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**Young Scientists Summer Program**

# The Causal Effect of Schooling on Overweight/Obesity in Low – and Middle-Income Setting

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This report represents the work completed by the author during the IIASA Young Scientists Summer Program (YSSP) with approval from the YSSP supervisor.

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# Abstract

In high-income countries, increases in educational attainment are strongly associated with a decline in mortality and morbidity, including obesity. The effect of increased education on obesity may, however, be strongly contextual and depend on the stage of the population in the nutritional transition. While initial increases in education in low- and middle-income countries may foster obesity, the link is expected to be negative thereafter. There is some evidence on a negative correlation between education and obesity in low- and middle income countries. Most of them are, however, based on simple correlations and do not establish causal effects. Hence, this study aims to investigate the causal effect of education on obesity in Indonesia.

We estimate the effect of years of schooling on being overweight/obese using high-quality individual-level data from the Indonesia Family Life Survey, which provides detailed information on education histories and health status. We start by estimating simple probit models. To account for potential endogeneity, we then use exposure to a substantial primary school construction program (SD INPRES) as an instrument for years of schooling. For this, the individual-level data is linked to district-level data capturing the intensity of the program across regions from 1973-1978. All models control for relevant individual characteristics and a regional specific confounders.

**Results**

Preliminary findings based on the simple probit model show a significant positive association between years of schooling and the likelihood of an individual being overweight/obese. In particular, an additional year of schooling increases the probability of individuals being overweight/obese by 0.02, ceteris paribus. We then employ two-stage least squares regression analyses for binary outcomes to elicit the causal effect of education on health. The preliminary results of the first stage suggest that exposure to the education program is a strong instrument, as indicated by an F-statistic of 153.71. Similar to the simple probit model, we find a positive effect of years of schooling on the probability of being overweight/obese in the second stage. This effect is, however, only significant at the 10-percent level.

**Conclusions**

Our results show a positive causal effect of schooling on the probability of being overweight/obese for our sample. The educational transition theory suggests that this positive effect could be temporal and possibly change into a negative effect as the nutritional transition continues. It would then match the effects observed in high-income countries. Our findings suggest population obesity prevention strategy can be intervened by increasing population education level in order to gain the protective effect of high education level to better health outcome.

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## 1. Introduction

Obesity is a chronic disease and recognised as a significant risk factor for non-communicable diseases (NCDs), in particular diabetes. The prevalence of obesity and diabetes have increased over time in all countries, thus posing as global health problem. For instance, the World Obesity Atlas 2022 predicts over 1 billion people living with obesity worldwide, and estimates that the disease will affects one in seven men and one in five women by 2030 [1]. Corresponding with the rising trend of obesity, populations worldwide face an increase in people living with diabetes, with projections suggesting 643 million of adults aged 20-79 years (11.3%) by 2030 [2]. Moreover, the prevalence of obesity and diabetes are increasing faster in low- and middle-income countries (LMIC) that face double burden of diseases from communicable and NCDs, as well as double burden of malnutrition, next to an unprepared health system to address the rising of obesity and diabetes [1, 2]. In addition, obesity and diabetes are associated with chronic diseases such as high blood pressure, cardio-vascular disease, and disability that all are threatening country's public health system and economic development [3-5].

The risk of obesity and diabetes can be associated with individual factors – such as dietary behaviour, physical activity, socioeconomic status, as well as contextual factors including environmental factors and structural factors (e.g. economic and social policies) that affect education, employment, and access to health services [6-8]. Recognising the complexity in addressing the obesity epidemic and growing of diabetes globally, there is a need to understand the drivers of obesity and diabetes from different dimensions to develop effective intervention beyond individual responsibility, particularly in LMIC. Effective population-based interventions are critical for LMIC to slow the rapid increase in obesity and diabetes, as well as their consequences to population health and sustainable economic growth.

### The role of education on health outcomes: obesity and diabetes

A body of literature has emphasised the importance of education as a determinant of health. The compelling evidence from previous literature demonstrates that the average educational attainment is strongly associated with the long-term decline in morbidity and mortality of a population [9]. However, studies on obesity illustrate that the relationship between education and obesity can have different directions depending on the economic development of a country and the population transition [10-13]. Shifts in population's diet known as "Nutritional Transition" can shape the direction, consistency, and magnitude of the association between education and obesity [11-13]. On the early stage of a nutritional transition, the education effect might be positive, and negative thereafter [13, 14]. A recent study on the association between socioeconomic status and risk of diabetes in LMIC reported greater educational attainment is positively associated with the risk of diabetes that may relate with current nutritional transition experienced by LMIC [15]. However, the direction of education association with diabetes in LMIC is different compared to high-income countries that show a protective effect to the risk of obesity [16]. The mixed findings suggest the temporal effect of education on obesity that also may affect the direction of relationship between education and diabetes subsequently.

Despite the strong association between education and health outcomes, there is also wide debate whether this relationship is causal. Quasi-experimental studies investigating the effect of compulsory schooling reforms in high income countries showed the causal effect of schooling on better health outcomes; more years of schooling is protective to the risk of chronic diseases such as heart diseases, hypertension, arthritis, diabetes and disability [17]. However, more mixed evidence is reported by studies on the protective effect of years of schooling on obesity across countries, gender, and social disadvantaged group [18-20]. The empirical evidence on the causal effect of education on obesity comes predominantly from developed countries, evidence is scarce in LMIC experiencing rapid growth in obesity and diabetes. Hence, there is a need to investigate the causal effect of educational attainment on being obese or diabetic in LMIC settings. This investigation can support framing education policies as instrument to slowing down the rapid increase in obesity and diabetes prevalence.

**Case study Indonesia**

This study examines the Indonesian population as a case study of LMIC. This fourth populous country is among the top 10 countries with the most rapid increase in obesity prevalence and in the number of people living with diabetes [1, 2]. In last three decades, diabetes even has risen from the $17^{th}$ to $3^{rd}$ most important cause of mortality and disability [21]. Indonesia Basic Health Survey 2018 reported overweight and obesity are more prevalent among women and adults aged 30-59 compared to young adults and elderly [22]. The survey also reports that the prevalence of diabetes in adult population is increasing with age - especially after age 45 [22]. The increasing trend on these preventable diseases can threaten the health systems and the sustainable economic development of a country in the absence of effective interventions on the diseases. The consistent association between education and obesity was also found in previous study indicating a shifting effect of education on the weight gain in the population [23]. To our knowledge, published paper on the causal effect of education on obesity and diabetes are rare in this population context.

In terms of education, the mean years of schooling of the population aged 25 years and over in Indonesia is 8.5 years in 2021 [24], which is equal with complete primary school but not yet reaching the attainment of junior high school level (i.e. 9 years). Over time, Indonesian government has ongoing massive investment to improve the education of its population through various education policies including a primary school construction program in 1973, increasing the compulsory schooling years to 6 years in 1978 and 9 years in 1994 [25]. In particular, primary school construction program implemented in 1973-1978 has been recognized as the largest school construction program ever present, aiming to increase the enrolment rate of children in primary school. The program specifically designed to target areas or regions with low enrolment rates and high number of children who were not yet enrolled in primary school in 1971 [26]. Hence, there is heterogeneity on the number of schools constructed across region over time from 1973-1978. Compelling evidence show the policy is proven effective to increase average years of schooling from 0.12 to 0.19 years and wages from 1.5 to 2.7 percent for cohorts affected by the program (i.e. born 1968 – 1972) [26]. Further the program was proven effective to reduce the distance for children traveling to school in sparsely populated regions and had more impact on less developed regions [26]. Thus, the time and variations in the implementation of the school construction program can affect educational attainment differently across birth cohorts and regions in exogenous way.

**Aims and research questions**

This present study aims at providing scientific evidence to support refining education policies as instrument to tackle the rising of obesity in Indonesia population. Further, it aims to examine the causal relationship between education and overweight/obesity or diabetes by using variations in the exposure to school construction program as instrument for years of schooling.

The two research questions of this study are:

1. What is the causal effect of schooling in low-income countries on health, in particular on being overweight/obese (or diabetic)?
2. Is there heterogeneity in the effect of schooling on health (by gender, occupation etc.)?

## 2. Data and methods

a. Data sources:

This research links individuals from the Indonesia Family Life Survey (IFLS) with regional level data on the implementation of a school construction program in Indonesia to answer the two research questions mentioned above. The Indonesia Family Life Survey (IFLS) is publicly available and can be accessed through https://www.rand.org/well-being/social-and-behavioral-policy/data/FLS/IFLS/access.html. The survey collects information on individual health measurements, including measured individual weight and height that are essential to calculate the individual body mass index as biomarker for health status related overweight/obesity and risk of diabetes. The survey also collects dried blood tests providing information on HbA1c level used to diagnose diabetes. IFLS gathers information on individual socioeconomic status with detailed information on individual's education history such as education level, repetition grade, or gap years in education.

Based on individual's place of birth, individual data are linked to regional level data on the implementation of the primary school construction program in Indonesia from 1973-1978. The regional level data includes information on the number of schools built by region by year and other characteristics of region. The regional level data was initially used by Duflo [26] and generously shared by the author for this present study.

b. Health outcome: overweight/obese or diabetic

Individual' status on overweight/obesity is identified based on individual's body mass index calculated from individual weight in kilograms divided by the square of the person height in meters (kg/$m^2$) [27]. Weight and height of individuals were measured on the IFLS. Individual's This study use the cut points for Asia-Pacific population to classify individual's BMI that are ≥23kg/m$^2$ for overweight/obese because the risk of chronic diseases is higher at lower BMI cut off as compared to international BMI cut points (≥25kg/m$^2$ for overweight/obese) [27, 28]. This present study excludes underweight individuals (BMI<18.5 kg/m$^2$) from the analysis because in general we assume increasing in education improves individual health outcome as well as nutritional status.

The diabetic status is measured from HbA1c level obtained from dried blood test. HbA1c is used for diagnosis of diabetes and monitoring sugar level in blood among diabetic people. HbA1c level indicates the average of glucose in the blood over the past two to three months [29]. Hence the HbA1c test is considered a gold standard for assessing sugar level and provide reliable diagnosis for diabetes status compared to fasting blood glucose test that only measure the level of sugar in blood at the moment of testing [29]. This study follow ADA recommendation to HbA1c cut-off point ≥6.5% for diagnosis diabetes on the observations [30].

c. Identification strategy

This present study follows the identification strategy first implemented by Duflo [26]. Based on the program period 1973-1978 and its implementation strategy, which targeted areas with low enrolment rate, individual exposure to the school construction programs is determined as follows:

First, year of birth determines individual exposure to the program. The exposed group of children are individuals who were at primary school age (aged 7-12) and enrolled or not enrolled in primary school during the program implementation, along with younger cohort who were born two years after 1974. Hence, the exposed group is everybody born from 1962-1976. The non-exposed group is individuals born 1950-1961 who should have completed their primary school in 1974 when the school construction started.

Second, as the number of schools constructed in each district varies based on the number of children and the enrolment rate in 1971, individual place of birth is the second dimension important to the identification strategy. Region of birth is classified into low and intensity region to capture the characteristic of program's design targeting areas with low enrolment rate. The regional classification is strictly following Duflo [26] approach. Regions with high intensity programs are in general least developed compared to low intensity regions.

Third, taking advantage on variation in number of schools constructed by year from 1973-1978, intensity of individual exposure to the program by place of birth determined by the actual average schools built per 1,000 children when the individuals were at primary school or prior enrolment at primary school. Individuals aged 7-12 years old in 1974 were assumed partially exposed to the program with the assumption they had been enrolled in primary school during the program implementation. Their exposure is calculated by average number of school built per 1,000 children during the children's remaining years at primary school. Further, children younger than 7 years old were assumed fully exposed to the program because school construction program had been completed in their region of birth before the children enrolling to primary school. Hence, their exposure are average number of schools built per 1,000 children from 1973-1978 in individual region of birth.

d. Statistical Analysis

This study applies (1) a simple probit model and (2) two-stage least squares (2SLS) regression analyses for binary health outcomes (i.e. obese/diabetic), instrumenting individual years of education with exposure to the primary school construction program (SD INPRES) from 1973-1978.

First, the relationship between individual years of schooling with the probability of being overweight/obese or diabetic will be fitted in a simple probit model. Individual year of birth, dummy region of birth based on program intensity in the region, and population of children aged 5 to 14 in 1971 are included in the model as control variables to account for variation in implementation of school construction program and to adjust estimation on individual years of schooling association with the health outcome. This simple probit model use the cumulative standard normal distribution to model the regression function. Relationship in the regression is estimated with the following function:

$$Y_i = \beta_0 + \beta_1 Schooling_i + \beta_2 Birth_i + \beta_3 Region_i + \beta_4 Population + \beta_n X_n \quad (1)$$

$Y_i$ is observed overweight/obesity or diabetes status of an individual $i$, whereas 0 denotes to normal BMI and 1 to overweight/obesity BMI. In a separate model, health outcome diabetes is denoted by 1 and 0 for non-diabetic. $Schooling$ is a continuous variable for individual years of schooling. $Birth$ indicates a continuous variable for the birth year of each individual. $Region$ indicates a dummy variable for region of birth based on program intensity in the region with values 0 for a low intensity region and 1 for high intensity one. $Population$ indicates the number of children aged 5-14 years in the region. Other control variables $X_n$ included sex and age.

The probit model provides preliminary estimation on the association between years of schooling and the probability of being overweight/obese or diabetic. However, this model cannot facilitate causal inference estimation on the effect of schooling, as the schooling variable is endogenous [17]; individual years of schooling can be affected by parent socioeconomic status that simultaneously can affect individual health outcome. Further, there might be a revers causality in relationship between years of schooling and health, with unhealthy students being less likely to attend schooling.

Hence, to account for this endogeneity issue, this study applies two-stage least squares regression analyses for binary outcomes with individual exposure to primary school construction program (SD INPRES) as an instrumental variable. By using the school construction program as an instrument, we assume that: (1) the school construction program has an effect on the years of schooling and that (2) the school construction program only affects health outcome through years of schooling. This approach can reveal the causal effect of years of schooling on the probability of an individual being overweight/obese or diabetes. Generally, IVProbit model applied here can be stated as for a single endogenous variable:

$$Schooling_i = \Pi_1 X_i + \Pi_2 Z + v_i \quad (2)$$

$$Y_i = (\alpha X_i + \beta(Schooling_i) + u_i) \quad (3)$$

The parameter $\Pi_2$ in equation (2) captures the first-stage effect of Z (exposure to primary school construction program) on individual years of schooling, adjusting for exogenous covariates $X_i$ as shown in equation (1). The exogenous are place of birth, a dummy region of birth based on program intensity in the region, the number of children aged 5-14 years in the region, as well as sex and age at BMI measures. $Schooling_i$ indicates individual years of schooling after instrumented by exposure to school construction program. Equation (3) captures the second-stage of model on the probability of individual being overweight/obese regress against instrumented $Schooling_i$ from equation (1), adjusting for exogenous covariates. The model is jointly estimated using maximum likelihood estimation in STATA 17.0.

## 3. Results

### 3.1. Descriptive

In this study on the causal effect of education on the probability of being overweight/obesity 6,646 individuals living in Indonesia are examined. The sample for analysing the education effect on the probability of having diabetes includes 1,009 individuals. This study only examines individuals at normal weight or being overweight/obese according to their BMI category. The proportion of sample being overweight/obesity is 64% and 10.3% living with diabetes.

Data exploration shows that the key independent variable "years of schooling" has a mean of 8.7 years for the overweight/obesity sample with a standard deviation 4.3 and 8.5 years for the diabetes sample (SD 4.2). The mean age of sample for overweight/obesity analysis is 45.8 years old and 46.4 years old for diabetes analysis with age ranging from 31 to 62 years old. The proportion of respondents are 47% male (overweight/obesity sample) and 39% male (diabetes sample).

Further, cross tabulation on distribution of overweight/obesity and diabetes by respondents' characteristics is shown in Table 1. Further, table 1 indicates that the proportion of overweight/obesity increases by education level. The proportion of overweight/obese people is significantly higher among the tertiary educated group. However, there is no clear educational gradient on distribution of diabetes. Based on individual exposure to the schooling construction program, the table illustrates significant higher distribution of diabetes among non-exposed group (cohort 1950-1961) than exposed group (cohort 1962-1976), namely 18% compared to the exposed group with 9%. This pattern the age related risk of diabetes that increases with age. No significant different distribution of overweight/obesity is found between exposed and non-exposed cohort groups. Based on individual region of birth and program intensity in their region, people born in low intensity region have higher prevalence of overweight/obesity compared to their counterparts born in high intensity regions. Interestingly, there is no significant difference between these groups in the health outcome diabetes. The proportion of overweight/obesity is much higher among women than men.

In terms of educational status (Table 2), a t-test shows a significant differences on mean years of schooling, whereas it is 2.07 years higher for the exposed cohort group than non-exposed cohorts (1950-1961). People born in low intensity regions (developed areas) are more educated than people born in high intensity regions, which reflects the gap in development between developed and least developed region in Indonesia. A gender gap in educational status also persists in the country with men being more educated than women. Comparison on mean years schooling based on individual health outcomes shows significant differences in mean years of education between normal and overweight/obese people. However, there is not statistical difference in mean years of schooling by diabetes status.

*Table 1. Distribution of overweight/obesity and diabetes by respondent characteristics using Pearson's Chi-squared Test*

| Respondent Characteristics | BMI Cut-off | | Diabetes Status | |
|---|---|---|---|---|
| | Normal | Overweight/ Obese | Non Diabetic | Diabetic |
| *Highest education level* | | | | |
| None/Preschool | 46.5 | 53.5 | 91.7 | 8.3 |
| Primary | 39.9 | 60.1 | 88.7 | 11.3 |
| Secondary | 34.6 | 65.4 | 91.0 | 9.0 |
| Tertiary | 25.3 | 74.7 | 88.5 | 11.5 |
| p-value | <0.001 *** | | 0.696 | |
| *Birth cohort* | | | | |
| 1950-1961 | 38.2 | 61.8 | 82.1 | 17.9 |
| 1962-1976 | 35.6 | 64.4 | 91.4 | 8.6 |
| p-value | 0.137 | | <0.001 *** | |
| *Intensity school built in region of birth* | | | | |
| Low intensity region | 34.6 | 65.4 | 88.4 | 11.6 |
| High intensity region | 37.0 | 63.0 | 90.9 | 9.1 |
| p-value | 0.042* | | 0.195 | |
| *Sex* | | | | |
| Female | 26.9 | 73.1 | 88.2 | 11.8 |
| Male | 46.1 | 54.0 | 92.0 | 8.0 |
| p-value | <0.001 *** | | 0.051 | |

Pearson's Chi-squared test statistics in parentheses

* p<0.05, ** p<0.01, *** p<0.001

*Table 2. Mean years of schooling across birth cohorts, regions, gender and the two health outcomes using t-Tests*

| | Mean Years of Schooling | std. err. | diff. |
|---|---|---|---|
| *Birth cohort* | | | |
| 1950-1961 | 6.90 | 0.13 | -2.064*** |
| 1962-1976 | 8.97 | 0.06 | |
| *Intensity school built in region of birth* | | | |
| Low intensity region | 9.52 | 0.08 | 1.485*** |
| High intensity region | 8.03 | 0.07 | |
| *Sex* | | | |
| Female | 8.16 | 0.07 | -1.085*** |
| Male | 9.25 | 0.08 | |
| BMI cut-off | | | |
| Normal | 8.12 | 0.08 | -0.870*** |
| Overweight/Obese | 8.99 | 0.07 | |
| Diabetes status | | | |
| Non diabetic | 8.51 | 0.14 | 0.503 |
| Diabetic | 8.01 | 0.44 | |

t statistics in parentheses

* p<0.05, ** p<0.01, *** p<0.001

## 3.2. Simple probit model

Our first analysis using a simple probit model finds a positive correlation between individual years of schooling and the probability of being overweight/obese (Table 3). Predicted margins from the model estimate that an additional year of schooling increases the probability of being overweight/obese by 0.02 point.

In contrast for diabetes outcome, this study does not find a significant association between schooling and the probability of having diabetes. Controlling additionally for the individual BMI status in the model does not change the insignificant association between years of schooling and the probability of individual diagnosed with diabetes.

*Table 3 Summary simple probit model for overweight/obesity and diabetes outcome with main covariate the years of schooling, adjusting control variables.*

| **Variables** | **Overweight/Obesity Model** | | **Diabetes Model** |
|---|---|---|---|
| | Coef. Probit Model | Average Margin Effects | Coef. Probit Model |
| Years of schooling – main covariate | 0.042*** | 0.016*** | -0.001 |
| | (0.004) | | (0.014) |
| Birth cohort | -0.012*** | -0.005*** | -0.029* |
| | (0.003) | | (0.011) |
| Program Intensity | | | |
| High intensity region | 0.009 | 0.003 | -0.131 |
| | (0.033) | | (0.111) |
| Sex | | | |
| Male | -0.563*** | -0.208*** | -0.137 |
| | (0.032) | | (0.119) |
| Num. of children in 1971 | 3.30e-07* | 1.23e-07* | 5.77e-07 |
| | (1.47e-07) | | (5.19e-07) |
| Intercept | 24.18 | | 55.17* |
| | (6.515) | | (22.36) |
| Number of observations | 6646 | | 1009 |

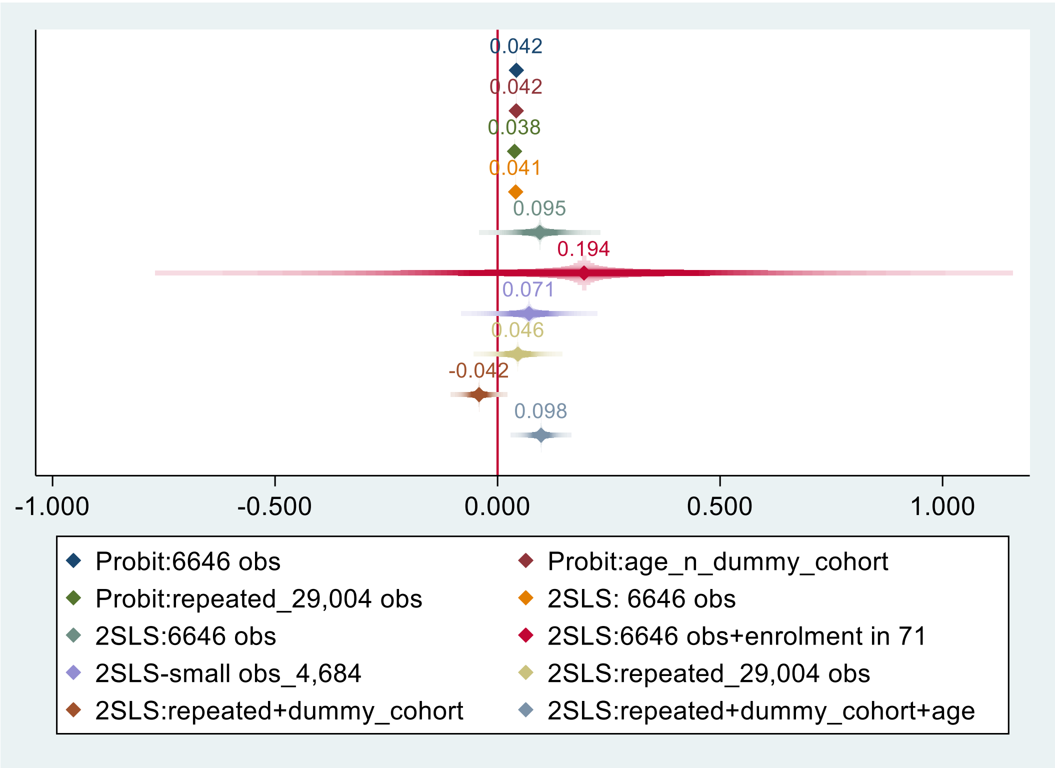
### 3.3. The causal effect of schooling on being overweight/obesity using 2SLS

This section elaborates analysis using 2SLS probit model to estimate the causal effect of schooling on being overweight/obesity. This analysis includes 6,646 individuals based on their BMI status on the last time individuals participating in the survey. This study finds the exposure to the education program is a strong instrument, as indicated by an F-statistic of 153.71. The model shows a positive (0.1) causal effect of schooling on the probability of being overweight/obese, table 4 column (5). This effect is, however, only significant at a 10-percent level.

### 3.4. Robustness checks

Exploiting the advantage of longitudinal design of our dataset, we conduct further analysis by including repeated measurements of an individuals' BMI from 1993 – 2014. Hence, individuals may have BMI observed 1 to 5 times with a potentially varying BMI category. In total there are 29,004 observations from 9,831 individuals. Correlation of observations within individual in this analysis is accounted by applying ivprobit with additional cluster commands in STATA 17.0. Further, age at BMI measured is included as a control variables to account for heterogeneity on the effect of age on individuals BMI over time. Table 4 column (10) shows that this approach increases the robustness of our findings suggesting by increasing the significant effect years of schooling on the probability of being overweight/obese at less than 1 percent and with slightly higher coefficient years of schooling at 0.098. Further sensitivity analysis using different specifications, control variables and sample size reveal that most coefficients for the effect of schooling on overweight/obesity probability are positive as shown on Figure 1. It indicates the robustness of this finding.

*Figure 1. Coefficient plot illustrating the coefficients and their confident intervals for years of schooling from different model with varying samples*




## 4. Discussion and Conclusion

This study finds a positive causal effect of schooling on the probability of being overweight/obese. A Similar positive effect of education on obesity is also found in Turkey-a developing country [31]. At face value, this finding may not be intuitive. However, we suggest that our finding should be interpreted with caution because this result does not necessarily imply education is having poor effect on health. Understood within the scope of the nutritional transition and educational transition theories [12, 13], this evidence reflects the temporal effect of education on health risk behaviors leading to an increase in risk of obesity during a nutritional transition. This positive effect may be observed at earlier stages of nutrition transition indicated by shifting in population diet from traditional food to highly processed food which contains high fat and sugar [13, 14]. In developed countries where the health risk of obesity has been pronounced for decades, the protective effect of education on obesity is likely observed as highly educated population is changing their health behaviors to prevent the risk of obesity [10, 32].

Policy implication

If the relationship between education and obesity persist, and follows the population education transition curve with health outcome [13], we will likely see the shifting direction from positive to negative effect of years of schooling on the risk of obesity occurred in LMIC. A study on overweight estimated that 10 years of schooling is a critical point for shifting education effect on overweight from positive to negative in early stages of nutritional transition, and 7 year of schooling for population in middle stages of nutritional transition [12]. The positive effect of education on better health outcome including preventing the risk of obesity has been observed in high-income countries with a minimum of 9 years of compulsory schooling and mean years of schooling of the population above the compulsory education policy [17, 18]. This suggests that increasing population education level can be an effective solution to slow down and prevent the rapid increase in overweight/obesity in low-middle income countries. General education policies that increase years of schooling can be effective as a population-based intervention strategy to combate the rise of overweight/obesity in spite of individual level intervention. For these policies to work on improving better health outcome, causal evidence from this study provide support to inform education policy in Indonesia. Although Indonesia has been implementing 9 years of compulsory schooling laws since 1994, recent evidence shows the policy has not proven to increase the population level of schooling [33]. Hence, this present study provides support to Indonesian government to improve effectiveness of education policies in order to gaining potential impacts of education policies beyond education and economic returns, in particular using education policy to contribute to long term improvement in population health.

## 5. Limitation and Further Analysis

There might be some heterogeneity in our findings for different subpopulations that has not yet been explored, for example differences between parent's socioeconomic backgrounds. Further study on understanding the mechanism from education to risk of obesity can improve knowledge to inform education policy and health education to combat obesity epidemic. This study will be continued to replicate the 2SLS analysis to diabetes outcome and answer the second research question on the heterogeneity effect of schooling on health.

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*Table 4. Summary table of all conducted models regressing the effect of education on the probability of being obese/overweight*

| | (1) Simple probit | (2) Probit with age and dummy cohort | (3) Probit with repeated observations of individual | (4) Probit repeated obs with age and dummy cohort | (5) IVprobit | (6) IVprobit control enrolment rate | (7) IV probit small sample by narrowing exposed cohort to 1968-1976 | (8) IVprobit clustered obs | (9) IVprobit clustered obs and dummy cohort | (10) IVprobit clustered obs, dummy cohort and control age at BMI measured |
|---|---|---|---|---|---|---|---|---|---|---|
| Year of birth | -0.0122*** | | -0.0180*** | | -0.0224* | -0.0350 | -0.0153 | -0.0195* | | |
| | (0.00332) | | (0.00219) | | (0.0108) | (0.0484) | (0.0122) | (0.00776) | | |
| Years of schooling | 0.0422*** | 0.0419*** | 0.0381*** | 0.0407*** | 0.0949+ | 0.194 | 0.0708 | 0.0456 | -0.0417+ | 0.0977*** |
| | (0.00402) | (0.00402) | (0.00271) | (0.00285) | (0.0530) | (0.374) | (0.0594) | (0.0393) | (0.0233) | (0.0295) |
| Program Intensity | | | | | | | | | | |
| High intensity region | 0.00881 | 0.00922 | -0.0212 | -0.00978 | 0.0915 | 0.214 | 0.0976 | -0.00997 | -0.146*** | 0.0773 |
| | (0.0330) | (0.0330) | (0.0218) | (0.0232) | (0.0897) | (0.466) | (0.111) | (0.0650) | (0.0360) | (0.0529) |
| Sex | | | | | | | | | | |
| Male | -0.563*** | -0.563*** | -0.465*** | -0.518*** | -0.619*** | -0.724+ | -0.609*** | -0.474*** | -0.375*** | -0.585*** |
| | (0.0325) | (0.0325) | (0.0218) | (0.0234) | (0.0656) | (0.404) | (0.0688) | (0.0521) | (0.0371) | (0.0425) |
| Num. of children in 1971 | 0.000000330* | 0.000000230 | 8.28e-08 | 5.38e-08 | 0.000000420* | 0.000000684 | 0.000000231 | 9.97e-08 | -0.000000196 | 0.000000242 |
| | (0.000000147) | (0.000000163) | (9.58e-08) | (0.000000113) | (0.000000173) | (0.000000899) | (0.000000206) | (0.000000139) | (0.000000120) | (0.000000164) |
| *Birth cohort* | | | | | | | | | | |
| 1962-1976 (exposed group) | | 0.0965 | | 0.207*** | | | | | 0.0463 | 0.0763 |
| | | (0.0674) | | (0.0399) | | | | | (0.0588) | (0.0915) |
| Age | | 0.0157*** | | 0.0476*** | | | | | | 0.0489*** |
| | | (0.00406) | | (0.00116) | | | | | | (0.00122) |
| Enrolment rate 1971 | | | | | | -1.066 | | | | |
| | | | | | | (3.583) | | | | |
| _cons | 24.18*** | -0.561* | 35.20*** | -2.123*** | 43.79* | 67.88 | 30.02 | 38.01* | 0.513** | -2.589*** |
| | (6.515) | (0.232) | (4.297) | (0.0645) | (20.73) | (92.33) | (23.58) | (14.92) | (0.174) | (0.240) |
| N | 6646 | 6646 | 29004 | 29004 | 6645 | 6607 | 4684 | 29000 | 29000 | 29000 |

p-value in parentheses + p<0.10, *0.05, **0.01, ***<0.001