion Rate in 1997-2003

Sources: Statistical yearbook of education of Korea 1997-2003
Note: Figure (a) shows the trend of school meal participation rate in national level 1997-2003. Figure (b) is the trend by school level.

The school lunch program expanded gradually, and the rate of implementation differs by region and level of schools. The program expanded in elementary schools first, so the implementation rate of lunch serving elementary schools was almost 100 percent in 1998. Figure 1 shows the rate of students and schools join in the school lunch program. In the case of middle schools, the percentage of schools serving lunch varies from 1.9 percent to 82.9 percent by region. Also, for high schools, the rate ranges from 8.3 percent to 65.8 percent. The cities such as Jeju had a higher rate of implementation while major cities such as Busan or Seoul had lower rates. This is because the school lunch policy was differently enforced by local governments. The rates of schools providing lunch increased drastically in 2001, but the gaps across regions remain. As national implementation rates also increased to around 60 percent in 2001, the number of participants and nonparticipants became comparable.

4. Data and Descriptive Statistics

This study uses two different data sets to examine both the short-term and long-term effects of the school lunch program. I first use the Korea National Health and Nutrition Examination Survey (KNHANES) to analyze the short-term impact of the school lunch program on nutrient intakes. We can obtain personal history information of individuals from the Korean Labor & Income Panel Study (KLIPS) data to check the long-term effects of the school lunch program.

The information about the intake of foods and nutrients of each meal and the characteristics of individuals can be obtained from the KNHANES. The KNHANES uses independently drawn samples every year and the samples are selected to represent the whole country. The survey was conducted every 3 years until the year 2007, so the first and second surveys were conducted in the years 1998 and 2001. Since every school in the nation started participating in the school lunch program by 2003, the pooled data from the years 1998 and 2001 were used in the analyses of nutrient intakes.

The KNHANES includes the nutrition survey which collects information about the kinds and quantities of foods that interviewees took over the last 24 hours. The nutrition survey questioned interviewees from age one, and if an interviewee is unable to answer than the survey was done with guardians' help. 10,400 and 9,968 respondents participated in the nutrition survey in 1998 and 2001, respectively. The KNHANES collected single-day food intakes by in-person 24-hour recalls approach. The trained interviewers visit respondents' homes with intake aids, which includes a 2D model for food and food containers, measuring cups and spoons, 30 cm ruler, thickness ruler, for dietary intake investigation (Ministry of Health & Welfare of Korea, 2012). As it depends on personal recall, the data might not be accurately measured, but it reduces the problem of plate waste.

Table 1. Summary Statistics of the Lunch Energy Intake (kcal)

	Non-school Lunch Takers			School Lunch Takers			
	n	Mean (kcal)	sd	n	Mean (kcal)	sd	Diff (se)
Elementary School *(age 7 to 12)*	775	505	382.91	1224	576	260.72	-71.09 (15.64)
Middle School *(age 13 to 15)*	661	645	405.79	264	711	343.96	-65.59 (26.41)
High School *(age 16 to 18)*	761	658	464.17	148	729	381.99	-70.47 (35.62)
Total	2197	600	425.10	1636	612	294.56	-11.33 (11.63)

Note: The food intake survey data from Korea National Health and Nutrition Examination Survey (KNHANES) 1998 and 2001are used. The means of each group are computed by using simple averages within each group.

Only samples of ages 7 to 18 who participated in the food intake survey were used for the analysis as this study aimed to examine the effectiveness of the school lunch program. There are 1,891 and 1,942 samples in the years 1998 and 2001, respectively, so that 3,833 observations are used. The school lunch program was implemented gradually from elementary schools to middle schools. The school lunch program implementation rate was already high in 1998 for elementary school students but it was around 10 percent for middle and high school students. The implementation rate increased by more than 50 percent after 2001. Therefore, for higher statistical power, I conducted the estimation with the pooled data from 1998 and 2001.

Unfortunately, the rounds I & II of KNHANES do not provide the information about the researched intake day and it is impossible to distinguish between weekday and weekend observations. Since there are big differences in the patterns of diet at weekday and weekend, the estimation might be biased downward. Still, the dataset provides detailed information about where and how people are dining out, the samples who had taken school lunch on the surveyed day are clearly defined. Therefore, the difference between the food intake of school lunch and non-school lunch is comparable.

The recommended intake (RI) for the school-aged children refers to a recommended allowance for school-aged children. Enforcement Rules of School Meals Act guides the nutritional standard reference for a single meal to each age and gender group. Both school lunch and non-school lunch provides a sufficient amount of the macronutrient such as protein and fat, but most of the micronutrients are not adequately consumed for the daily recommendation.

By the comparison of the means of the dietary intakes of the school lunch takers and non-school lunch takers, there are differences between the amount of two groups intake. Table 1 provides summary statistics for total energy intake within lunch meals taken by the school lunch takers and non-school lunch takers, respectively. As shown in differences, those who do not eat school lunch take significantly fewer calories than the school lunch taker for lunch.

I examine the long-term effects of the school lunch program with the data from 11th KLIPS. The KLIPS data is representative household panel survey data conducted every year since 1998. In the 8th (2005), 10th (2007), and 11th (2008) rounds, the current height of respondents was asked. Also, the retrospective information such as birthplace, location of middle and high schools, and living standard at age 14 was interviewed in the 11th survey. From the 9,874 respondents of the 11th additional survey, only 4,195 samples who born from 1969 to 1988 remains after removing elder respondents. The individuals at age 20 to 39 in survey year is used to find the long-term effect. The probability to expose to the lunch program varies for individuals as the program expanded gradually to each province with different implementation rates from 1991 to 2003.

There is retrospective information related to the region of middle schools and high schools that respondents went to. However, the location of elementary schools is not recorded on KLIPS, and so the proxies such as birthplace replace instead of the region of elementary schools that individuals went in the past. Also, the samples who lives at Jeju was not included to the KLIPS data until 12th (2009). Therefore, the individuals who went school at Jeju is excluded in this sample. As Jeju is the first province fully implemented the school meal, KLIPS data is limited to conduct clear estimation of the long-term effect.

5. The School Lunch Program and Nutritional Intakes of Children

One of the key objectives of this study is to empirically assess the impacts of the school lunch program on the nutritional intakes of school-aged children. In this section, I first describe the naïve approach and the results. I then discuss underlying identification issues, assumptions, propose alternative strategy, and report and discuss the results.

5.1 Estimation Method

I estimate the effect of the school lunch program on the intakes of food and nutrients for school-aged children. To achieve the objective, the simplest estimation method can be used is ordinary least squares (OLS). I estimated the effect of school meal with following equation

$$y_i = \beta_0 + \beta_1 SM_i + \Gamma X_i + \varepsilon_i. \quad (1)$$

In the equation (1), y_i is child i's lunchtime or over 24 hours total energy intake and intakes of each nutrient, SM_i is the dummy variable for whether the child i's lunch was a school meal or not, X_i is the vector of the characteristic of child i which are observable and can be controlled, ε_i is a random error term. The school meal dummy, SM_i, is 1 if the child i had lunch in a school for a given day and 0 if the child takes lunch in any other forms.

For the dependent variables, I use the total energy intake and macronutrients (protein, fat, and carbohydrate), vitamins (A, C and thiamin, riboflavin), minerals (calcium, iron), and other (sodium). As a vector of covariates, X_i includes variables such as age, gender, average monthly income of the household, and the region where children registered. The OLS regression models estimate the intake of nutrients taken more or less by the school lunch taker compared to that of non-school lunch takers. To check the difference in the effect of taking school lunch among different groups, I also conducted the equation (1) by income level, gender, and level of the school of observations.

The main source of the identification to examine the effect of SM_i comes from the regional variations in the expansion of the school lunch program over time. The child from the region that the school lunch program implemented earlier is more likely to take school lunch. Arguably, the school-level provision of the school lunch and the regional variations are exogenous to the intakes of energy or nutrients for individual children. However, there may be remaining endogeneity in the variable SM_i which I further mitigated by using the Heckman two-stage approach.

Table 2. The Estimated Effects of School Lunch on the Energy Intake (kcal)

	Impact of School Meal on Energy Intake (kcal)		
	Lunch	24-Hour	Non-lunch
	(1)	(2)	(3)
Panel A: without controls			
Taking school lunch	10.72	-68.63*	-79.35***
	(22.07)	(36.92)	(22.57)
Observations	3,833	3,833	3,833
Panel B: +Age and Gender			
Taking school lunch	61.77***	14.82	-46.95*
	(19.28)	(34.00)	(23.73)
Observations	3,833	3,833	3,833
Panel C: +Household average monthly income			
Taking school lunch	62.63***	19.49	-43.14*
	(19.16)	(35.34)	(23.17)
Observations	3,707	3,707	3,707
Panel D: +Region			
Taking school lunch	73.51***	50.18	-23.33
	(18.08)	(32.68)	(21.97)
Observations	3,707	3,707	3,707

Note: In this table, the effects of school lunch on the energy intake (kcal) that student's intake is estimated by simple regression equation (1). I only reported the coefficient for the dummy variable of taking school lunch. Control variables are additively contained from Panel A to D. Region variable is included as cities and provinces units. A single asterisk denotes statistical significance at the 90% level of confidence and triple 99%. Robust standard errors in parentheses.

The results of OLS estimation show that the total calories of the school lunch takers are significantly higher than those of the non-school lunch takers.

As column (1) in Table 2 show that there are positive effects of school lunch on total intakes (kcal) for the lunch. After controlling for observed characteristics by including the explanatory variables, the coefficients in Panel D gets larger and still robust. In the column (2), however, the effect seems to disappear when it comes to 24-hour.

5.2 Identification Issue

Many studies pointed out the self-selection of program participation as a problem (Bhattacharya et al., 2004). The students in the U.S choose to participate in the school meal program. The characteristic of students such as social and economic background might affect not only the nutritional outcomes but also the participation choices. This correlation between the participation and the error term can lead to bias estimates of the effect of the school meal program. As described in the earlier section, the selection bias is less likely to occur in the case of the school lunch program in Korea. Since once a school serves the school lunches, almost all students who attend that school gets school lunches.

Although the selection bias is less likely to exist in the analyses, some students may choose not to participate in the school meal program, and their decisions might be correlated with their parent's characteristics or current nutritional status. For example, low-income students can opt-out when there is no support on the school meal fee. Moreover, even though the implementation of the school meal program depends on the policy of the local government, there is a possible correlation between the implemented rate and regional characteristics. Therefore, the endogeneity problem could occur from the omitted factors in are correlated with SM_i.

To check and correct for the endogeneity of the SM_i, I apply the model with the Heckman two-stage approach as following equation.

$$y_i = \beta_0 + \beta_1 SM_i + \Gamma X_i y_i + \delta\lambda + \varepsilon_i \quad (2)$$

Since there are variation across provinces in 1998 and 2001, the regional rate of students taking school meals is used in the first stage to calculate the Inverse Mills Ratio λ. I estimate the equation (2) as second stage, which is same with equation (1) but with the Inverse Mills Ratio λ. Also, I additionally use the total food intakes (g) as the dependent variable to check the robustness.

Table 3. The Estimated Effects of Taking School Lunch on the Total Food Intake

	Impact of School Lunch on Total Intake			
	Breakfast	Lunch	Dinner	24-Hour
	(1)	(2)	(3)	(4)
Panel A: OLS model				
Total Energy Intake (kcal)	-17.10**	73.51***	5.56	50.18
	(6.41)	(18.08)	(12.00)	(32.68)
Total Food Intake (g)	-13.73***	62.17***	-9.61	35.92
	(4.49)	(9.88)	(9.48)	(21.78)
Observations	3,707	3,707	3,707	3,707
Panel B: Heckman 2-staged model				
Total Energy Intake (kcal)	-13.96**	80.83***	0.62	59.50*
	(6.09)	(17.68)	(10.62)	(30.44)
Inverse Mills ratio	30.53	71.05***	-47.96	90.40
	(25.48)	(18.26)	(43.86)	(69.72)
Total Food Intake (g)	-11.76***	62.62***	-15.26	32.86
	(3.98)	(9.85)	(8.82)	(21.71)
Inverse Mills ratio	19.12	4.38	-54.82**	-29.71
	(14.91)	(14.90)	(23.69)	(46.89)
Observations	3,707	3,707	3,707	3,707

Note: This table only reported the coefficients of dummy variable for taking school lunch and Inverse Mills ratio. The columns (1)-(3) is regressions with full controls and for intakes of lunch and 24-hour, non-lunch each. Panel B is results from Heckman 2-staged model and therefore, inverse Mills ratio is added on Panel B. A single asterisk denotes statistical significance at the 90% level of confidence, double 95%, and triple 99%. Robust standard errors in parentheses.

The results of Heckman two-stage model are consistent with the OLS results. The panel B on Table 3 shows that coefficient of the Inverse Mills Ratio is statistically significant in lunch level for total energy intake (kcal), which means the results of OLS might be biased by self-selection of SM_i. After controlled the endogeneity of the participating in school lunch, the positive effect of the school lunch is still significant. For total food intakes (g), the coefficient of the Inverse Mills Ratio is statistically insignificant. Therefore, the results of Heckman two-stage verify that OLS estimation is not biased by the endogeneity of SM_i. Despite the self-selection exists for taking school lunch, the results after the Heckman correction is still consistent with the results of OLS estimation. For the least of the paper, the results of OLS estimation is reported as baseline estimation.

5.3 Results

Table 3 presents that taking school lunch significantly increases the food intake both at the level of calories and grams for lunch. This effect, however, does not remain for 24-hour. Since school lunch takers take less food for breakfast, the impact of school lunch disappears. To clear out the impact of school lunch on children's daily diet, I also estimate equation (1) with the intake of micronutrients. The OLS estimation results reveal that taking school lunch positively influence the intake of some micronutrients. At lunch, taking school lunch increases the intake of almost every micronutrient as school lunch led children to take more food. This positive effect of the school lunch remains for protein and some minerals and vitamins for 24-hour. Notably, for calcium, iron, and vitamin A, the significantly positive impact is maintained to 24-hour.

As presented in Tables 3 and 4, the effect of school lunch disappears for some nutrients. This result is due to the decrease in total food intake at breakfast. Due to the significant decrease in intakes of protein and carbohydrate, the total energy intake of school lunch takes at breakfast is less than non-school lunch takers. Also, the students who taking school lunch consumed less sodium, thiamin, and vitamin C at breakfast. This trade-off leads to no significant differences between school lunch takers and non-school lunch takers in intakes of energy, carbohydrate, sodium, and vitamin C at 24 hours.

Unfortunately, the mechanism of the trade-off between breakfast and school lunch is unclear. Previous literature found the frequent skipping of breakfast as a factor of affecting plate waste of school lunch. The plate waste of students who have breakfast less frequently was more sensitive to school lunch satisfaction (Cha & Kim, 2007). However, this correlation between breakfast and lunch was not found in the research of Park et al (2015). The importance of adequate breakfast is getting attention from researchers as it affects daily nutrient intake and school performance (Boschloo et al., 2012; Chitra & Reddy, 2007; Levitsky & Pacanowski, 2013). The impact of the trade-off between breakfast and school lunch should be examined. Further research is needed to determine if there is a difference between distributing daily nutrients at each mealtime and concentrating on lunchtime.

Table 4. The Estimated Effects of School Lunch on the Micronutrients

	Impact of School Lunch			
	Breakfast	Lunch	Dinner	24-Hour
	(1)	(2)	(3)	(4)
Food Energy				
Protein (g)	-1.28**	4.61***	-0.65	2.58**
Fat (g)	-0.06	1.38**	0.49	1.78
Carbohydrate (g)	-3.56***	10.87***	0.45	5.22
Vitamins & Minerals				
Calcium (mg)	1.84	47.63***	5.11	83.55***
Iron (mg)	-0.16	0.76***	0.02	0.48*
Sodium (mg)	-102.19***	97.87**	-5.53	33.42
Vitamin A (R.E.)	-9.57	63.15***	6.14	73.78***
Thiamin (mg)	-0.02***	0.03	0.00	0.00
Riboflavin (mg)	-0.00	0.02	0.01	0.07**
Vitamin C (mg)	-3.37***	8.99***	-1.27	0.53
Observations	3,707	3,707	3,707	3,707

Note: The simple regression equation (1) estimated with micronutrients. A single asterisk denotes statistical significance at the 90% level of confidence, double 95%, and triple 99%.

The effect of the school lunch program on total food intakes does not persist for 24 hours. Still, the additional intakes of micronutrients are meaningful because average micronutrient intakes of students are inadequate than recommended. In most of the developed countries, children consume a sufficient amount of food in total calories. Industrialization brought the price of extra calories cheap, but it does not guarantee the balance of diet. The average amount of micronutrient intake for Korean students also falls short of the recommendation. Taking school lunch may not increases total food intake for the whole day but it promotes the balance of the diet as it increases the intake of vitamins and minerals for significant size. For example, an increase in calcium intake is crucial for children's bone health and height growth.

The estimated result about micronutrients is constant with the previous literature except for fat and sodium. In this paper, having school lunch increase the intake of fat and sodium at lunchtime, but not for 24 hours. The insignificant increase of fat and sodium conflict with the results of the OLS model by Gleason and Suitor (2003). The increase in intake of sodium pointed out as a cause of child obesity (Grimes et al., 2013), and so there was concern that the NSLP led to an increase in sodium intake. In the case of the school lunch programs of Korea, childhood obesity would be less likely to be problematic. One potential explanation of this distinction is the cultural difference of diet supplied. The meals provided by the school lunch programs in Korea are mainly focused on Korean traditional meals.

5.4 Analyses by Subgroup

The impact of school lunch is not identical among different subgroups. In Tables 5, 6, and 7, I report the coefficients of taking school lunch for each of the subgroups distinguished by income, age, and gender. The estimation with different income groups is conducted to assess the impact of school lunch programs on the low-income child. Since the required amount of nutrients differs by age and gender groups, the subgroup analysis is done to evaluate the impact of the school lunch program on child growth. Each result is derived from equation (1) with the same control with the main analysis on a characteristic of children and households.

Table 5 describes the difference in the impact of taking school meals by income groups. As the 4th quartile group is the highest income group, 4th quartile is the base group for analysis. From Panel A, the result presents that the school lunch program is more effective for lower-income groups. Both the 2nd and 3rd quartile group intakes more food in terms of gram at lunchtime, but not for 24-hour. This middle-income group takes additional protein, vitamin C, calcium and iron at lunchtime.

Nevertheless, the lowest income group does not take more benefit from the school lunch program in comparison with the middle-income group. Considering the eligibility, the lowest income group gets assistance from more than one policy. The child support policy was concentrated on the lowest-income families. Researchers pointed out that the child in need was excluded from the support and the government expanded eligibility to the second-lowest income group after the early 2000s (Misuk Kim, 2013; Ryu et al., 2014). Therefore, during 1998 and 2001, the Korean policies to support underfed children were also limited to the lowest income group. I assume that the lowest income group gets less benefited than the middle-income group as the impact of other food supplying programs. Unfortunately, it is hard to clear out the impact of other food policies due to the deficiency of information about exposure to the school lunch programs.

The effect of taking school lunch also emerge differentially for each demographic group. In Table 6, the estimated effect of school lunch is reported by gender and level of schools of students. The actual percentage that coefficients take in RDA is calculated in columns (2), (4), (6), and (8). RDA is the reference from the School Meals Act Enforcement Rule for nutritional intakes students should get in lunch. Boys get nutritional benefits from school lunch for every level of the school, while girls hardly get any additional intake from school lunch in middle school. For both boys and girls, the intake for calcium are significantly higher for school lunch takers than non-school lunch takers at every school level. Also, boys take more protein and iron when they take school lunch regardless of the school level. The coefficients take 10 to 50 % which is a great fraction of RDA for additional nutrients intakes for lunch.

Table 5. The Effects of the School Lunch Program by Different Income Quartile Groups

	Estimated Impact of School Lunch								
	Total Energy (kcal)	Total Food Intake (g)	Protein (g)	Vitamin A (R.E.)	Thiamin (mg)	Riboflavin (mg)	Vitamin C (mg)	Calcium (mg)	Iron (mg)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A. Estimated impact of school meal for lunch									
Taking school lunch	47.75	37.54***	2.46*	36.39	0.02	0.01	5.66***	32.87***	0.39*
	(27.83)	(12.54)	(1.21)	(25.54)	(0.02)	(0.03)	(1.89)	(9.35)	(0.20)
1st quartile (lowest)	-1.38	-20.67	-1.83	-53.47**	-0.03	-0.04**	-5.79*	-8.47	-0.43
	(39.31)	(21.81)	(1.45)	(20.91)	(0.02)	(0.02)	(2.87)	(11.08)	(0.28)
2nd quartile	-41.12	-39.63***	-2.85**	-39.48*	-0.00	-0.03	-5.91***	-26.94***	-0.46**
	(27.92)	(11.20)	(1.28)	(19.00)	(0.02)	(0.02)	(1.78)	(7.75)	(0.20)
3rd quartile	-23.40	-29.34**	-2.00	-36.24*	0.02	-0.02	-7.13***	-19.23**	-0.25
	(33.75)	(11.25)	(1.37)	(19.75)	(0.02)	(0.02)	(1.46)	(8.70)	(0.22)
Taking school lunch × 1st quartile	-8.96	21.75	2.14	59.87*	0.03	0.05	5.07	6.66	0.39
	(39.36)	(27.77)	(1.69)	(29.91)	(0.04)	(0.04)	(3.43)	(15.99)	(0.34)
× 2nd quartile	40.39	43.64***	3.13*	19.00	0.01	0.02	3.24	24.39***	0.54**
	(30.06)	(12.92)	(1.67)	(24.26)	(0.03)	(0.03)	(2.91)	(6.45)	(0.25)
× 3rd quartile	29.13	27.15*	2.45*	42.58	-0.01	0.00	6.33**	13.74	0.32
	(38.59)	(15.39)	(1.34)	(41.04)	(0.03)	(0.03)	(2.45)	(11.17)	(0.25)
Observations	3,711	3,711	3,711	3,711	3,711	3,711	3,711	3,711	3,711

Note: The income quartile means higher income as it is closer to 4th quartile. The highest income group, 4th income quartile, is a base for comparison. The simple regression equation (1) estimated with interaction terms with income status of children for micronutrients. A single asterisk denotes statistical significance at the 90% level of confidence, double 95%, and triple 99%. Robust standard errors in parentheses.

Table 5. The Effects of the School Lunch Program by Different Income Quartile Groups (Continued)

	Estimated Impact of School Lunch								
	Total Energy (kcal)	Total Food Intake (g)	Protein (g)	Vitamin A (R.E.)	Thiamin (mg)	Riboflavin (mg)	Vitamin C (mg)	Calcium (mg)	Iron (mg)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel B. Estimated impact of school meal for 24-hour									
Taking school lunch	20.52	26.82	-1.75	67.45**	0.02	0.12**	-0.07	83.96***	0.28
	(48.98)	(51.23)	(1.96)	(26.89)	(0.06)	(0.04)	(5.83)	(21.64)	(0.35)
1st quartile (lowest)	-151.33*	-153.11*	-12.88***	-109.87***	-0.24***	-0.22***	-17.50	-52.02	-0.55
	(75.41)	(78.87)	(3.00)	(32.16)	(0.06)	(0.06)	(20.55)	(34.41)	(0.57)
2nd quartile	-103.47	-138.48**	-9.81***	-82.58**	-0.11*	-0.14*	-15.91	-77.26**	-1.18***
	(73.48)	(59.59)	(2.97)	(36.02)	(0.06)	(0.07)	(11.21)	(30.83)	(0.39)
3rd quartile	-130.45*	-114.39**	-9.78***	-68.22**	-0.05	-0.11**	-19.12**	-47.88**	-0.99*
	(62.67)	(52.89)	(2.60)	(24.95)	(0.04)	(0.04)	(7.33)	(18.88)	(0.52)
Taking school lunch × 1st quartile	9.61	-11.77	6.26	-0.80	0.12	0.01	-4.14	-20.72	-1.20**
	(89.95)	(90.59)	(3.90)	(42.27)	(0.12)	(0.09)	(18.65)	(45.48)	(0.48)
Taking school lunch × 2nd quartile	6.26	17.57	5.85	-22.74	-0.04	-0.06	-2.72	-9.67	0.66
	(107.42)	(84.27)	(5.30)	(38.08)	(0.08)	(0.09)	(11.15)	(36.38)	(0.53)
Taking school lunch × 3rd quartile	-1.47	10.22	3.98	26.58	-0.09	-0.09**	12.50	-11.01	-0.05
	(63.20)	(60.15)	(3.30)	(47.82)	(0.05)	(0.04)	(8.07)	(16.87)	(0.68)
Observations	3,711	3,711	3,711	3,711	3,711	3,711	3,711	3,711	3,711

Note: The income quartile means higher income as it is closer to 4th quartile. The highest income group, 4th income quartile, is a base for comparison. The simple regression equation (1) estimated with interaction terms with income status of children for micronutrients. A single asterisk denotes statistical significance at the 90% level of confidence, double 95%, and triple 99%. Robust standard errors in parentheses.

The effect of school lunch on some nutrients disappear at 24-hour level estimation. Table 7 represents the estimated effect of school lunch at a 24-hour in different gender and age group. The actual percentage in columns (2), (4), (6), and (8) is calculated with nutrition standards from Dietary Reference Intakes for Koreans 2015. As the results of Table 7 show, the school lunch in early childhood at the low grade of elementary schools is significant for both boys and girls. While girls get more impact in the upper grade of elementary schools, boys take additional intake from the school lunch program at the high school level.

6. Long-term Effect of the School Lunch Program

A sufficient nutritional provision is more critical for students in a period of growth. The school meal program is an investment to promote the growth and development of children. Since the school meal program is related to increasing the nutrition intake, to assess the long-term effect of the programs, I follow up the cohorts potentially benefited from the school lunch in their childhood.

In this paper, I use height to measure the benefits of the school lunch program. After Fogel (2004) has related height with health and income, many studies utilized height as an indicator to measure childhood circumstances and the health status of individuals. Considering the net nutrition is the difference between losses from disease and gains from food intakes, adult height reflects social and economic circumstances (Deaton, 2007). Also, height can present current well-being as the taller earn more wages because of better productivity (Strauss & Thomas, 1998). Unlike other health indicators such as morbidity, mortality, and life expectancy, using height is more beneficial to investigate inequality in health status. It is highly free from measurement error attributed to correlation with incomes (Pradhan et al., 2003). Therefore, to evaluate long term effects of the school lunch program, this paper uses adult height as a health status in adulthood.

By using the KLIPS data, the cohorts from various years and region could be analyzed with retrospective information.

$$y_i = \beta_0 + \beta_1 ProbS_{lt} + \delta X_i + \varepsilon_i \tag{3}$$

The variable y_i is the individual i's height as an grown up and the variable $ProbS_{lt}$ is the probability of exposure to the school lunch program. The $ProbS_{lt}$ would be zero for older cohort those who was lived in the city that the school lunch program was not implemented. The probability would gradually increase to hundred percentage point as it comes to 2003. The gender and living standard around age 14, education level of parents was controlled as explanatory variables.

For the $ProbS_{lt}$, the implementation rate of the school lunch program on school's location l at year t is used. Unfortunately, there is no information about the location of elementary school. I used birthplace and location of middle school that individuals attended as proxy of location of elementary schools. The regression is also done with samples limited for those who went to a middle school in their birthplace. The long-term effect of the school lunch program on individual's height is reported for full sample and limited sample on Panel A and B for Table 6, respectively. In the Panel A, the birthplace is used as proxy of elementary school location for the columns (1) and (2) and the middle school location is used for columns (3) and (4).

The results on Panel A in Table 8 shows that a rise in the probability of exposure to the school lunch program significantly increases the height in adulthood for boys. Particularly, the exposure to the school lunch program during elementary school brings a rise in boys' height. The increase in the possibility for a standard deviation from the rate on our data means an increase in height for 0.94 to 1.46 cm. For girls, the school lunch program at middle school is efficient for enhancing health status. Both in Panel A and B, the implemented rate of the school lunch program has a significantly positive effect on girl's height. A standard deviation rises in the possibility to get a school lunch brings a 0.6 cm rise in girl's height.

On the contrary, the significant negative effect of school meals is found in Panel B for boys in high school. This is an inconsistent result with the Table 6 as the effect on additional nutrient intakes is significant for boys in high school and insignificant for girls in middle school. However, few samples in this analysis get the benefit of the school lunch program for full time in their school-age while others get none or few years in elder age. The long-term effect is hard to measure as height is affected by many other circumstances than nutritional status. There is very limited information about the past of individuals. Therefore, the results should be interpreted with consideration of bias.

Table 6. The Effects of the School Lunch Program on the Lunch Intake by Different Age and Gender Groups of Children

	Estimated Impact of School Lunch at lunch							
	Elementary low grade		Elementary upper grade		Middle		High	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A. Boy								
Food Energy								
Total energy (kcal)	69.32	13.0%	73.59	11.6%	156.83**	19.6%	178.97**	19.9%
Protein (g)	4.87***	58.0%	4.40***	37.6%	7.33**	43.9%	6.70**	33.5%
Vitamins & Minerals								
Vitamin A (R.E.)	55.41***	41.4%	-32.02	-17.4%	116.13***	49.6%	112.40***	39.6%
Thiamin (mg)	0.06*	25.0%	-0.04	-13.3%	0.05*	12.5%	0.14**	29.8%
Riboflavin (mg)	0.03	10.0%	-0.04	-10.8%	0.05	10.0%	0.05	8.3%
Vitamin C (mg)	12.10***	60.5%	4.92	21.0%	11.28***	33.8%	16.80***	45.8%
Calcium (mg)	68.30***	29.2%	52.21***	19.6%	32.39*	9.7%	42.74**	12.8%
Iron (mg)	0.96***	32.0%	0.73***	18.3%	1.39**	34.8%	0.59*	10.9%
Observations	551		496		469		419	
Panel B. Girl								
Food Energy								
Total energy (kcal)	111.39***	22.3%	-28.39	-5.0%	29.02	4.4%	104.99**	15.7%
Protein (g)	6.24***	74.3%	2.41	20.6%	1.36	9.1%	6.35***	42.3%
Vitamins & Minerals								
Vitamin A (R.E.)	74.44***	55.6%	55.22***	33.1%	30.89	14.2%	125.34**	53.6%
Thiamin (mg)	0.07**	35.0%	-0.07	-25.9%	-0.02	-5.9%	0.03	8.8%
Riboflavin (mg)	0.09**	37.5%	-0.01	-3.3%	-0.03	-7.5%	0.06	15.0%
Vitamin C (mg)	9.36***	46.8%	7.09**	30.3%	5.36	17.9%	7.59**	22.7%
Calcium (mg)	56.78***	24.3%	33.89**	12.7%	31.86**	10.6%	52.62***	17.5%
Iron (mg)	0.88***	29.3%	0.56	14.0%	0.16	4.0%	1.00***	18.5%
Observations	441		452		428		451	

Sources: School Meals Act Enforcement Rule

Note: The columns (1), (3), (5), (7) is the estimated impact of school lunch programs on children's nutrition intakes for lunch. The column (2), (4), (6), (8) is the percentage of estimated impact takes in the reference. The Reference for Dietary Allowances, RDA is the amount aimed in School Meals Act Enforcement Rule. A single asterisk denotes statistical significance at the 90% level of confidence, double 95%, and triple 99%.

Table 7. The Effects of the School Lunch Program on 24-Hour Intake by Different Age and Gender Groups of Children

	Estimated Impact of School Lunch for 24-Hour							
	Elementary low grade		Elementary upper grade		Middle		High	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A. Boy								
Food Energy								
Total energy (kcal)	116.16	6.8%	40.92	1.9%	-46.78	-1.9%	318.94*	11.8%
Protein (g)	5.11	17.0%	0.88	2.2%	-3.37	-6.1%	6.14	9.4%
Vitamins & Minerals								
Vitamin A (R.E.)	115.57***	25.7%	-70.48	-11.7%	84.73	11.3%	155.73*	18.3%
Thiamin (mg)	0.09	12.9%	0.03	3.3%	-0.07	-6.4%	0.33**	25.4%
Riboflavin (mg)	0.13**	14.4%	0.02	1.7%	-0.03	-2.0%	0.15	8.8%
Vitamin C (mg)	-0.35	-0.6%	-4.42	-6.3%	17.47	19.4%	-1.10	-1.0%
Calcium (mg)	127.47***	18.2%	68.31**	8.5%	9.42	0.9%	143.82***	16.0%
Iron (mg)	0.84	9.3%	0.22	2.2%	-0.06	-0.4%	0.03	0.2%
Observations	551		496		469		419	
Panel B. Girl								
Food Energy								
Total energy (kcal)	129.94***	8.7%	15.79	0.9%	-64.28	-3.2%	68.16	3.4%
Protein (g)	7.00*	28.0%	4.80	12.0%	-3.41	-6.8%	4.03	8.1%
Vitamins & Minerals								
Vitamin A (R.E.)	154.71***	38.7%	78.13***	14.2%	-20.53	-3.2%	61.91	10.3%
Thiamin (mg)	0.05	7.1%	-0.09	-10.0%	-0.10	-9.1%	-0.12	-10.0%
Riboflavin (mg)	0.18***	22.5%	0.09*	9.0%	-0.03	-2.5%	0.00	0.0%
Vitamin C (mg)	12.03	20.1%	-11.22	-14.0%	-7.56	-7.6%	-12.19	-12.8%
Calcium (mg)	109.27***	15.6%	122.66***	15.3%	34.31	3.8%	51.23*	6.4%
Iron (mg)	0.83	10.4%	0.87	8.7%	0.55	3.4%	0.63	4.5%
Observations	441		452		428		451	

Sources: Dietary Reference Intakes for Koreans 2015

Note: The columns (1), (3), (5), (7) is the estimated impact of school lunch programs on children's nutrition intakes for 24 hours. The column (2), (4), (6), (8) is the percentage of estimated impact takes in the reference. The Dietary Reference Intakes (DRIs) is used for the reference of dietary allowances. The Recommended Nutrient Intake (RNI) is used for all nutrients except for total energy (kcal) as the Estimated Energy Requirements (EER) is recommended for energy intakes. A single asterisk denotes statistical significance at the 90% level of confidence, double 95%, and triple 99%.

Table 8. The Long-term Effects of Taking School Lunches to Height in Adulthood

Proxy for Elementary School Location:	Birthplace		Location of Middle School			
	Elementary Lower	Elementary Upper	Elementary Lower	Elementary Upper	Middle	High
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. Whole Sample Age Group 20-39						
Boys						
Possibility to Take School Meal	0.018	0.056*	0.067***	0.049*	-0.003	-0.079
	(0.020)	(0.027)	(0.022)	(0.025)	(0.046)	(0.058)
Magnitude		1.460	0.945	1.255		
Observations	1,249	1,246	1,246	1,243	1,253	1,244
Girls						
Possibility to Take School Meal	-0.013	0.004	-0.007	-0.017	0.038*	0.081
	(0.026)	(0.030)	(0.029)	(0.020)	(0.019)	(0.054)
Magnitude					0.656	
Observations	1,595	1,592	1,587	1,575	1,597	1,577
Panel B. Limited Sample that Birthplace = Middle School						
Boys						
Possibility to Take School Meal	0.033	0.048			-0.038	-0.136*
	(0.025)	(0.028)			(0.049)	(0.072)
Magnitude						-3.944
Observations	923	922			929	925
Girls						
Possibility to Take School Meal	0.019	0.031			0.036*	0.054
	(0.028)	(0.026)			(0.020)	(0.054)
Magnitude					0.636	
Observations	1,211	1,209			1,216	1,208

Note: I conducted the regression in equation (3) for the height of age group 20 to 39 who born in 1969~1988. As there are no information about the location of elementary school individual went, two different proxies for elementary school region was used. Also, the whole sample was used for Panel A and the sample was limited for Panel B to those who went to middle school in region where they born. The estimation is done for each gender groups. The coefficient means the effect on height (cm) per % point change and magnitude represent the impact of increase in possibility to take school meal for a 1 standard deviation. A single asterisk denotes statistical significance at the 90% level of confidence and triple 99%. Robust standard errors in parentheses.

7. Conclusion

The almost mandatory nature of the Korean school lunch program made the selection bias much less problematic than other studies. The results are consistent with the previous studies on dietary intakes. Similar to those of Gleason and Suitor (2003) and Campbell et al (2011), I find that receiving school lunch has positive impacts on the intake of energy and most of the nutrients. Yet, the statistically insignificant impacts on the intake of fat and sodium from school lunch were different from the results of previous studies. While the higher intake of fat and sodium through the school lunch program is problematic as it can cause child obesity, we find an insignificant effect of the school lunch program on fat and sodium intake. This difference could be due to the difference in the diet of countries or the way the school lunch program operates. Revealing this mechanism behind this difference can be helpful to offer designs of more effective school meal programs.

As the positive effect persists for the intakes during 24-hour, we also investigate the long-term effects. We find that the long-term effect on height is significantly positive. Despite the retrospective data is limited, the analogous results show that the school lunch program can reduce inequality in nutrition status. The school meal program could be an effective investment to improve future human capital.

The budgets on the school lunch program are more than 6 trillion KRW were spent in 2018. The fraction of self-pay is constantly decreased as the budget rises(Ministry of Education, 2019). The local government of Gangwon provides 100 percent free lunch to every student from elementary schools to high schools and other local governments are also plans to convert the school lunch program into 100 percent free. Considering the cost of the school lunch program, the effectiveness of the school lunch program on human capital should be measured.

Kim and Han (2017) used KLIPS from 1998 to 2012 to evaluate the height-wage premium in Korea. According to the research, men and women earn 0.73% and 0.56% higher monthly wages, respectively, when there is a 1 cm increase in height. As the magnitude in Table 8 Panel A shows, the 100% implementation of the school lunch program brings 4.89cm of height growth for boys and 3.8cm for girls. To calculate the amount of increase in expected income, I assume the cohort of 25 years old men in 2012, who has been fully exposed to the school lunches for 12 years and works until 60 years old. The average monthly wages for each age group in 2018 in the KLIPS report are used to reflect the income changes by the life cycle. Under a 4.5% discount rate, the additional height-wage premium from school lunches is approximately 25 million KRW for men. For women, the extra earning would be 10 million KRW. The school lunch program cost per person in 2006, when the cohort was in the last year of their high school, was 466,375 KRW. Accordingly, the cost during 12 years of schooling is 9 million KRW. Considering the cost and benefit, the benefit of the school lunch program is greater than its cost.

As the expected income represents only the increase in labor productivity, the impacts on other social and economic benefits such as a reduction in health insurance cost and improvement in the satisfaction and quality of life should be investigated. Hence, even if the increase in the expected income caused by the school lunch program is over-estimated, the program could still be a cost-effective policy. Moreover, the school meal program is a very powerful intervention to maintain children's health and reduce inequality. The value of the school meal program as a basic safety net for low-income children should also be considered. The mechanism to make the student more balanced diets and the long-term effect of the school meal on various aspects remains to be an open question. Therefore, further research is required to reveal the effect of the school meal program on future human capital.

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국문초록

국내 학교급식사업이 아동기의 영양과 성인기의 키에 미치는 영향

본 연구는 1998 년과 2001 년의 국민건강영양조사 자료를 활용하여 한국의 학교급식사업이 아동들의 영양섭취에 미치는 영향을 살펴보고자 하였다. 학교급식사업이 확대되던 시기에 지역마다 사업 도입 시기에 차이가 있음을 이용해서 단순회귀분석을 하였으며 학교급식이 학생들의 에너지 섭취량에 긍정적인 영향을 주는 것을 보였다. 또한, 늘어난 영양 섭취량은 단백질이나 비타민, 무기질의 24 시간 동안의 섭취량도 증가시키는 효과가 있는 것으로 나타났다. 학교급식의 장기적인 효과를 살펴보기 위해서 급식을 통해 증가한 에너지와 영양소 섭취량이 급식에 노출된 세대의 키에 미치는 영향을 분석했다. 한국노동패널 자료를 이용하여 분석한 결과 장기적으로 초등학교 때 급식에 노출된 남성의 키 성장에 통계적으로 유의하게 긍정적인 영향을 준다. 본 연구는 학교급식사업의 확대가 아동의 영양 상태를 개선으로 이어진다는 점에서 의의가 있다.

주요어: 학교급식사업, 영양, 건강과 인적 자본

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