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The impacts of free school lunch policies on adolescent BMI and mental health: Evidence from a natural experiment in South Korea

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ABSTRACT

In spring 2015, the South Korean province of South Gyeongsang stopped providing free school lunches to primary and secondary school students while large portions of schools in other provinces continued to provide free lunches at school. After the provincial government faced strong opposition, South Gyeongsang reintroduced the free-school-lunch program the very next year. Using a difference-in-differences design, we exploit these policy changes to evaluate their impact on students' body mass index (BMI) and on a measure related to students' mental health status (MH). Our results show that the abolishment of free school lunches harmed (female) underweight students by causing additional weight losses of about 4.5 percent whereas the reintroduction of free school lunches led to an average weight loss of 2.1 percent among overweight students (both male and female). Moreover, the school lunch policy changes had significant impacts on our MH measure: crying without any reason increased when the free-school-lunch policy was abolished and it decreased when the policy was reintroduced. The results are of great interest to decision makers: introducing free school lunches helps to achieve healthier weights and decreases crying without any reason and as a result, benefits student welfare. Free-school-lunch policies, therefore, may provide simple and inexpensive means to improve the health and welfare of students.

1. Introduction

In spring 2015, the South Korean province of South Gyeongsang[1] stopped providing free school lunches to primary and secondary school students while large portions of schools in other provinces maintained free lunches for all students at school (see Fig. 1).

The governor's stated reasons for this change were to strengthen the financial soundness of the province and to increase the welfare of students from lower-income families by saving resources used to provide free school meals to upper-income families. However, the provincial government faced strong opposition and reintroduced free school lunches in spring 2016. The primary goal of our paper is to use these policy changes as experiments to identify (and quantify) their impacts on measures/indicators related to bodyweight and mental health.

Using a difference-in-differences (DID) design, we find that the abolishment of the free-school-lunch policy in 2015 decreased the BMI of the average student by about 1.3 percent and that the reintroduction of that policy one year later had the opposite effect: the average student BMI increased by about 1.7 percent. In addition we show that the free-school-lunch policy led to healthier weights: on average the abolishment of the free-school-lunch policy caused underweight female students to lose even more weight while its reintroduction helped overweight female and male students to lose weight. Furthermore, the policy changes affected students in yet another way: the abolishment of the program caused significantly more students to cry without any reason while its reintroduction significantly lowered this measure. These results provide a strong argument for policy makers willing to promote a free-school-lunch policy.

Our focus on the two outcome variables BMI and 'crying without any reason' is justified by the importance both variables have for overall (adolescent) health. High body mass indices, in particular, are associated with – among others – hypertension, hyperlipidemia, diabetes, and cardiovascular problems (see, for example, Daniels et al., 2005; Dehghan et al., 2005). 'Crying easily for no reason' is – according to the American Psychiatric Association (2013) – one of the symptoms of a clinical depression. In our statistical analysis, we show that free school lunches help to achieve both healthier weights and less crying without

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[1] With a population of 3.16 million (census 2010), South Gyeongsang is the second most populous of the nine South Korean provinces.

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List of abbreviations

BMI	body mass index
CEP	community eligibility provision
DID	difference-in-differences
KCYPS	Korean Children and Youth Panel Survey
NYPI	National Youth Policy Institute
MH	mental health

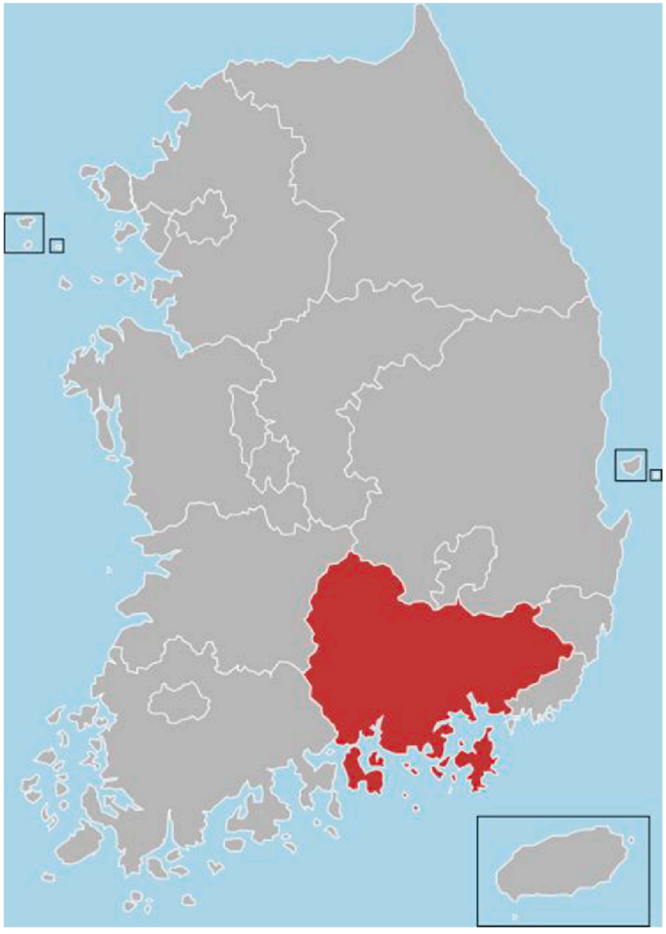

Fig. 1. Location of South Gyeongsang within South Korea (credit: Wikipedia).

reason. We therefore argue that free school lunch policies benefit students' overall health and hence welfare.

2. Related literature

The impact of diverse interventions, including free-lunch policies, on bodyweight and mental health of students has long been subject to empirical scrutiny by health policy scholars and social scientists alike. One strand of literature relevant in this context studies the impacts of free-school-lunch policies on students' academic outcomes, BMI, misconduct, and meal satisfaction. The other strand of literature uses quasi-experimental designs (such as education policy changes or cash transfer changes) to measure the effects on students' depressive symptoms, cognitive ability, and BMI. Our paper contributes in three ways to this existing literature: first, it uses a sudden and short-lived free-lunch policy change to examine the effects on student health measures. Second, we study both the abolishment and the introduction of free-school lunches. Third, our study focuses on South Korea and therefore adds to the only scant literature on East Asia.

Plenty of evidence suggests that universal free school meal programs significantly improve students' academic outcomes (Gordanier et al., 2020; Ruffini, 2021; Schwartz & Rothbart, 2020). Although the effect of such programs varies by socioeconomic status, even students from affluent family backgrounds experience an increase in academic performance. Improving school meal quality also has significant effects on academic achievements of students. The British government's "Feed Me Better" campaign to enhance school meal quality, for instance, led to a significant increase in student educational outcomes, especially in English and Science subjects (Belot & James, 2011). Likewise, free school breakfast programs increase students' cognitive achievements (Frisvold, 2015).

Other studies focus on the effect of free school meals on student BMI, obesity, and health. Davis et al. (2020) estimate that exposure to the Community Eligibility Provision (CEP)[2] increases the student BMI by about two percent. Focusing on K-12 schools in Georgia, Davis and Musaddiq (2019) show that the CEP increases the probability of having a healthy weight and decreases the average student BMI. Similarly, Gundersen and Kreider (2009) show that food security is crucial for students attaining favorable health conditions and healthier weights.

There are also studies with a wider focus such as student misconduct and meal satisfaction after students are offered free school meals. Lee and Baek (2016) and Altindag et al. (2020) measure the impact of free school lunches on student misbehavior. They find that incidents of student misconduct decreased significantly after free school lunches were introduced. In light of growing concerns among parents about an alleged decrease in meal quality after introducing a free-school-lunch program, a few studies also evaluate the satisfaction with free school meals in primary and secondary schools. Jang et al. (2016) evaluate the meal satisfaction of elementary school students in Busan. Similarly, Yang et al. (2021) measure the satisfaction of free school meals of secondary school students in Busan. Both studies find no significant decrease in student satisfaction with school meals even after the free school lunch is implemented.

In general, empirical research shows that free school meals lead students into a healthier direction and turn schools into better environments for children and adolescents. The introduction of free school meals obviously levels out social differences and thereby might lead to a reduction of stress among students. And with less stressed students, school violence is likely to decrease. Furthermore, a number of studies shows that perceived stress levels affect eating behavior and result in BMI changes (Barry & Petry, 2008; Nishitani & Sakakibara, 2007; Ohara et al., 2019). Also, it is well established that this kind of effect is generally larger for females than for males (see, for example, Barry & Petry, 2008; Liu & Umberson, 2015; Ohara et al., 2019; Udo et al., 2014).

Another strand of literature related to our paper uses experimental and quasi-experimental designs to study the impacts of social interventions on body weight and mental health outside the Western world. Prencipe et al. (2021), for example, focus on the impact of cash transfers on depressive symptoms of youth aged 14–28 in Tanzania. The meta-analysis by Durao et al. (2020) examines how cash transfers help reducing food insecurity in low and middle income countries. It is shown that both conditional and unconditional cash transfers weakly increase the dietary diversity; moreover, unconditional cash transfers weakly increase cognitive ability of children. Similarly, Prencipe et al. (2021) find that conditional cash transfers in Tanzania decreased depressive symptoms among children.

In a quasi-experimental design, Barlow (2021) uses exposure to the

[2] CEP is a free breakfast and lunch program for schools and school districts located in low-income areas in the United States.

Universal Primary Education reform in Nigeria[3] as an instrument for total years of schooling. In her second stage regressions, the author finds that each additional school year had only an insignificant (positive) effect on the probability of being overweight or obese. Barlow's finding stands in stark contrast to previous studies of the Nigerian case that do not use an (quasi-) experimental design which highlights the importance of the underlying identification strategy. Similar to Barlow (2021), Dursun et al. (2018) use exposure to the 1997 Compulsory Schooling Reform in Turkey[4] as the source of identification. Their regression results indicate that an additional year of schooling increases the likelihood of obesity for males but helps to maintain a healthy weight for females.

Our paper contributes in three ways to the existing literature. First, we are in the rare and fortunate position to examine the abolishment of the free-school-lunch policy as well as its immediate reintroduction just one year later. The existing literature on school meal policies typically measures the effect of introducing free meals to students. However, research on the abolishment of free school lunches is still scarce. Besides 2015 – the year of the free school lunch abolishment in South Gyeongsang – our dataset also covers the years prior to and after this change. As a result, we are able to study both the abolishment and the introduction of free-school lunches.

Second, our analysis benefits not only from its quasi-experimental approach but also from its clear and simple econometric design. Often in this literature, researchers face difficulties as schools adopt free school meal policies at different points in time. Some schools might choose to provide free school meals very early while others might postpone the adoption of the policy. Consequently, the number of schools providing free school meals might vary over the observation period. Due to this timing issue, control and treatment groups change between different points in time. This complicates the interpretation of the measured regression coefficients because they reflect a weighted average of long-term effects (driven by schools that adopted the policy earlier) and short-term effects (from recent adopters of the policy). In our analysis, this is not the case. Only one province – South Gyeongsang – made policy changes. Schools in the other provinces were not affected by these changes. As a result, our analysis is able to apply a clear and simple econometric model that does not need to consider timing issues related to the province's implementation of the two policy changes.

Third, in contrast to an already rich body of literature on the impact of social interventions on bodyweight and mental health in Western countries, our study focuses on an East-Asian country, South Korea, and therefore adds to a scant literature that mostly focuses on Japan (Asakura & Sasaki, 2017; Ishida, 2015; Kohri et al., 2016; Murayama et al., 2017; Yamaguchi et al., 2018). Moreover, the case of South Korea is interesting in its own right because of the country's very rapid development. Until the 1960s South Korea was one of the poorest countries in the world (in terms of GDP per capita) while it is nowadays considered a developed country. The country might therefore share characteristics with both developed and developing countries.

3. Data and methodology

The dataset used in our study is the 2010 wave of the Korean Children and Youth Panel Survey (KCYPS) by the National Youth Policy Institute (NYPI) which is managed by the Korean Prime Minister's Office. Based on the size and population of a total of 17 first-tier administrative divisions (eight cities and nine provinces), the NYPI chose the schools to be surveyed using proportional stratified sampling. After the schools are chosen, the NYPI randomly chooses students based on the information on class size and number of classrooms. Most measured variables describe the socio-economic backgrounds of students and students' test scores in mathematics, social science, natural science, Korean, and English. Moreover, the dataset comprises a few detailed variables such as students' study characteristics, mental health, and personal characteristics such as their weight and height. Students' personal and academic characteristics are reported by the students themselves while some of the socio-economic variables such as parents' education and health level that students may not know are reported by their parents. The 4th grade cohort tracks the students for 7 years from 2010 to 2016.[5]

To focus on secondary students, we use the 4th grade cohort who are 8th graders in 2014 – the year before the free school lunch abolishment – and are 10th graders in 2016– the year of its reintroduction. The dataset is an unbalanced panel, maintaining a total of 2070 observations in 2014, 2061 observations in 2015, and 1979 observations in 2016. Table 1 describes our research design.

In our main regressions, we use the pooled ordinary least squares method (clustered at individual level) which is summarized in equation (1):

$$Y_{it} = \beta_0 + \beta_1(Year_t) + \beta_2(Location_i) + \theta(DID_{it}) + \beta_4(Covariates_{it}) + \varepsilon_{it} \quad (1)$$

Year and Location are both dummy variables where the treated year/the treated province equal one. DID is the interaction of Year and Location. Covariates denotes a vector of individual characteristics that we control in our regressions. The above DID design calculates the difference in change between the treated group and the control group, and then uses that value to obtain information about the precision of the estimates.

The individual covariates controlled in the BMI regressions are mother's education, the health of parents, allowance, the time students go to bed, having a girlfriend or boyfriend, and time spent on television, game, and friends. Mother's education, the health of parents, and allowance are common socio-economic determinants of students' BMI (Fertig et al., 2009; Keino et al., 2014; Klein-Platat et al., 2003; Li et al., 2017; Müller et al., 2001). Variables related to student sociability such as spending time with friends and having a girlfriend or boyfriend can affect the BMI of adolescents (Paxton, Schutz, Wertheim, & Muir, 1999; Webb & Zimmer-Gembeck, 2013). Other common determinants for BMI are related to time use such as playing games, sleeping, and watching television (Kenney & Gortmaker, 2017; Sijtsma et al., 2015).

The individual covariates controlled for in the MH regressions additionally comprise relationships with teachers and peers as they are commonly known to influence student mental health. Tables 2 and 3

Table 1
Summary of research design.

	2014–2015 Regression		
Control/Treatment	2014	2015	2016
South Gyeongsang	Controlled	Treated	
Other Regions	Controlled	Controlled	
	2015–2016 Regression		
Control/Treatment	2014	2015	2016
South Gyeongsang		Controlled	Treated
Other Regions		Controlled	Controlled

[3] The UPE reform in Nigeria 1976 was designed to increase educational attainment and schooling by providing tuition-free primary school and increasing the number of primary schools, classrooms, and qualified teachers.

[4] By combining elementary and middle schools, Turkey increased the duration of compulsory schooling from five years of elementary education to eight years.

[5] The dataset is publicly available and its detailed description can be found at https://www.nypi.re.kr/archive/board?menuId=MENU00329 [last accessed January 25, 2022].

Table 2
Descriptive statistic for outcome variables.

variable	2014		2015		2016		description
	obs	mean (sd)	obs	mean (sd)	obs	mean (sd)	
BMI	2039	20.24628 (3.138918)	2032	20.70385 (3.194226)	1946	21.49263 (3.29940)	student BMI
MH	2068	3.298356 (0.763498)	2058	3.293003 (0.736017)	1964	3.363035 (0.739042)	often cry without any reason

Note: The natural logarithm of BMI is used in the following regressions. MH is a categorical variable where 1 denotes “strong yes”; 2,“yes”; 3,“no”; 4,“strong no”.

Table 3
Descriptive statistics for control variables.

variable	2014		2015		2016		description
	obs	mean (sd)	obs	mean (sd)	obs	mean (sd)	
year	2068		2058		1964		treated year = 1, controlled year = 0
location[a]	2068	0.060928 (0.239257)	2058	0.063168 (0.243324)	1964	0.059572 (0.236753)	treated province = 1, control province = 0
moeduc	1888	14.16843 (2.196789)	1869	14.17764 (2.178961)	1734	14.19089 (2.164581)	mother’s education in years
healthpar	2018	1.930129 (0.485357)	1986	1.964753 (0.518442)	1841	1.934275 (0.49070)	health of parents 1 = very healthy 2 = healthy 3 = unhealthy 4 = very unhealthy
allowance	1690	3.985976 (3.542266)	1822	4.489462 (2.880964)	1807	6.526895 (4.571352)	monthly allowance in 10,000KRW
withteach	2068	1.838491 (0.653988)	2058	1.811467 (0.634776)	1964	1.738798 (0.605209)	confident saying hello to teachers 1 = very confident 2 = confident 3 = insecure 4 = very insecure
withpeer	2068	1.647485 (0.571038)	2058	1.696307 (0.560051)	1964	1.65835 (0.572664)	confident with friends 1 = very confident 2 = confident 3 = insecure 4 = very insecure
bedhour	2066	23.33398 (0.977112)	2058	23.73518 (1.036681)	1964	24.33248 (1.042619)	time student go to bed
tvtime	2061	70.77729 (63.17977)	2058	69.53158 (68.59966)	1964	43.79888 (56.44976)	minutes spent in watching tv
gametime	2056	69.03745 (68.79921)	2058	72.34014 (76.38425)	1964	47.57892 (64.13305)	minutes spent in playing games
friendtime	2052	46.82115 (58.78566)	2058	58.16084 (71.19275)	1964	39.18839 (67.89069)	minutes spent with friends
girlfriend	2068	1.848646 (0.35848)	2058	1.830904 (0.374928)	1964	1.826375 (0.378883)	having girlfriend or boyfriend 1 = have, 2 = don’t have

[a] We dropped the students who did not report their province information as the location is necessary to divide students into control and treatment groups.

show the descriptive statistics of the variables used in our regressions.

For both the BMI and the MH analyses, we also ran separate regressions by gender to measure the potentially heterogeneous effects the free-school-lunch policy had on male and female students. In our BMI regressions, we went one step further and also analyzed the effect of the policy on underweight and overweight students. This way we hope to see whether or not the free school lunches are leading students into healthier directions. For the identification of underweight, normal weight, overweight, and obese students, we used the age and gender specific BMI percentiles suggested by the World Health Organization (2007). The categorization then follows the guideline of the United States Center for Disease Control which happens to coincide with the corresponding Korean guideline published by the Seoul National University Hospital.[6] This procedure allows to measure the difference (between the control and treatment groups) of average BMI changes (after one year) separately for underweight and overweight as well as female and male students. Consequently, we obtained four additional DID coefficients (by gender and weight status).

To cope with the relatively small numbers of observations in the gender-specific underweight and overweight regressions, we applied the

[6] Underweight children are students less than the 5th percentile in BMI, overweight children are students from 85th to less than the 95th percentile in BMI, and obese children are students from the 95th percentile and higher (Center for Disease Control and Prevention, 2022; Seoul National University Hospital, 2021).

bootstrap method to measure the accuracy of our estimation. Following the standard procedure (Efron & Tibshirani, 1993), we drew a bootstrap sample and calculated the theta coefficient $\widehat{\theta}_i$. Repeating this procedure one thousand times allowed us to estimate the standard error of θ as follows:

$$\widehat{se} = \left[\frac{1}{k-1}\sum_{i=1}^{k}(\widehat{\theta}_i - \overline{\theta})^2\right]^{½}, \text{ where } \overline{\theta} = \frac{1}{k}\sum_{i=1}^{k}(\widehat{\theta}_i) \quad (2)$$

In our MH regressions, we also ran separate regressions for girls and boys. However, we did not run separate regressions for underweight and overweight students. Unlike the BMI variable, which is continuous, mental health is a categorical variable. Therefore, only a small portion of observations changes over time. If we focus on the smaller groups like underweight and overweight students, only a few observations will decide the magnitude and sign of coefficients, which leads to consistency issues.

4. Results

Table 4 displays the DID coefficients[7] of our BMI regressions organized by year, gender, and weight status. In particular, we are restricting our regressions to female and male as well as underweight and overweight individuals and use ln(BMI) as the outcome variable.[8]

On average, student BMI decreased approximately by 1.3 percent when the free-school-lunch program was abolished but increased by about 1.7 percent when it was reintroduced. Unsurprisingly, weight losses are smaller in magnitude and statistically less significant than weight gains. For losing weight takes generally more time than gaining weight (Hanson et al., 1995). Nevertheless, our results show that an average student consumed more food when the free-school-lunch program was reintroduced.

Most importantly, we find that the program benefits students' health. Once the program was abolished in 2015, the average BMI of underweight female students decreased even further by approximately 4.5 percent. On the contrary, the average BMI of overweight male and female students decreased by approximately 2.1 percent after the program was reintroduced in 2016. We also checked the robustness of these findings. In a first step, we addressed the relatively small number of observations by applying the bootstrapping method described in equation (2). As can be seen in Table 4, the estimated coefficients are still statistically significant even with bootstrapped standard errors.

In a second robustness check, we took a closer look at students leaning toward low weights (BMI percentile $\leq$ 25%). Table 5 summarizes our results. Again, we reconfirm that lower-weight (BMI percentile $\leq$ 25%) females generally lost weight once the program was abolished. Moreover, the DID coefficients close to zero for the 2015–2016 regressions restricted to students whose BMI percentile is greater than 25 percent (we refer to this group as upper-weight students) also reconfirm our point that average students gained weight while overweight students lost weight (as shown in Table 4). However, the DID coefficient is slightly bigger than zero for upper-weight female students as the portion of overweight female students is smaller than the portion of overweight male students.

The following Table 6 displays the DID coefficients[9] of our MH regressions organized by year and gender. As the MH regressions in Table 6 show, students cried more often without any reason when the free school lunch was abolished but less cried when the free school lunch was reintroduced with high statistical significance. Note that the coefficients' magnitude and statistical significance are higher when the program was abolished as opposed to its reintroduction. Moreover, the MH effects are stronger for female students as the regression results display both bigger magnitudes as well as higher statistical significance than the regression results for male students.

We also rerun the MH regressions for the split estimation samples (along the 25th BMI percentile). The results obtained are not only consistent with Table 6 but also allow an insight into which group of students is affected more. Table 7 summarizes the regression results. We find that lower-weight female students are more affected by the abolishment of the free-school-lunch policy than the other females. Similar effects of the policy abolishment can be seen for male students although they are generally affected less and insignificant at conventional levels. With respect to the reintroduction of the free-school-lunch policy in the following year, the results show that female students cry less without any reason and this finding is less pronounced for the lower-weight females. The corresponding regressions for male students do not lead to any conclusive results.

In our final robustness check, we are restricting our sample to South and North Gyeongsang[10] for both the BMI and the MH regressions. South and North Gyeongsang share similar history, climate, culture, dialects as well as political preferences and attitudes. By controlling North Gyeongsang and treating South Gyeongsang, we isolate regional fixed effects more precisely compared to the main regressions. However, due to the small number of observations, we cannot separate students into certain BMI groups. Table 8 presents our results of the BMI robustness check with the restricted sample. As Table 8 shows, we reconfirm that on average students' BMI decreased once the policy was abolished and increased once it was reintroduced. And once again, we find a more significant effect for female students than for male students (despite the smaller number of females).

Table 9 presents our results of the MH robustness check when restricting the sample to South and North Gyeongsang. Although the regional fix effects are more precisely controlled by using very homogenous provinces, we obtained similar results as in Table 6. Students cried significantly more without any reason once the policy was abolished while they cried significantly less without any reason once the policy was reintroduced. Moreover, we again observe that females are more affected than males.[11]

5. Discussion

Our analysis reveals a strong impact of free-school-lunch policies on student health outcomes, most importantly on students' BMI. As Table 4 shows, underweight female students experienced additional weight losses of about 4.5 percent once the policy was abolished. After its reintroduction, overweight students (both female and male) benefitted from weight losses of approximately 2 percent. Several robustness checks corroborate our results (see Tables 5 and 8). Our findings

[7] We conducted a total of three placebo tests for the ln(BMI) regression. We first used the 2013–2014 dataset with the same controlled and treated provinces. We then used North Gyeongsang as a treated province instead of South Gyeongsang using 2014–2015 and 2015–2016 regressions. In all three regressions, we could retain the null hypothesis ($\theta = 0$) if $p < 0.10$.

[8] This specification allows us to identify weight changes even when they do not lead to a switch between categories. The (presumably more natural) approach where the outcome variable is dichotomous - indicating 'healthy weight' or 'not' - does not lead to conclusive results because there are not enough switches between the two categories to produce significant results.

[9] We conducted two placebo tests for the MH regression using North Gyeongsang as a treated province instead of South Gyeongsang for both the 2014–2015 and the 2015–2016 regressions. We could retain the null hypothesis ($\theta = 0$) if $p < 0.10$ for both placebo regressions.

[10] With a population of 2.60 million (census 2010), North Gyeongsang is the third most populous of the nine South Korean provinces.

[11] North Gyeongsang was also considered as a treated province in a few placebo regressions resembling our main BMI and MH analyses. Reassuringly, neither exerts a statistically significant influence on the DID coefficient (see Table A in the Appendix).

Table 4
BMI regression DID coefficients.

ln(BMI)	average	female (underweight)	female (overweight)	male (underweight)	male (overweight)
2014–2015	−0.012911	−0.045022***	0.014840	0.018715	0.008174
	(0.011765)	(0.016774)	(0.018788)	(0.03236)	(0.017584)
P>|t|	0.273	0.010	0.432	0.565	0.643
obs	3263	79	89	96	218
$\hat{\theta}$ **(boot. se)**		−0.045022*	0.014840	0.018715	0.008174
		(0.026131)	(0.022631)	(0.035562)	(0.020333)
P>|t|		0.085	0.512	0.599	0.688
replications		649	837	623	995
2015–2016	0.016597*	0.060515	−0.021406*	−0.006812	−0.021569*
	(0.010019)	(0.058901)	(0.011492)	(0.035931)	(0.012211)
P>|t|	0.098	0.309	0.067	0.85	0.079
obs	3392	71	88	85	239
$\hat{\theta}$ **(boot. se)**		0.060515	−0.021406*	−0.006812	−0.021569*
		(0.068333)	(0.012091)	(0.038647)	(0.012921)
P>|t|		0.376	0.077	0.86	0.095
replications		543	860	881	656

Note: standard errors are clustered at student level and reported in parentheses. (boot. se) denotes bootstrap standard errors. Because of occasionally occurring collinearities, numbers of replications are below one thousand in our bootstrap analysis.

Table 5
Robustness Check Using Students with Lower and Upper Weight on ln(BMI).

ln(BMI)	female (BMI percentile ≤25%)	female (BMI percentile >25%)	male (BMI percentile ≤25%)	male (BMI percentile >25%)
2014–2015	−0.021677	−0.013249	0.015392	−0.020719
	(0.016305)	(0.015935)	(0.016766)	(0.021758)
P>|t|	0.185	0.406	0.359	0.341
Obs	434	1114	399	1316
2015–2016	0.021220	0.012292	0.018690	0.000007
	(0.016774)	(0.012747)	(0.014640)	(0.019506)
P>|t|	0.207	0.335	0.203	1.00
Obs	451	1143	402	1396

Note: standard errors are clustered at student level and reported in parentheses. We did not get the DID coefficient close to zero as the portion of overweight female students is smaller than the portion of overweight male students.

Table 6
Mental health regression DID coefficients.

MH	average	female	Male
2014–2015	−0.3212785***	−0.4793953***	−0.1762045*
	(0.081016)	(0.124339)	(0.103899)
P>|t|	0.000	0.000	0.09
Obs	3300	1578	1722
2015–2016	0.1318867*	0.289502***	−0.0463791
	(0.073136)	(0.10649)	(0.098481)
P>|t|	0.072	0.007	0.638
Obs	3430	1629	1801

Note: standard errors are clustered at student level and reported in parentheses.

Table 7
Robustness check using students with lower and upper weight on MH.

MH	female (BMI percentile ≤25%)	female (BMI percentile >25%)	male (BMI percentile ≤25%)	male (BMI percentile >25%)
2014–2015	−0.580159***	−0.401678**	−0.174461	0.146469
	(0.213240)	(0.161942)	(0.153403)	(0.140716)
P>|t|	0.007	0.013	0.256	0.298
Obs	434	1114	399	1316
2015–2016	0.130650	0.259139*	−0.060789	−0.029795
	(0.241997)	(0.135447)	(0.180577)	(0.119459)
P>|t|	0.59	0.056	0.737	0.803
Obs	451	1143	402	1396

Note: standard errors are clustered at student level and reported in parentheses.

Table 8
Robustness Check with South and North Gyeongsang on ln(BMI).

ln(BMI)	average	female	male
2014–2015	−0.02243	−0.02184	−0.02556
	(0.016943)	(0.022758)	(0.026808)
P>|t|	0.187	0.339	0.342
Obs	400	186	214
2015–2016	0.034174**	0.043415*	0.03205
	(0.014280)	(0.021844)	(0.022964)
P>|t|	0.017	0.050	0.165
Obs	430	192	238

Note: standard errors are clustered at student level and reported in parentheses.

Table 9
Robustness check with south and North Gyeongsang on MH.

MH	average	female	male
2014–2015	−0.37279***	−0.44421**	−0.24942*
	(0.111958)	(0.183467)	(0.143645)
P>|t|	0.001	0.017	0.085
Obs	400	186	214
2015–2016	0.177153*	0.447069***	−0.04322
	(0.102854)	(0.16890)	(0.132148)
P>|t|	0.086	0.009	0.744
Obs	431	193	238

Note: standard errors are clustered at student level and reported in parentheses.

strongly suggest that introducing free school lunches helps students to reach and maintain a healthier weight which is consistent with Davis and Musaddiq (2019).

Our analysis also shows that free-school-lunch policies had significant effects on students' responses to the statement 'I often cry without any reason' (see Tables 6, 7 and 9). Although this measure does not fully determine a student's mental state (only a clinical diagnosis could do that), it is - as mentioned above - one symptom of a clinical depression (American Psychiatric Association, 2013; Murberg & Bru, 2005; Whitton et al., 2008). As a consequence, it has long been used as an indicator for stress (see, for example, Kearney et al., 1993; Zeidner & Hammer, 1990). In this light and with all due caution, our regression results may therefore indeed imply that once the policy was abolished, students (both female and male) tended to experience deteriorated mental health statuses. Notably, lower weight females suffered the most from the abolishment. On the contrary, students' (especially female students) mental health did recover once the policy was reintroduced. These findings are consistent with the existing literature which shows that the mental health of female students is more vulnerable to outside shocks and stress levels (Barry & Petry, 2008; Liu & Umberson, 2015; Ohara et al., 2019; Udo et al., 2014).

One possible explanation of the above MH regression results lies in the revealed socio-economic information. During the time when the free-school-lunch program was abolished, students had to prove their eligibility (i.e. low economic status) for free school lunches. Thus, teachers, classmates, and other peers implicitly knew about precarious economic backgrounds. Consequently, eligible students were mentally disadvantaged by the policy change in 2015. Another possible explanation is a better and healthier diet after the introduction of free lunches at schools[12] as higher quality nutrition intake benefits the mental health of adolescents and children (Dimov et al., 2019; O'Neil et al., 2014). Indeed, one intention of introducing the policy was to provide students with quality meals made from locally grown and healthy ingredients (Kim et al., 2018; Shin & Jeon, 2013). As a result, the nutritional intake most likely improved after the introduction of school lunches and probably worsened after the abolishment. Evidence from Japan, which is probably most comparable to South Korea, supports this view. School lunch programs are shown to close the high-quality nutritional intake gap between students from different socio-economic backgrounds (Asakura & Sasaki, 2017; Yamaguchi et al., 2018). Assessing which of these two explanations (or yet another) is most relevant, however, is beyond the scope of our paper.

Our MH regression results do not only stress the positive effects free-school-lunch policies have for students, but they also insinuate that mental stress and BMI might be linked to each other. As previously discussed in our literature review, plenty of evidence supports the view that there is a link between mental stress and BMI measures. At the same time, many studies find that free-school-lunch policies (or the absence thereof) can be linked to student misconduct (low subjective wellbeing, more stress, etc.). As a consequence, besides the obvious (and direct) link between free-school-lunch policies and students' diets there can be another (and indirect) pathway via stress. Moreover, a similar point can be made about the effect(s) a free-school-lunch policy has on students' mental health: there can be a direct link on crying without any reason but there might also be an indirect pathway via the students' physical conditions. While an identification of these pathways is beyond the scope of this paper, the similar directions of DID coefficients of both BMI and MH regressions (i.e., Tables 8 and 9) are in fact grounds for further research. A mediation analysis (using for example mental stress as a mediator) could help to identify indirect pathways between BMI measures and crying without any reason.[13]

6. Conclusion

Our analysis has produced empirical evidence that free-school-lunch policies do influence the body mass indices and mental health statuses of school children in South Korea. A sudden and soon withdrawn policy change in South Gyeongsang has provided us with the quasi-experimental situation needed to identify any causal effect of free-school-lunch policies. We have shown that the abolishment of the policy in 2015 decreased the BMI of the average student by about 1.3 percent (see Table 4), a result that is mainly driven by lower weight females who suffered from a 2.1 percent weight loss (see Table 5). The reintroduction of the free-school-lunch policy in 2016, in contrast, led to a 1.7 percent increase of the average BMI (see Table 4) although overweight female and male students experienced a decrease of BMI (ibid). Furthermore, our regressions show that the policy changes had significant impacts on crying. The number of students reporting to cry without any reason significantly increased when the free-school-lunch policy was abolished and it decreased when the policy was reintroduced (see Table 6). We also show that these results are more pronounced for female students as the corresponding regression results display both bigger magnitudes as well as higher statistical significance compared to the findings for males (ibid).

Both our BMI regressions as well as our MH regressions suggest that free-school- lunch policies generally benefit students' health and welfare. In particular female students do profit from free-school-lunch programs. The case for free-school-lunch policies is further strengthened by our analysis of different body types. Our weight specific regressions show that free-school-lunch policies are linked to healthier outcomes. The existence of such a program leads to weight losses among overweight students (both female and male) whereas the absence of free school lunch harms (female) underweight students by causing additional weight losses. Considering the fact that crying without any reason is a depressive symptom, our MH regressions also suggest that free-school-lunch policy changes may be determinants for student mental

[12] One could argue that publicly provided meals follow the latest scientific recommendations for an optimal diet and also that the production of publicly provided meals benefits from economies of scale.

[13] We would like to thank an anonymous referee for pointing this out to us.

health. The abolishment of the program caused significantly more students to cry without reason while its reintroduction significantly lowered the occurrence for female students. It is very plausible that our weight and gender specific results are not just driven by a direct change of students' diets attributable to free school lunches. In fact, various pathways may simultaneously be at work.

The limitations of our study are related to the duration of the policy change, to the relatively small number of observations, and to the absence of a valid mediator. The free-school-lunch policy was abolished for merely a year in the province of South Gyeongsang. This short duration of the policy change is both a blessing but also a curse for our analysis. Because losing weight takes more time than gaining weight, an extension of the abolishment period by one more year could have led to more precise estimations. Moreover as is often the case in this area of research, more observations would have been advantageous. For instance, if we had 2017 and 2018 data, we could measure any long(er)-term effect of the free-school-lunch policy changes. Furthermore, the relatively small number of observations calls the external validity of our conclusions beyond Asian countries into question. Finally, it would be desirable to find a valid mediator able to capture the direction of any indirect pathway between our two outcome measures. Despite these limitations, we would like to stress that our results do have a causal interpretation and that they fit squarely into a growing body of literature with similar results for non-Western countries.

By and large, our analysis makes a strong point in favor of free-school-lunch policies and hence may be a useful argument for its advocates. Free school lunches may provide simple and inexpensive means to improve student health and welfare, to advance and benefit female students, and thus to help the student body in general.

Author statement

Dirk Bethmann: Conceptualization, Methodology, Writing – reviewing, commenting, and revising.

Jae Il Cho: Conceptualization, Research design, Methodology, Statistical software, Writing – Original draft preparation and revising.

Conflicts of interest

The authors declare that they have no financial and personal conflicts of interest.

Ethical Statement

Hereby, I/**Jae Il Cho**/consciously assure that for the manuscript/**The Impacts of Free School Lunch Policies on Adolescent BMI and Mental Health: Evidence from a Natural Experiment in South Korea**/the following is fulfilled:

1) This material is the authors' own original work, which has not been previously published elsewhere.
2) The paper is not currently being considered for publication elsewhere.
3) The paper reflects the authors' own research and analysis in a truthful and complete manner.
4) The paper properly credits the meaningful contributions of co-authors and co-researchers.
5) The results are appropriately placed in the context of prior and existing research.
6) The data collected by National Youth Policy Institute of South Korea which is publicly available for research purposes.
7) All sources used are properly disclosed (correct citation). Literally copying of text must be indicated as such by using quotation marks and giving proper reference.
8) All authors have been personally and actively involved in substantial work leading to the paper, and will take public responsibility for its content.

The violation of the Ethical Statement rules may result in severe consequences.

I agree with the above statements and declare that this submission follows the policies outlined in the Guide for Authors and in the Ethical Statement.

Date: December 17th 2021

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Appendix

The following Table A shows the results of statistical hypotheses testing when the underlying regression uses a pre-trend (year 2013) or province (North Gyeongsang) that should be largely irrelevant for our analysis.

Table A
Placebo Regression Results

Regression Years	Treated Province	Outcome Variable	Retain the Null
2013-2014[a]	South Gyeongsang	ln(BMI)	Yes
2013-2014[a]	South Gyeongsang	MH	No MH data available
2014–2015	North Gyeongsang[b]	ln(BMI)	Yes
2014–2015	North Gyeongsang[b]	MH	Yes
2015–2016	North Gyeongsang[b]	ln(BMI)	Yes
2015–2016	North Gyeongsang[b]	MH	Yes

Note: The same control variables as in the main regression are used except for the treated year ([a]) or treated province ([b]). Reject the null-hypothesis ($\theta = 0$) if $p < 0.10$.

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