World Development Sustainability 2 (2023) 100041

Contents lists available at ScienceDirect

World Development Sustainability

journal homepage: www.elsevier.com/locate/wds

Education and health in developing countries: Evidence from Ghana's FCUBE

Gabriel Aboyadana*

Department of Economics, University of Strathclyde, Glasgow, United Kingdom

1. Introduction

For a long time, it has been observed that people who have more education tend to be healthier [5,7–9]. Some suggest that the reason for this is because better-educated people have better labour market outcomes which provide them with higher income with which they are able to access quality healthcare [5,28]. Others have also suggested that schooling develops cognitive skills which enhance health decision-making and the adoption of positive health behaviour [38,44]. At the national level, the UNDP health index [51] and national literacy rates [11] reveal that on average, the more literate countries also have higher health indices. There is, however, no conclusive evidence that suggests that this relationship is causal in nature [28,55]. While a few studies have pursued the path of finding causal relationships in developed countries, particularly in the US and UK in the last decade, the same cannot be said for developing countries [18,22,23,25]. This paper extends the frontiers of this strand of research by examining data from a natural experiment originating from an early childhood policy in Ghana, a developing country.

This study contributes to our understanding of the education-health nexus by examining the causal relationship between education and health. There are relatively more studies that have shown that there is a correlation between education and health. Studies concerned with the causality of this relationship are however limited. The small (but fast-growing) literature in this area, however, presents mixed results [5,28]. For instance, [14] and [34] explored compulsory schooling laws, as a source of exogeneity in Britain and concluded that while those policies increased average years of schooling, there was no causal effect on health outcomes. Albarran et al. [5] obtain a similar conclusion using cross-country data for Europe. One explanation suggested for those results is that the general quality of, and access to healthcare in those countries are high so that there is little variation based on educational attainment. Other studies such as [15] however, using data for Britain and exploiting the same compulsory schooling laws, find very strong causal effects of education on health. This paper contributes to this discussion by providing new evidence.

The evidence supporting both sides of the discussion above has mostly been from European countries and the US. The evidence from developing countries is limited. This is noted in recent reviews of the literature by Hamad et al. [28] and Arcaya and Saiz [8]. A search of the literature shows that the few studies on developing country contexts mostly examine the fertility effects of education. The review by Hamad et al. [28] for instance, found one published in Africa (from Kenya) which examined sexual health. Also, I find [46], for Nigeria, [10] for Ghana and [35] for Uganda, all of which examined female fertility effects of schooling. This study examines other outcomes in addition to fertility. I am not aware of any other study on Africa that examines other outcomes besides fertility. Most studies examined female data. The present study however includes data for men for some variables.

This paper also examines the effect of a universal school fee waiver at the basic education level. Universal primary education (UPE) has been implemented in other African countries. This included 6years of free primary education. However, Ghana's version of the policy included 3 years of junior secondary school; a total of 9 years. Uganda's UPE has been exploited using a similar methodology by Keats [35]. The policies examined in developed countries have been at the secondary school level. It has however been shown that early education interventions are important for long-term outcomes. This paper examines the long-term health effects of an early childhood education policy. The fact that school fee policies have not been previously studied makes the findings of this paper relevant for poor countries and for developed countries that experience health inequalities resulting from inter-generational poverty.

The identification strategy relies on the discontinuity in school attainment as a result of the FCUBE[1] policy in 1996 and the assumption that observations close to the eligibility threshold are as good as randomized. Pupils enrolling in primary one at different times around the policy implementation year received different treatments. I analyze this as a natural experiment in a regression discontinuity framework such that those close to the implementation boundary received either full treatment or at least one year less of treatment. The units of analysis in this study are the residents of Ghana, a small emerging economy in West Africa. Ghana's ethnic diversity is like other African countries. Its political stability over several decades, and the ECOWAS[2] policy of free movement within the sub-region has made it home to millions of people from other West African countries. This regional character means the

[1] Free Compulsory Universal Basic Education.

[2] Economic Community of West Africa States.

* Corresponding author.
E-mail address: gabriel@aboyadana.com

https://doi.org/10.1016/j.wds.2022.100041
Received 4 June 2022; Received in revised form 3 December 2022; Accepted 22 December 2022

study findings are relevant for other west-Africans countries as some of these countries plan to implement similar policies [41].

This study is similar to [10] in that the two studies are the first to have examined the impact of the Ghana FCUBE on health outcomes and both use identical estimation strategies. However, [10] pool different waves of the survey, use the year of birth as cohorts, and select 1989 as the cut-off year. This approach assumes that all children born in a given year start school in the same year. However, because the school year starts in August or early September, children born in the last quarter are required to enrol in the following school year. This also means that children are exposed to the FCUBE policy in one-year increments. The approach I take in this paper is to define an annual cohort as children born in or after August up to July of the following year. That is, I define a cohort as people starting school in the same academic year instead of people born in the same calendar year. This approach allows the cut-off point in the regression discontinuity to be precisely determined. This reflects the fact that children born in January and December of the same year will start school in different years. That is, all things being equal, though they are born in the same year, they would start school in different years and receive different treatments. Thus the cohorts to the right of the cutoff serve as placebo checks. Being born closer to the official school start month (mostly late August up to mid-September) increases the probability of receiving the full treatment. Using the year of birth masks this. Nonetheless, I check for the existence of discontinuity using a definition similar to [10] and an alternative dataset to verify that the approach used here is robust (see Fig. A.7).

I give an overview of the study context in Section 2 and describe the data and methods in Section 3. The results are discussed in Sections 4 and 5 concludes.

2. The study context

2.1. The education system

Ghana's current education system, introduced in 1987, includes 2 years of non-compulsory kindergarten from age 4 to 6; 6 years of primary school from ages 6 to 12; 3 years of junior secondary school from ages 12 to 15; 3 years of senior secondary school (or vocational/technical school) from ages 15 to 18; qualifying students can then enrol for tertiary education. Basic education in Ghana is classified to include primary school and junior secondary school and pupils are required to take a school-leaving exam called the Basic Education Certificate Exam (BECE) in the final year of junior secondary school. The BECE examines the syllabus of the junior secondary school, which comprises 8 compulsory subjects and 2 optional subjects (a Ghanaian language and French). Pupils must obtain at least 6 passes, which must include English, Maths, and Integrated Science, to be able to progress to senior secondary school. They take 8 subjects in secondary school and must pass at least 6 of them (including English, Maths, and General Science) in the West Africa Secondary School Certificate Exam (WASSCE) to qualify for admission into the university and other post-secondary educational institutions. Students require at least 50% to pass a subject [53].

Until 1987, the educational system consisted of 6 years of primary school, 4 years of middle school, 5 years of secondary school, and 2 years of sixth form; a total of 17 years. The political and economic events prior, together with deteriorating educational infrastructure led to a decrease in school enrolment by more than 100,000 and stagnated until 1986/1987. Government spending on education also reduced from 6.4 to 1.5% of a much lower GDP by 1984 [42]. These events led to the deepening of inequality in school enrolment [4]. By reducing the years of pre-tertiary school to 12 years, the savings were channelled to expand the infrastructure and reverse the decline in enrolment. These interventions, however, did not lead to a rapid increase in enrolment until after the implementation of FCUBE in 1996.

2.2. The policy

The 1992 constitution mandated the government to make basic education fee-free and compulsory, hence the FCUBE policy was implemented in the school year starting in August 1996 [4]. Prior to this, the 1961 Education Act(Act 87) had made education tuition-free but pupils were required to buy books and pay for other costs. This policy was discontinued after the country's first president was overthrown in a coup d'état in 1966 (see [21] and [4] for a detailed history of education in Ghana). Various forms of additional cost were introduced and enrolment declined until the FCUBE policy was implemented in 1996. Besides eliminating fees and levies, the FCUBE policy required the government to provide books and other learning materials pupils needed for school. In the years following, the government introduced free school meals and free school uniforms [49]. Thus, the FCUBE policy sought to eliminate all forms of direct money cost. To improve quality, the government also embarked on a large-scale expansion of education infrastructure across the country and trained more teachers to teach at the basic school level and reduced the number of untrained teachers it employed.

Unlike other universal primary education policies that have been implemented in other African countries, Ghana's FCUBE eliminated fees for all pupils at the basic level, not just for those who entered primary school after the implementation of the policy. This means that all children enrolled in primary and junior secondary school from 1996 benefited from the policy regardless of the grade they were at.

3. Empirical strategy

3.1. Study design

Children in Ghana are required to enrol in primary school in the academic year starting after their 6th birthday. The policy implementation date was the academic year starting in August 1996. Thus, children born after August 1989 up to August 1990 were the first cohort the policy targeted for full treatment. As a result, August 1989 is chosen as the cut-off for eligibility. This allows for analysing the implementation of the FCUBE within the framework of a regression discontinuity design (RDD). The FCUBE policy was however not implemented strictly. This generates non-compliance on either side of the cut-off point. This non-compliance implies a fuzzy RDD and captures an intent-to-treat effect.

The analysis proceeds as follows. First, I select an optimal bandwidth[3] [12,31,32] from the full sample of adults from the DHS dataset and I estimate the impact of the policy on attainment. Secondly, I estimate the effects of schooling on various health variables. This study seeks to isolate the causal effect of schooling on health. I compare the average health (H) outcomes for the birth cohorts(c) who were exposed to full treatment ($D = 1$) and those who were not($D = 0$). That is:

$$E[H_{1c}|D_i = 1] - E[H_{0c}|D_i = 0] = E[H_{1c} - H_{0c}|D_i = 1] \tag{1}$$

I estimate the effect of assignment to full treatment at the time of enrolment on schooling using specification 2:

$$S_{ic} = \Upsilon_0 + \Upsilon_1 D_{ic} + f(R_{ic}) + \mathbb{X}'_{ic}\Upsilon_2 + \varepsilon_{ic} \tag{2}$$

Where S is the years of schooling completed, D is the dummy for whether an individual was assigned to receive 9 years of fee waiver. R is the centred running variable (measures age), centred at 0. Thus, months prior to August 1989 take negative values, and those born after August 1989 take positive values, in each case, at increments of 1. August 1989 takes a value of 0. $\mathbb{X}$ is a vector of controls. Its inclusion in the first stage reduces the variation in the residual and so improves the efficiency of the estimates. The function $f(\cdot)$ estimates the relationship between the outcome and birth cohort. The error term, ε captures other factors that

[3] The optimal bandwidth is a range of observations selected close enough to the cut-off point to minimize bias in the estimation. see [12,31,32] for detailed discussions.

may affect schooling besides the controls. The parameter of interest is Υ_1. It captures the effect of FCUBE on schooling. The subscripts i and c are individual and cohort, respectively. An interaction term is included to capture the effect of differences in slope on either side of the cut-off.

I estimate Eq. (3) in the second stage of two stage least square (2SLS) with Eq. (2) as instrument.

$$H_{ic} = \beta_0 + \beta_1 S_{ic} + h(R_{ic}) + X'_{ic}\beta_2 + v_{ic} \quad (3)$$

Where H_{ic} is health for individual i in cohort c. Other variables have the same description as before. The function $h(\cdot)$ captures the relationship between birth cohort and health. β_1 captures the effect of an additional year of fee waiver and X' is a vector of other controls and an interaction to capture differences in slope on either side of the cut-off. I estimate β_1 via 2-stage least square using D_{ic} as the excluded instrument to obtain an estimate of the health return to additional schooling induced by assignment to an extra year of fee waiver.

3.2. Internal validity

The literature suggests two ways to implement regression discontinuity analysis [31–33]. The parametric estimation characterises the treatment as a discontinuity at the cut-off and finds an optimal specification (functional form) to fit the data. The nonparametric approach, on the other hand, characterises the treatment effect as local randomisation and finds the minimum data that fits a linear specification. While the parametric approach produces more efficient estimates, bias is more likely. The reverse is true for the nonparametric approach. However, a trade-off in favour of less bias is preferred (see [32] for detailed discussion). Consequently, I follow the nonparametric approach which is also the more preferred in the literature. This approach is underpinned by the assumption that the conditional expectation of outcomes by birth cohorts is smooth through the cut-off point (R=0). Hence, any discontinuity can be attributed to the causal impacts of the policy. The optimal bandwidth allows for a comparison of those who were born late enough to be exposed to 9 years of fee-free schooling and those born early enough to receive 8 years of fee-free schooling [27].

Three important concerns may be raised regarding the ability of the FCUBE as a natural experiment to recover the policy effect [37]. The first is that parents of children from poor households are likely to delay enrolling their children if they know the policy implementation date to benefit from the policy. This is however not likely to have happened because all children in school were going to benefit from the policy regardless of the grade they were in as of August 1996. Since the policy was announced in 1995, if this concern holds, there would have been a significant decline in gross enrolment in 1995. Data presented by Akyeampong [4] however shows that gross enrolment in 1994 was comparable to 1995. They observe a sharp increase only from 1996 (see Fig. 2). Moreover, the announcement was made when the school year had already started.

A second concern is whether the exclusion criterion is likely to hold. A potential problem is that other government policies are likely to have occurred at the same cut-off. To the best of my knowledge, no other policy was implemented whose eligibility criteria for treatment is similar to the FCUBE or which only affected a portion of the observations in the optimal bandwidth. Furthermore, if any private educational investment created a discontinuity at the cut-off, this would affect the internal validity of the results. It will imply that the estimates are a combined effect of both the private investments and the policy; hence the effects will be overestimated. The exclusion criterion is tested by examining pretreatment variables [33]. The best pretreatment variables in the data are ethnicity and religion. I conduct a two-sample t-test to check for this. The result is as shown in the appendix. Together with other formal tests in Fig. 3, there is no evidence of manipulation.

Finally, because survey data was used, concerns may be raised regarding social desirability bias and recall bias, particularly for self-reported variables. In the case of the former, people may answer questions in a way that they consider to cast them in a good light in the eye of society. For instance, if smoking carries a social stigma, a person who smokes may fail to disclose the truth about their smoking status or the substance they smoke. While this is likely, it is not avoidable in surveys. However, its effects are not likely to be significant. In any case, the summary statistics for the variables that could possibly carry a stigma (example: Smoking and Sexual Infections) are consistent with official estimates in other datasets. In addition, because respondents are interviewed individually, and by a stranger who visits in an official capacity, respondents are likely to feel more confident to disclose accurate information. Recall bias, on the other hand, is likely to be minimal since information on the variables used in this study is usually about recent events. In the case of other events that may have occurred in the distant past, these are often major events that are unlikely to be forgotten. For instance, a person is unlikely to forget that they ended their schooling at the secondary school level.

3.3. Other estimation issues

It is well established in the related literature that education is endogenous partly because schooling is a choice variable. This endogeneity has been shown theoretically to arise from omitted ability which correlates with the choice of years of schooling and health outcomes. That said, [25] and [39] found from using twins data that unobserved ability might be uncorrelated with schooling level. Measurement errors in years of schooling could also account for endogeneity. Measurement errors are likely to be small because the schooling data is reliable. I confirm that years of schooling is endogenous in the data using Wooldridge's test.

The endogeneity problem is addressed by using assignment-to-full-treatment status as an instrument in the second stage estimates. I confirm the validity and strength of the instrument using the Kleibergen-Paap Rank LM (F) test, Cragg-Donald Wald test, Stock-Yogo, and Hansen's J-test in all specifications. Using a large sample provides additional efficiency gains, which is important in a nonparametric estimation [26]. Reverse causality is also a concern in empirical studies. For instance, pupils may drop out of school due to ill health [17,30,40]. The Ghana Living Standards Survey (GLSS7) shows that ill health accounted for a small part of the reasons for not attending school. Instead, it shows that the most important reason was financial and this is addressed by the policy. Besides, this concern is mitigated by the research design.

Following the recommendations by Abadie et al. [1] and Nunn [43] standard errors are clustered at the level of survey clusters. This approach to clustering yields standard errors that are robust against arbitrary patterns of within-cluster variation and covariation [13]. Clustering at survey clusters is useful because while respondents are identical across cohorts, their characteristics may differ by location; in the context of this study, social and economic status can vary much within and between clusters. A section of the literature also clusters at the level of running variables. The point estimates remain robust to clustering at the level of the running variable. The strength of the instrument, however, becomes sensitive to alternative bandwidths in this approach. I report results for the former only. As expected, the point estimates and conclusions remain robust to not clustering. For brevity, only the relevant main results are reported.

3.4. Data

The Dataset: This study analyses data from round seven of the Ghana standard DHS conducted from September to December 2014 by the USAID[4] funded DHS[5] Program. Round seven of the Ghana DHS survey includes adult females in all sampled households between ages 15 and 49 years and males in selected households between ages 15 and 59

[4] United States Agency for International Development.

[5] Demographic and Health Surveys.

Table 1
Summary statistics.

Variable	Mean (SD)
Smokes	0.0172 (0.1512)
Antenatal Visits	6.1668 (2.75)
Fertility Intention	3.979(1.2121)
Healthy Eating	3.6156 (2.4127)
Weight for Height	0.0067 (0.1131)
Body Mass Index	23.9794 (4.0553)

Notes: Data is from the 2014 Ghana Demographic and Health Surveys. Means are presented for the optimal bandwidth. Standard deviations are in parentheses

years. The optimal bandwidth for this study includes respondents who were between 22 and 28 years on the survey date. Summary statistics are presented in Table 1 and discussed below for respondents in the optimal bandwidth. Data for some variables are available for only males or only females. Where this is the case, the discussion highlights it.

Table 1 reports the summary statistics for the outcome variables in this study. The variable **Smokes** is an indicator variable for whether an individual smokes any substances. **Fertility Intention** is measured as the total number of children one wants to have or their ideal number of children. **Healthy Eating** is defined as how many days in a week a respondent ate vegetables. **Antenatal Visits** is the total number of times a woman visited the hospital or health centre for antenatal care during her last pregnancy. **Risk of Obesity** is measured using Body Mass Index and Standard deviation of Weight for Height. The DHS survey measures respondents' height and weight and calculates body mass index (BMI) from it. Higher values signal a high risk of various diseases. High BMI is associated with health conditions including type 2 diabetes, high mortality, and obesity. The mean BMI of 24 puts the average person in the overweight category. Weight for height index measures the body mass of individuals relative to their height and is an indicator of current nutritional status [45]. The index expressed as a standard deviation shows whether a person is malnourished (including being overweight). It is a comparison of weights of individuals

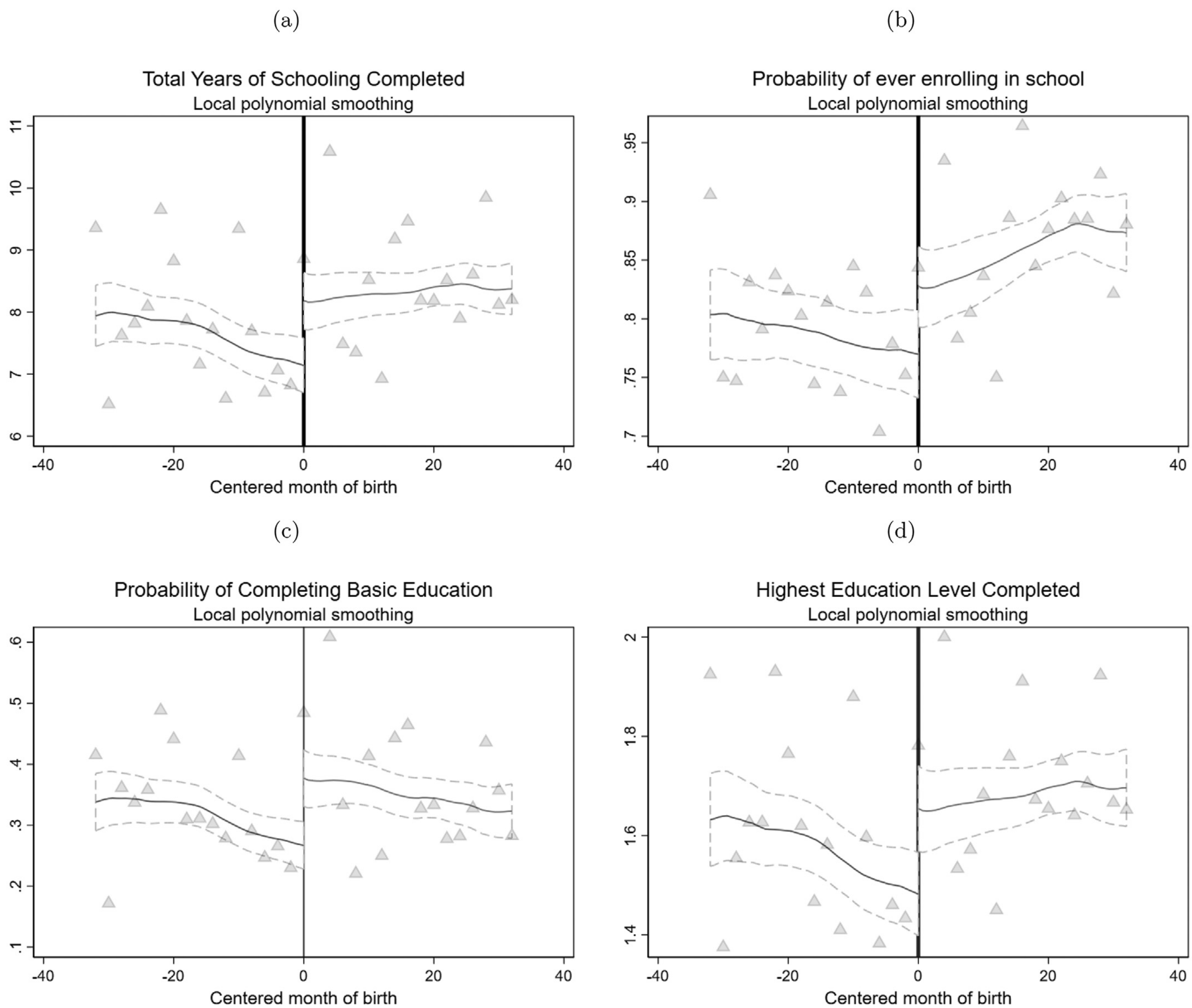

Fig. 1. Discontinuity in Schooling **Notes:** This figure shows the increase in school attainment as a result of the introduction of FCUBE using different measures of school attainment. Total Years of Schooling is measured in single years. Highest level of education attended is measured from 0 to 3; where 0 is no education (person has never been enrolled in school), 1 is "attended primary school (including Junior Secondary School)", 2 is "attended secondary school" and 3 is attended higher education". All other measures of schooling are indicator variables.

Table 2
First stage estimates with different bandwidths.

	32 months (Optimal bandwidth)		12 months		24 months		36 months	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable = Total number of years of education								
Assigned	1.4697***	1.2797***	2.4484***	2.2248***	1.8572***	1.7021***	1.3709	1.1717***
	(0.4064)	(0.3638)	(0.6334)	(0.5607)	(0.4533)	(0.3973)	(0.3807)	(0.3485)
Observations	2,333	2,332	959	959	1,774	1,773	2,626	
F-stat	13.08	12.37	14.94	15.74	16.78	18.35	6.79	41.65
Controls	No	Yes	No	Yes	No	Yes	No	Yes

Notes: This table shows the first stage results. Columns (1), (3), (5) and (7) do not include controls and columns (2), (4), (6) and (8) include controls for ethnicity and religion. It shows the average effect of the FCUBE policy on the total number of years in education. The policy was intended to get pupils into school and to keep them enrolled for at least 9 years. Using the optimal bandwidth, the results show that the additional year of fee waiver increased the total years of schooling completed by about 1.5years. This suggests that the policy was effective. Standard errors are clustered at the survey clusters and reported in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

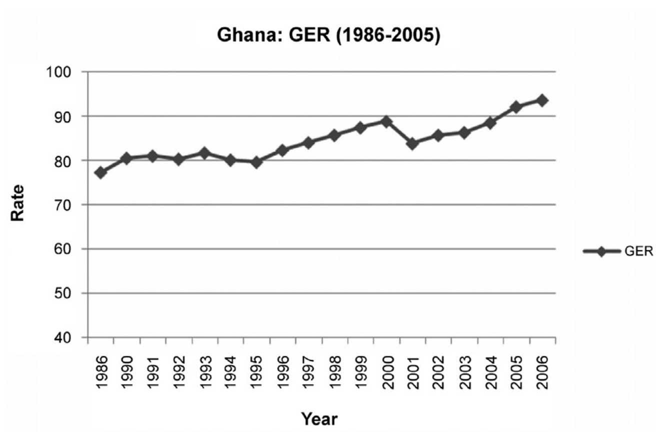

Fig. 2. Gross Enrolment Rate This graph is from [4]. It shows gross annual primary school enrolment for Ghana. The gross enrolment rate was stable around 80% and with a downward trend up to 1995 but rises continually from 1996, the year the FCUBE was implemented.

with identical heights globally using a WHO benchmark weight for their height.

4. Results and discussion

4.1. School fee waivers increased attainment

The FCUBE policy had as part of its objectives to increase enrolment, reduce dropout, and consequently increase the average total years of schooling completed. The first stage results suggest that the policy was effective in achieving these objectives. Fig. 1 shows the local average effect of the FCUBE policy on the years of schooling completed using the cohorts closest to the assignment threshold. An optimal bandwidth of 32 months was selected using the [12] local polynomial bandwidth selection method. The corresponding regression in Table 2 shows that the average effect of the policy was up to 1.5 years more for the cohorts who were assigned to 9 years of fee waiver compared to those who were assigned to receive fewer years of fee waivers. This size is close to 1.4years from [44]'s first stage; she used Nigeria's 1976 UPE.

The size of the effects gets larger with narrower bandwidths and smaller with wider bandwidths, as expected (see Fig. A.9). Back of the envelope estimates using all adults in the survey show a difference of 1.7 years, similar to what [44] finds for Nigeria. I check for the robustness of the policy effect estimates to functional forms. The results are summarised in Fig. A.8. It shows that the policy effects are well within identical ranges regardless of the functional form selected. Using the Information Criteria (BIC, AIC), the linear interaction form is implemented. This is also appropriate given the differences in slope on both sides of the cutoff [33].

4.2. Education improves health

Having established that the FCUBE policy has a positive impact on years of schooling completed, I now discuss its impact on health. The health outcome variables included in this study also reflect health behaviours. The expectation is that people who have higher educational attainment will have better health behaviour because they can access information on healthy living and are able to process such information better. Also, they have better labour market outcomes.

The first set of results is presented in Table 3. The second set of results is presented in Table A.5. The main difference between the two sets is that the algorithm of the second selects a different optimal bandwidth for each outcome variable. These bandwidths are reported in the results table for information. On the other hand, the first set uses a single bandwidth, which was discussed earlier.

OLS estimates may be biased upwards due to unobserved factors such as innate ability or biased downwards due to measurement errors. These are ameliorated by the instrument used in the IV estimates given that the eligibility criteria for assignment to full treatment for FCUBE are not manipulated and also given the placebo. The IV results are interpreted as the effect of 1 year of schooling completed. The reduced form (RF) results are interpreted as the effect of the fee waiver policy. The conclusions are stable across IV and RF estimates. Either of the two latter results is interesting but within a regression discontinuity framework, the RF estimates are more informative hence the discussion that follows is based on the reduced form estimates. Nonetheless, OLS, IV and RF estimates are all presented in all cases.

When comparing the IV and RF estimates, one must keep in mind that the policy effect is 1.5years whereas the IV results measure the effect of each year of schooling. Compared this way, the point estimates are intuitively identical. On the other hand, the results in Table A.5 are interpreted as the effects of the policy on those who were sufficiently close to be treated or untreated. That is the local average treatment effect(LATE). In nearly all cases, the results show a positive impact of the fee waiver on health.

4.2.1. Education reduces the likelihood of smoking

Results in Table 3 show that being in the cohorts assigned to an extra year of fee waiver reduces the likelihood that an individual will be a smoker by about 2.6%. The estimates in Table A.5 are close. This effect is significant relative to the sample mean. That means that the cohorts who were assigned to receive the full treatment were twice as likely not to be smokers at the time of the survey compared to those who were assigned to receive one year less of treatment [17]. makes a com-

(a) (b)

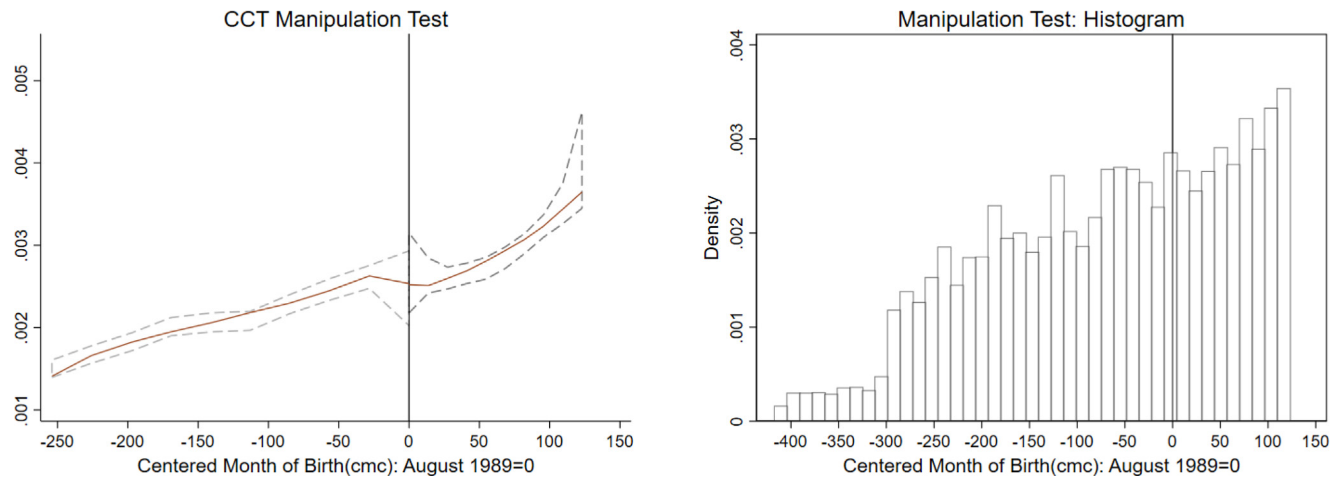

Fig. 3. Manipulation **Notes:** [12] method is used. The running variable is the centred month of birth using the century month code. Centred at zero, months increase(decrease) at intervals of one. Months to the left(right) are those before(after) August 1989. August 1989 is zero, the cut-off point. This definition of a cohort is more representative of the actual definition of a school cohort but has not been used in previous studies. For robustness, I use the common measure and a previously used dataset in Fig. A.7 to confirm that there is no manipulation.

Table 3
Fee Waiver, Schooling and Health.

	OLS	IV	RF	OLS	IV	RF
			Panel A			
		Smokes			Healthy Eating	
Schooling	-0.001**	-0.023*	-0.026**	0.005	0.311*	0.359**
	(0.001)	(0.012)	(0.012)	(0.012)	(0.177)	(0.176)
Observations		2,625			2,624	
			Panel B			
		Body Mass Index			Weight for Height	
Schooling	0.064**	0.852	0.826*	0.002***	0.049*	0.048***
	(0.028)	(0.666)	(0.482)	(0.001)	(0.028)	(0.013)
Observations		992			990	
			Panel C			
		Antenatal Visits			Fertility Intention	
Schooling	0.115***	1.464	0.8280***	-0.072***	-0.289***	-0.333***
	(0.020)	(1.225)	(0.288)	(0.006)	(0.096)	(0.085)
Observations		1,161			2,626	

Notes: This table presents estimates of the average effect of an additional year of schooling on health outcomes and behaviours. Three estimates are presented for each variable, OLS, IV and Reduced Form. In the case of the RF results, the coefficient of *Schooling* is the difference between those assigned to receive full treatment vrs partial treatment. All estimates include controls for ethnicity and religion and the functional form used is linear interaction. Errors are clustered at the survey cluster level and presented in parentheses $*** \ p < 0.01, ** \ p < 0.05, * \ p < 0.1$.

pelling case for why education and smoking habits may be associated citing arguments by [24]. Back-of-the-envelope calculations show that within the optimal bandwidth, individuals who had never enrolled in school were 2.8 times more likely to be smokers. Similarly, individuals who enrolled but did not complete JSS were 3.2 times more likely to be smokers than those who completed JSS. This compares to 4 times in the full sample. This reveals a possible spillover effect on the larger community. That is, there is a positive peer effect. Smoking can be *fashionable* if one's peers smoke. The fewer peers who smoke one has, the less likely they are to be smokers.

The magnitude of effects I find for Ghana is smaller than [52] finds for the US. He studied the effect of education in the US using the years of schooling above college as a measure of education. He finds that completing 1 year above college reduces the likelihood of smoking by about 5%. This is not surprising because smoking is more common in the US than in Ghana and the measure of schooling is set much higher. Thus, being educated in college (equivalent to a bachelor's degree) means a person in Ghana is going to be much less likely to smoke than one in the US. However, [29] finds effects to range for 2.6 to 3.3% and [17] finds 2.7%, both for high school graduation in the US and UK respectively. In an African context, [16] find that in South Africa, people who had dropped out of school before turning 20 years were much more likely to be smokers. Currently, about 6 million deaths annually are attributable to smoking [16]. This is expected to rise to 10 million in 2030 and it is projected that 70% of these deaths will occur in developing countries [47]. Globally, smoking prevalence is about 21% for people 15+. The rate is even higher in some developing countries. For instance, [16] reports a prevalence of 31% in South Africa. The dataset used in the present study places the prevalence rate at 3.7% for Ghana, similar to estimates by [47] of 3.8%. This means that smoking is not a big problem in Ghana as in other developing countries. Nonetheless, [47] finds, as in this study, that the few who smoke tend to be those with lower levels of education.

4.2.2. Education improves healthy eating

I define healthy eating as one that regularly includes vegetables. A healthier diet reduces the likelihood of illness and may accelerate the healing process if one is ill. Respondents provided information on how many days in the week they included vegetables in their diet. The results show that cohorts assigned to receive an extra year of fee waiver ate healthily more often. They ate healthily at least 0.36 days more per week than cohorts who received a year less of fee waiver. This is about 10% of the average days of healthy eating in the week.

The recommended healthy diet is one that has all nutrients available. The high cost of vegetables, resulting from higher costs of production, is considered an obstacle to their inclusion in diets regularly [45]. Well-educated people are more likely to understand the importance of a balanced diet and so choose to eat them often. Having more schooling also improves earnings and makes healthy eating more affordable.

4.2.3. Educated women use antenatal services more

Maternal mortality is high in developing countries [54]. Health personnel are able to detect any potential dangers to maternal health or dangers to the baby in the womb if the mother attends regular medical checkups [2]. Thus, antenatal care is important for the health of the mother and for the baby. Modern antenatal care practices coexist with traditional practices in developing countries. I take the view that women who have attended more schooling are likely to have a more favourable disposition to modern practices and so would attend the clinic when pregnant [20]. This view is supported by the findings of this study.

The results show that the cohorts that were assigned an extra year of fee waiver attended antenatal care sessions about 0.8 more times than others. This represents about 13% more visits than the mean. Antenatal care is free in Ghana at all health facilities. Coupled with the range of access options, attendance is not constrained by costs. A possible explanation is that better-educated women understand the benefits of antenatal care and so choose to attend more of it [2].

4.2.4. Education reduces fertility intention

This finding is not surprising and in fact not new. Many studies document this across nearly all contexts [10,35,36,48,50]. By design, respondents are younger than 30, so this variable sought to measure how many children they wanted in their ideal family. That is their desired number of children. The results in Table 3 includes both males and females.

The results show that one more year of schooling reduces this appetite by about 0.33 children (8% of the mean). The mean appetite in the estimation data is 4 children compared to 4.8 for women over 40 in the DHS data. Women over 40 are usually considered to have completed childbearing or are very close to finishing. It also confirms a trend of declining fertility and ideals around the family size in Ghana which has been attributed in part to an increasing rate of higher education, changing labour markets for women and access to contraception options. This finding and interpretation are consistent with a previous study on Ghana's neighbour, Nigeria, where it was found that an additional year of schooling reduced fertility by 0.26 [46]. Both estimates also compare to [6] who examines several birth cohorts, found effects ranging from 0.09 and 0.36; and suggests that the effects of education on fertility vary by cohort.

4.2.5. Education increases the risk of obesity for women

A person whose body mass is too high for their height is considered to be overweight or obese. Obesity is a function of weight for height and has been linked to the causes of several life-threatening diseases. The results show that one extra year of schooling increases a female's weight for height by 0.05 of a standard deviation. Body mass index also increases by about 0.8 for the cohorts who were assigned to receive the full treatment. While these estimates suggest an increased risk of obesity the means of these measurements reported in Table 1 is just under the threshold for obesity. This could be explained partially to be as a result of the sedentary nature of the employment that highly-educated people are involved in [3,19] and the fact that these people may also be able to afford more food. Secondly, there is a sub-culture where female obesity is associated with beauty and having a good life [19].

5. Conclusion

This paper examined whether a causal link exists between education and health by exploiting the FCUBE policy in Ghana as a source of exogeneity in a Fuzzy RDD. The paper makes important contributions to the literature as being one of scarcely any studies on the causal effect of education on health in Africa, and to have examined other variables besides fertility and one of scarcely any to have included men. Beyond Africa, existing evidence in Europe is mixed and split almost evenly on either side. Studies on the US mostly show findings consistent with the findings in this paper. This study also includes variables such as antenatal visits and fertility intention. On the whole, the question of causality has only begun to be addressed in empirical studies in the last decade.

Table A1
Two sample test of differences in pre-assignment variables.

	Ethnicity	Religion
t	0.9971	-0.8360
$Pr(\lvert T\rvert > \lvert t\rvert)$	0.3188	0.4033

Notes: This table tests the hypothesis that pretreatment variables do not differ for respondents on either side of the cut-off. It is generally difficult to get suitable variables in survey data for this type of hypothesis test. Ethnicity and Religion are the best two variables available in the dataset that can be used to test this. Ethnicity is fixed and religion is usually sticky; that is, it does not change often and most people tend to follow the religion of their families. The assumption here is that if treatment was randomly assigned, then respondents should not differ on pretreatment variables. The results presented in this table suggest this to be the case. Indeed, in Ghana, several socioeconomic factors differ systematically across ethnicities and religions and so we can be confident that this result is indicative that indeed the sample selection and treatment assignment are not biased.

Table A2
Fee Waiver, Schooling and Health.

	Coefficient	BW Left,Right
Weight for Height SD	0.0532 ***	51,29
	(0.0187)	
Body Mass Index	1.1181**	62,44
	(0.5653)	
Healthy Eating	0.4560**	111,37
	(0.2106)	
Smokes	-0.0388*	32,32
	(0.0208)	
Fertility Intention	-0.1539*	10,452
	(0.8898)	
Antenatal Visits	1.1714**	50,33
	(0.5026)	

Notes: This table shows the effect of the policy on health outcomes and health behaviour. A different bandwidth is selected for each outcome using the method recommended by [12]. It includes controls for ethnicity and religion. Robust standard errors are reported in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

(a) Only assigned to partial treatment (b) Only assigned to full treatment

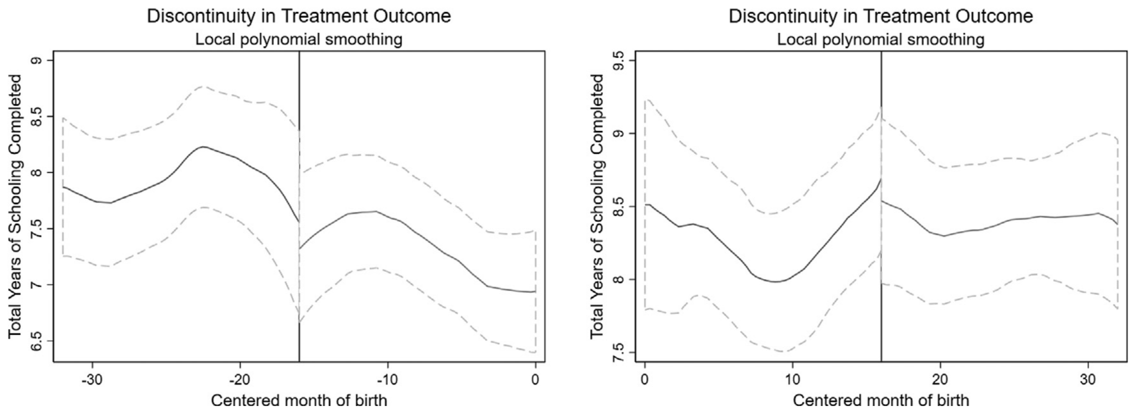

Fig. A1. Discontinuity at non-discontinuity point 1 **Notes:** Figure tests for discontinuity at points other than the cut-off point for robustness. I take all respondents whose cohorts were assigned to receive at least one year of treatment. The data is split into two halves on either side of the cutoff. For those on the left, those further left of the fake cut-off were assigned to receive one year less of treatment but are also older. For those on the right, everyone was assigned to receive full treatment. As a consequence, some jump is expected on the left half but less significant than at the real cut-off whereas no significant jump is expected on the right half. This is as shown.

(a) August 1987 as cut-off (b) August 1991 as cut-off

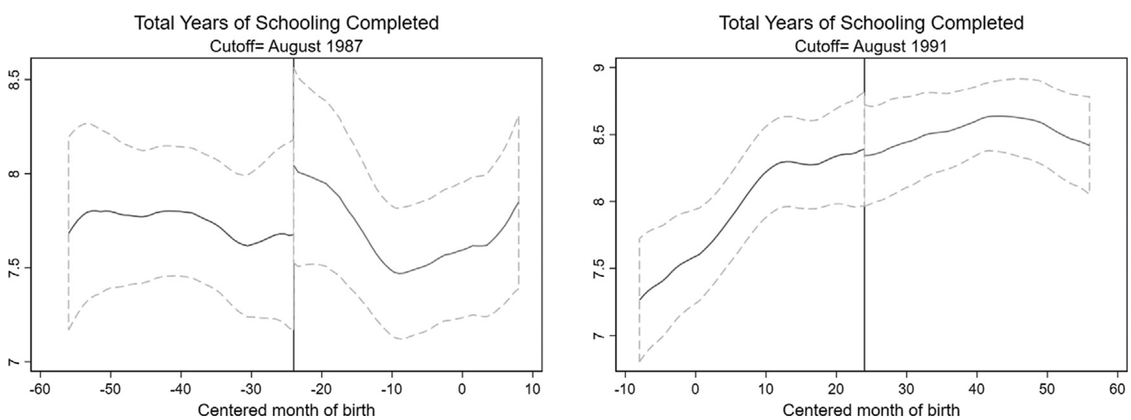

Fig. A2. Discontinuity at non-discontinuity point 2 **Notes:** This figure tests for robustness of discontinuity at cut-off points by using fake cut-offs for the optimal bandwidth. I choose one cut-off two years leftwards and another two years rightwards both within the optimal bandwidths. These cut-off points do not show significant jumps.

(a) August effect for partially treated only (b) August effect for fully treated only

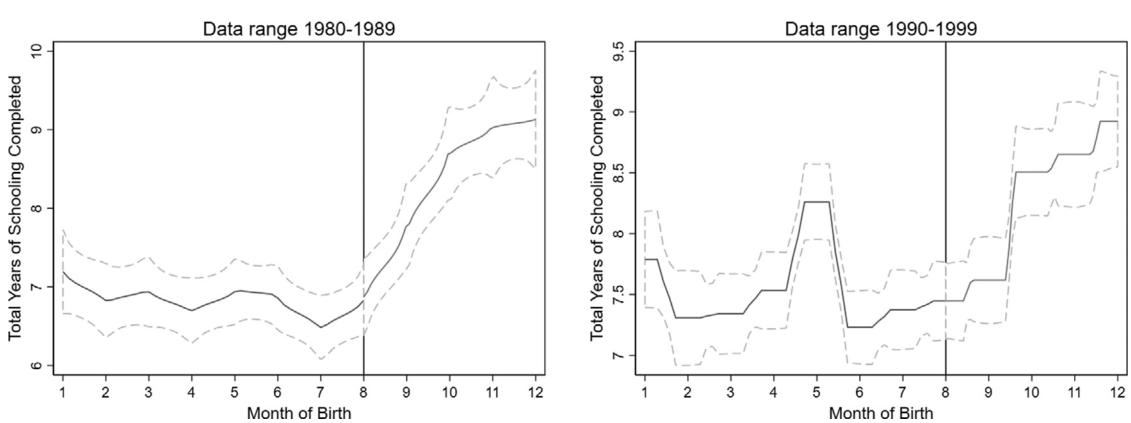

Fig. A3. Discontinuity at random August **Notes:** The literature shows that month of birth potentially affects the age of enrolment, performance in school and the total number of years of schooling. This is tested by checking for a month of birth effect in the data. If there is a jump in the month of the start of the school year, then the effects reported in the results would capture both the month of birth effect and the FCUBE effect. The results in the plots above are consistent with the literature in that those born after the start of the school year have more schooling for observations on either side of the cut-off but there is no discontinuity at August.

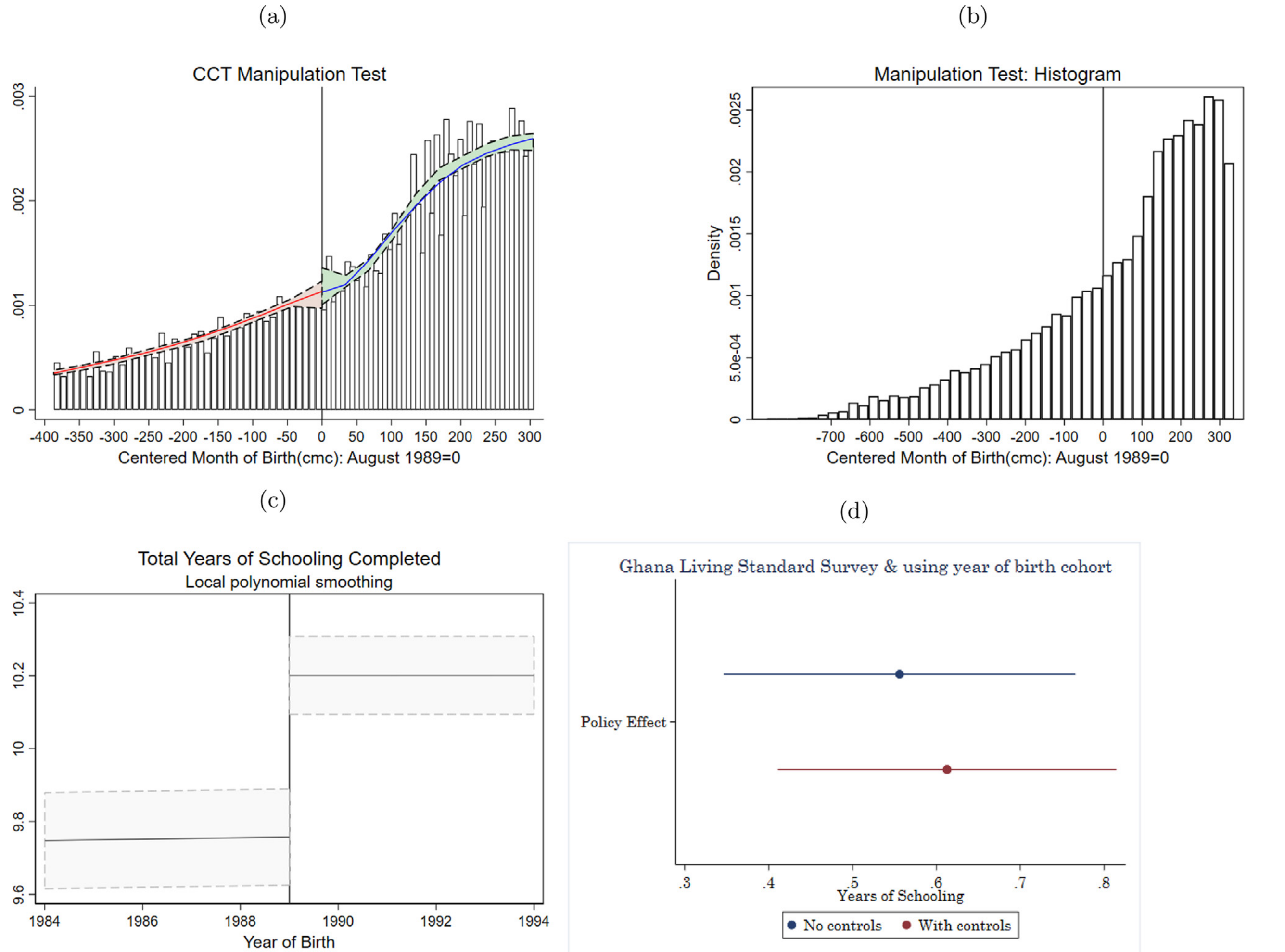

Fig. A4. Additional graphs using the Living Standards Survey **Notes:** I repeat the graphs for manipulation and policy effect on total years of schooling using the Ghana living standards survey round 7 (GLSS7) to check for robustness across data types. The GLSS7 is a more recent data and it includes a more even distribution on males and females[10]. used an earlier round of this survey to show a discontinuity. This is thus not an exact replication of their results but the policy effects estimates are close. I maintain their definition of a cohort in the policy effect graph but use the standard definition adopted in this study for the manipulation tests. These confirm the robustness of earlier conclusions.

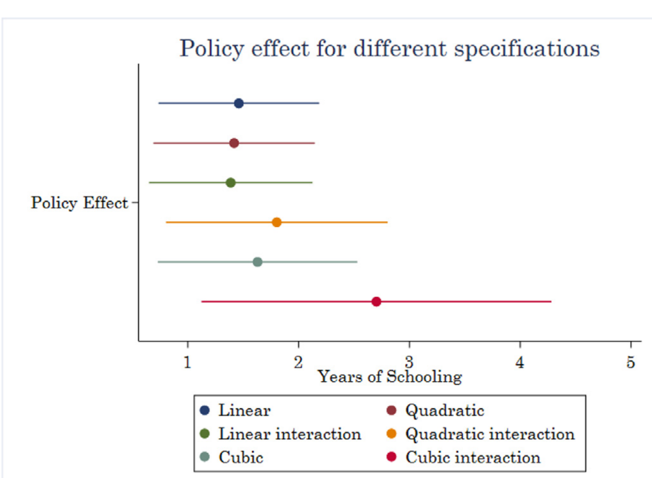

Fig. A5. Policy effect using different functional forms **Notes:** I check for robustness of the results for policy effects to functional form. I show the first stage results for various functional forms in this figure. The results presented here show that policy effects overlap for all functional forms.

The contributions of this paper are thus important both for the developing country context and the general literature.

The findings of this study have economic significance. Consistent with global trends, life expectancy and overall well-being are increasing in Ghana as a result of medical advances. The results presented here show that the increases in educational outcomes are partly responsible for these positive health outcomes. By design, the findings of this study apply specifically to the respondents in the optimal bandwidth. Nonetheless, the results can be extrapolated to the whole population especially because the under-30s constitute the larger share of the Ghanaian population. Ghana extended the tuition fee waiver to senior secondary schools in 2017. The effect of the fee waivers induced by the FCUBE is estimated to be at least 1.5 years. The mean years of schooling of the sample in the optimal bandwidth were 8 years. This means that the individuals included in this study did not complete junior secondary school, on average. The duration of senior secondary school is 3 years. This means that the fee waiver for senior secondary school can adduce more than twice the health benefits estimated in this study. This is not a small effect. With the exception of the risk of obesity (and arguably fertility), these effects can generally be regarded as positive.

Outside of Ghana's context, the results provide useful lessons for countries whose tuition fee waiver policies have not been extensively evaluated. It also provides lessons for those countries that have plans

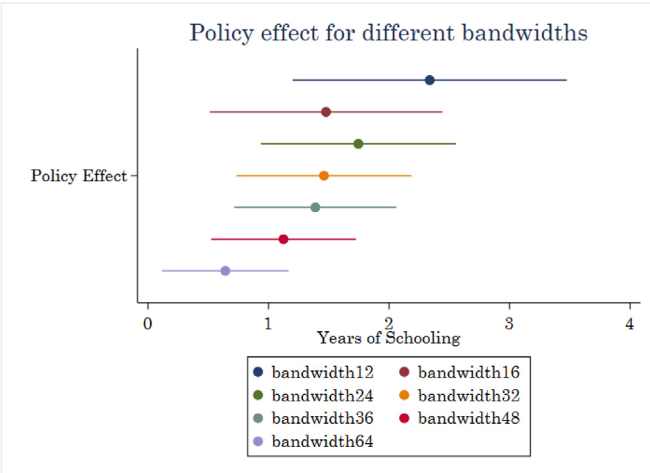

Fig. A6. Policy effect using different bandwidths **Notes:** I check for robustness of the results for policy effects to different bandwidths. I use the standard half bandwidth and double bandwidth suggested in the literature. Additionally, I check for different bandwidths. Smaller bandwidths yield larger effects than larger bandwidths and all are within identical ranges of the optimal bandwidth. As is expected, wider bandwidths have smaller effects because fully treated respondents furthest left were young and still in school whereas partially treated and untreated respondents were older yet had completed fewer years of schooling. Also, as the bandwidth gets larger and approaches the bandwidth used by [10], the effect becomes identical to theirs.

to adopt a similar policy. It may also be informative in that it provides a counterfactual for countries that have not implemented tuition fee waiver policies. Although such a comparison must consider any differences in national circumstances.

Considering that the health variables examined here are mostly behaviour, increasing educational attainment could mean lower public health expenditure in the long run. The results also suggest that health knowledge and employment are plausible channels for at least some health outcomes. In terms of the practical impact of the findings of this study. It is noteworthy that obesity is on its way to being endemic globally, malnutrition and smoking are already global crises. The findings of this paper contribute to efforts to understand the social and economic factors that cause or mitigate these health challenges. Thus a contribution to the solution

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

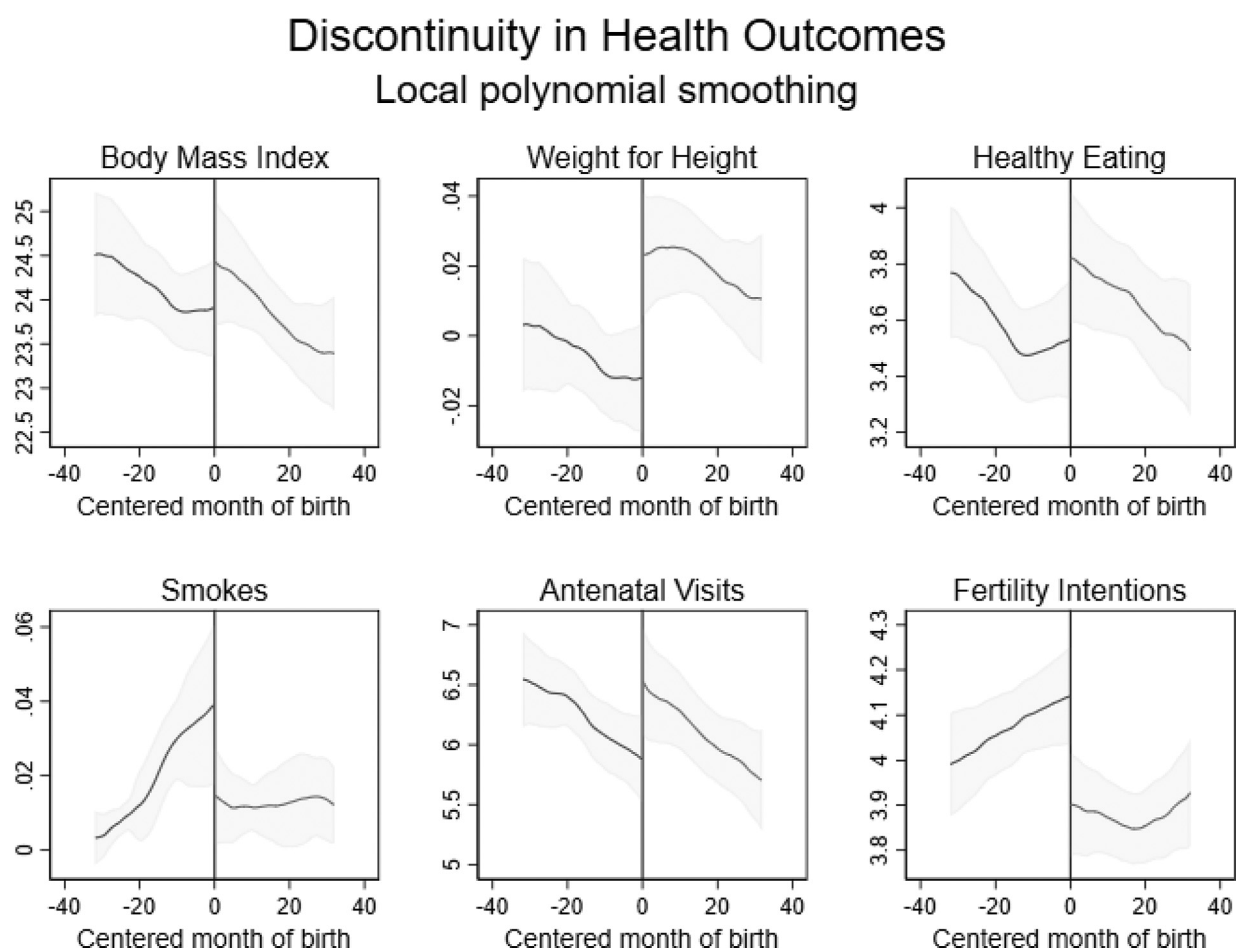

Fig. A7. Discontinuities in health outcomes at cut-off point **Notes:** The graphs presented here show the existence of discontinuities at the FCUBE intent-to-treat cut-off point. These can be taken as a graphical illustration of the treatment effect for each of the outcomes of the results presented in the tables. Keep in mind however that the graphs do not include controls but the tables do. The presence of significant jumps in the graphs confirms the point estimates in the tables.

References

[1] A. Abadie, S. Athey, G.W. Imbens, J. Wooldridge, When Should You Adjust Standard Errors for Clustering?, National Bureau of Economic Research, 2017, doi:10.3386/w24003. Working Paper

[2] P.A. Abor, K.S. Gordon AbekahNkrumah, C.K. Adjasi, J. Abor, The socioeconomic determinants of maternal health care utilization in Ghana, Int. J. Soc. Econ. 38 (7) (2011) 628–648, doi:10.1108/03068291111139258.

[3] J. Addo, L. Smeeth, D.A. Leon, Obesity in urban civil servants in Ghana: association with pre-adult wealth and adult socio-economic status, Public Health 123 (5) (2009) 365–370, doi:10.1016/j.puhe.2009.02.003. http://www.ncbi.nlm.nih.gov/pubmed/19362725

[4] K. Akyeampong, Revisiting free compulsory universal basic education (FCUBE) in Ghana, Comp. Educ. 45 (2) (2009) 175–195, doi:10.1080/03050060902920534.

[5] P. Albarran, M. Hidalgo-Hidalgo, I. Iturbe-Ormaetxe, Education and adult health: is there a causal effect? Soc. Sci. Med. 249 (2020) 112830, doi:10.1016/j.socscimed.2020.112830. http://www.ncbi.nlm.nih.gov/pubmed/32087484

[6] D. Altindag, C. Cannonier, N. Mocan, The impact of education on health knowledge, Econ. Educ. Rev. 30 (5) (2011) 792–812, doi:10.1016/j.econedurev.2010.10.003.

[7] V. Amin, J.R. Behrman, H.P. Kohler, Schooling has smaller or insignificant effects on adult health in the us than suggested by cross-sectional associations: new estimates using relatively large samples of identical twins, Soc. Sci. Med. 127 (2015) 181–189, doi:10.1016/j.socscimed.2014.07.065. http://www.ncbi.nlm.nih.gov/pubmed/25110343

[8] M.C. Arcaya, A. Saiz, Does education really not matter for health? Soc. Sci. Med. 258 (2020) 113094, doi:10.1016/j.socscimed.2020.113094. http://www.ncbi.nlm.nih.gov/pubmed/32563450

[9] P. Ayyagari, D. Grossman, F. Sloan, Education and health: evidence on adults with diabetes, Int. J. Health Care Financ. Econ. 11 (1) (2011) 35–54, doi:10.1007/s10754-010-9087-x. http://www.ncbi.nlm.nih.gov/pubmed/21213044

[10] E.A. Boahen, C. Yamauchi, The effect of female education on adolescent fertility and early marriage: evidence from free compulsory universal basic education in Ghana, J. Afr. Econ. 27 (2) (2018) 227–248, doi:10.1093/jae/ejx025.

[11] J. Burton, Worldatlas:list of countries by literacy rate, 2020, (http://www.worldatlas.com/articles/the-highest-literacy-rates-in-the-world.html:~:text=Literacy%2520Rate%2520by%2520Country%2520%2520%2520%2520%25EF%25BB%25BFCountry,%2520100.0%2520%25%2520%2520106%2520more%2520rows).

[12] S. Calonico, M.D. Cattaneo, R. Titiunik, Robust nonparametric confidence intervals for regression-discontinuity designs, Econometrica 82 (6) (2014) 2295–2326, doi:10.3982/ecta11757.

[13] C. Cameron, D. Miller, A practitioner's guide to cluster-robust inference, J. Hum. Resour. 50 (2) (2015) 317–373, doi:10.3368/jhr.50.2.317.

[14] D. Clark, H. Royer, The effect of education on adult mortality and health: evidence from Britain, Am. Econ. Rev. 103 (6) (2013) 2087–2120, doi:10.1257/aer.103.6.2087. http://www.ncbi.nlm.nih.gov/pubmed/29533059

[15] N.M. Davies, M. Dickson, G. Davey Smith, G.J. van den Berg, F. Windmeijer, The causal effects of education on health outcomes in the UK biobank, Nat. Hum. Behav. (2018), doi:10.1038/s41562-017-0279-y.

[16] R. Desai, L.A.G. Mercken, R.A.C. Ruiter, J. Schepers, P.S. Reddy, Cigarette smoking and reasons for leaving school among school dropouts in south africa, BMC Public Health 19 (1) (2019) 130, doi:10.1186/s12889-019-6454-5. http://www.ncbi.nlm.nih.gov/pubmed/30700276

[17] M. Dickson, The causal effect of education on wages revisited, Oxf. Bull. Econ. Stat. 75 (4) (2013) 477–498, doi:10.1111/j.1468-0084.2012.00708.x.

[18] M. Dilmaghani, The causal effects of education on health over the life course: evidence from canada, Public Health 186 (2020) 170–177, doi:10.1016/j.puhe.2020.05.060. http://www.ncbi.nlm.nih.gov/pubmed/32836007

[19] R.B. Duda, N.A. Jumah, A.G. Hill, J. Seffah, R. Biritwum, Interest in healthy living outweighs presumed cultural norms for obesity for Ghanaian women, Health Qual. Life Outcomes 4 (2006) 44, doi:10.1186/1477-7525-4-44. http://www.ncbi.nlm.nih.gov/pubmed/16857048

[20] P.A. Duodu, J. Bayuo, J.A. Mensah, L. Aduse-Poku, F. Arthur-Holmes, V.M. Dzomeku, N.E.Y. Dey, P. Agbadi, J.J. Nutor, Trends in antenatal care visits and associated factors in ghana from 2006 to 2018, BMC Pregnancy Childbirth Vol. 22 (59) (2022), doi:10.1186/s12884-022-04404-9.

[21] O.S. Ekundayo, The right to free and compulsory primary education in ghana: lessons for other african countries, J. Law Policy Glob. 69 (2018) 105–116.

[22] J.M. Fletcher, New evidence of the effects of education on health in the us: compulsory schooling laws revisited, Soc. Sci. Med. 127 (2015) 101–107, doi:10.1016/j.socscimed.2014.09.052. http://www.ncbi.nlm.nih.gov/pubmed/25311783

[23] R. Fonseca, P.-C. Michaud, Y. Zheng, The effect of education on health: evidence from national compulsory schooling reforms, SERIEs 11 (1) (2019) 83–103, doi:10.1007/s13209-019-0201-0.

[24] V. Fuchs, Time preference and health: an exploratory study, in: Economic Aspects of Health, National Bureau of Economic Research, Inc, 1982, pp. 93–120. https://EconPapers.repec.org/RePEc:nbr:nberch:6546

[25] T. Fujiwara, I. Kawachi, Is education causally related TC better health? a twin fixed-effect study in the usa, Int. J. Epidemiol. 38 (5) (2009) 1310–1322, doi:10.1093/ije/dyp226. http://www.ncbi.nlm.nih.gov/pubmed/19528192

[26] M. Gehrsitz, Speeding, punishment, and recidivism: evidence from a regression discontinuity design, J. Law Econ. 60 (3) (2017) 497–528, doi:10.1086/694844.

[27] J. Hahn, P. Todd, W. Van der Klaauw, Identification and estimation of treatment effects with a regression-discontinuity design, Econometrica 69 (1) (2001) 201–209, doi:10.1111/1468-0262.00183.

[28] R. Hamad, H. Elser, D.C. Tran, D.H. Rehkopf, S.N. Goodman, How and why studies disagree about the effects of education on health: a systematic review and meta-analysis of studies of compulsory schooling laws, Soc. Sci. Med. 212 (2018) 168–178, doi:10.1016/j.socscimed.2018.07.016. http://www.ncbi.nlm.nih.gov/pubmed/30036767

[29] J.J. Heckman, J.E. Humphries, G. Veramendi, Returns to education: the causal effects of education on earnings, health, and smoking, J. Political Econ. 126 (S1) (2018) S197–S246, doi:10.1086/698760.

[30] A. Hughes, K.H. Wade, M. Dickson, F. Rice, A. Davies, N.M. Davies, L.D. Howe, Common health conditions in childhood and adolescence, school absence, and educational attainment: mendelian randomization study, Sci. Learn. (2021), doi:10.1038/s41539-020-00080-6.

[31] G. Imbens, K. Kalyanaraman, Optimal bandwidth choice for the regression discontinuity estimator, Rev. Econ. Stud. 79 (3) (2011) 933–959, doi:10.1093/restud/rdr043.

[32] G.W. Imbens, T. Lemieux, Regression discontinuity designs: a guide to practice, J. Econom. 142 (2) (2008) 615–635, doi:10.1016/j.jeconom.2007.05.001.

[33] R. Jacob, P. Zhu, M.-A. Somers, H. Bloom, A Practical Guide to Regression Discontinuity, MDRC, 2012. Technical Report

[34] K. Janke, D.W. Johnston, C. Propper, M.A. Shields, The causal effect of education on chronic health conditions in the UK, J. Health Econ. 70 (2020) 102252, doi:10.1016/j.jhealeco.2019.102252.

[35] A. Keats, Women's schooling, fertility and child health outcomes: evidence from Uganda's free primary education program, J. Dev. Econ. 135 (2018) 142–159, doi:10.1016/j.jdeveco.2018.07.002.

[36] S. Klasen, A. Launov, Analysis of the determinants of fertility decline in the czech republic, J. Popul. Econ. 19 (1) (2006) 25–54, doi:10.1007/s00148-005-0030-2.

[37] D.S. Lee, T. Lemieux, Regression discontinuity designs in economics, J. Econ. Lit. 48 (2) (2010) 281–355, doi:10.1257/jel.48.2.281.

[38] A. Lleras-Muney, The relationship between education and adult mortality in the United States, Rev. Econ. Stud. 72 (1) (2005) 189–221, doi:10.1111/0034-6527.00329.

[39] P. Lundborg, The health returns to schooling what can we learn from twins? J. Popul. Econ. 26 (2) (2012) 673–701, doi:10.1007/s00148-012-0429-5.

[40] E. Miguel, M. Kremer, Worms: identifying impacts on education and health in the presence of treatment externalities, Econometrica 72 (1) (2004) 159–217, doi:10.1111/j.1468-0262.2004.00481.x.

[41] M. Nishimura, A. Byamugisha, in: The Challenges of Universal Primary Education Policy in Sub-Saharan Africa, Palgrave Macmillan US, New York, 2011, pp. 225–245, doi:10.1057/9780230339361_12.

[42] H.P. Nudzor, Unearthing the discursive shift in the FCUBE policy implementation in Ghana: using critical discourse analysis, Int. J. Res. Method Educ. 36 (2) (2013) 179–201, doi:10.1080/1743727x.2012.696242.

[43] N. Nunn, Religious conversion in colonial africa, Am. Econ. Rev. 100 (2) (2010) 147–152, doi:10.1257/aer.100.2.147.

[44] M.A. Odunowo, Essays in Applied Microeconomics, Texas A&M University, 2020. Doctoral dissertation

[45] R. Ofori-Asenso, A.A. Agyeman, A. Laar, D. Boateng, Overweight and obesity epidemic in Ghana-a systematic review and meta-analysis, BMC Public Health 16 (1) (2016) 1239, doi:10.1186/s12889-016-3901-4. http://www.ncbi.nlm.nih.gov/pubmed/27938360

[46] U.O. Osili, B.T. Long, Does female schooling reduce fertility? evidence from Nigeria, J. Dev. Econ. 87 (1) (2008) 57–75, doi:10.1016/j.jdeveco.2007.10.003.

[47] E. Owusu-Dabo, S. Lewis, A. McNeill, A. Gilmore, J. Britton, Smoking uptake and prevalence in Ghana, Tobacco Control 18 (5) (2009) 365–370, doi:10.1136/tc.2009.030635. http://www.ncbi.nlm.nih.gov/pubmed/19581276

[48] D. Philipov, Theories on fertility intentions: a demographer's perspective, Vienna Yearb. Popul. Res. 9 (2012) 37–45, doi:10.1553/populationyearbook2011s37.

[49] I. Salifu, J.K. Boateng, S.S. Kunduzore, S. Serpa, Achieving free compulsory universal basic education through school feeding programme: evidence from a deprived rural community in northern Ghana, Cogent Educ. 5 (1) (2018), doi:10.1080/2331186x.2018.1509429.

[50] C.A. Towriss, I.M. Timaeus, Modelling period fertility: schooling and intervals following a birth in Eastern Africa, Popul. Stud. 72 (1) (2018) 75–90, doi:10.1080/00324728.2017.1370121. http://www.ncbi.nlm.nih.gov/pubmed/28994345

[51] UNDP, Health index. Human development reports, 2020, (http://www.hdr.undp.org/en/content/health-index).

[52] D. de Walque, Does education affect smoking behaviors? Evidence using the Vietnam draft as an instrument for college education, J. Health Econ. 26 (5) (2007) 877–895, doi:10.1016/j.jhealeco.2006.12.005. https://www.ncbi.nlm.nih.gov/pubmed/17275938

[53] World Education Service, Education in Ghana, 2019, (https://www.wenr.wes.org/2019/04/education-in-ghana).

[54] World Health Organization, World health statistics 2019: monitoring health for the SDGS, sustainable development goals, 2019, (https://www.apps.who.int/iris/handle/10665/324835).

[55] X. Xue, M. Cheng, W. Zhang, Does education really improve health? A metaanalysis, J. Econ. Surv. 35 (1) (2020) 71–105, doi:10.1111/joes.12399.