China Economic Review 24 (2013) 165–176

Contents lists available at SciVerse ScienceDirect

China Economic Review

Eggs versus chewable vitamins: Which intervention can increase nutrition and test scores in rural China?

Max KLEIMAN-WEINER [a], Renfu LUO [b,*], Linxiu ZHANG [b], Yaojiang SHI [c], Alexis MEDINA [d], Scott ROZELLE [d]

[a] Department of Brain and Cognitive Sciences, Massachusetts Institute of Technology, 77 Massachusetts Avenue, Cambridge, MA 02139, USA
[b] Center for Chinese Agricultural Policy, Institute of Geographcial Sciences and Natural Resources Research, Chinese Academy of Sciences, No. Jia 11, Datun Road, Chaoyang District, Beijing 100101, China
[c] Northwest Socioeconomic Development Research Center (NSDRC), Suite 8502, School of Economics and Management, South Campus of Northwest University, Xi'an 710127, China
[d] Freeman Spogli Institute for International Studies, Stanford University, 616 Serra Street, Stanford, CA 94305, USA

ARTICLE INFO

Article history:
Received 27 August 2012
Received in revised form 30 November 2012
Accepted 11 December 2012
Available online 20 December 2012

JEL classifications:
I15
I25
J24
O53

Keywords:
Health
Education
Nutrition
Primary school children
Rural China

ABSTRACT

Despite growing wealth and a strengthening commitment from the government to provide quality education, a significant share of students across rural China still have inadequate access to micronutrient-rich regular diets. Such poor diets can lead to nutritional problems, such as iron-deficiency anemia, that can adversely affect attention and learning in school. Large scale policies in Northwestern China have attempted to tackle these nutritional problems using eggs. The overall goal of this paper is to assess the impact of the government's egg distribution program by comparing the effect on anemia rates of an intervention that gives students an egg per day versus an intervention that gives students a chewable vitamin per day. We will also assess whether either intervention leads to improved educational performance among students in poor areas of rural China. To meet this goal, we report on the results of a randomized controlled trial (RCT) involving over 2600 fourth grade students from 70 randomly-chosen elementary schools in 5 of the poorest counties in Gansu Province in China's poor Northwest region. The design called for random assignment of schools to one of two intervention groups, or a control group with no intervention. One intervention provided a daily chewable vitamin, including 5 mg of iron. The other mimicked the government policy by providing a daily egg. According to the findings of the paper, in the schools that received the chewable vitamins, hemoglobin (Hb) levels rose by more than 2 g/L (over 0.2 standard deviations). The standardized math test scores of students in these schools also improved significantly. In schools that received eggs, there was no significant effect on Hb levels or math test scores. Overall, these results should encourage China's Ministry of Education (MOE) to look beyond eggs when tackling nutritional problems related to anemia in an education setting.

1. Introduction

Despite increasing investment in rural China and rising incomes, the academic achievement of children in rural areas has persistently lagged behind that of children in cities. This performance gap can be readily observed in high school graduation rates, where rural students are 50% less likely to graduate from an academic or vocational high school than are students living in urban areas (Ministry of Education, 2006; Wang et al., 2011). In college and tertiary education the statistics are even more striking: 50%

* Corresponding author at: Center for Chinese Agricultural Policy, Institute of Geographical Sciences and Natural Resources Research, Chinese Academy of Sciences, No. 11 Jia Datun Road, Anwai, Beijing, China 100101. Tel.: +86 10 64888990.
E-mail address: luorf.ccap@igsnrr.ac.cn (R. Luo).

1043-951X/$ – see front matter © 2012 Elsevier Inc. All rights reserved.
http://dx.doi.org/10.1016/j.chieco.2012.12.005

of students in China's large municipalities will receive some tertiary education compared with only 5% of those in poor rural areas (Liu et al., 2011).

The high rates of return to higher education in China and the fact that access to higher education facilitates access to formal jobs with benefits and other rights mean that the poor performance of rural students is reinforcing inequality trends (Li, Liu, Ma, & Zhang, 2005; Wang, Fleisher, Li, & Shi, 2007). Moreover, it has been shown that there are intra-household externalities of education (Gao, 2009). When poor rural students go to college there are benefits for family members and neighbors who remain in the home communities (L. Zhang, Luo, Liu, & Rozelle, 2006).

Given such benefits, why are rural students forgoing secondary and tertiary education? Three possible explanations readily emerge to explain this reduced enrollment: first, insufficient knowledge about the gains provided by education; second, the high cost of tuition at the secondary and tertiary levels; and third and finally, the inability to test into high school (either at all, or into one that can provide a quality education).

In assessing which of these explanations might have the most explanatory power, there are reasons to doubt the first two (rural families do not appreciate the importance of education and tuition is too high). After more than 20 years of reform and experience in the off farm labor market, the returns to household income and increased economic mobility provided by education is certainly known and appreciated by Chinese families. Indeed while the exact rate of return to educational attainment is not known, most families will tell you it is positive and high (Loyalka, Song, & Yi, 2012). Moreover, while rural incomes have not increased quite as fast as urban incomes, rural incomes have risen steadily over the past 30 years (and especially in the past 10 years) and most families have more disposable income – and access to cash subsidies and government support programs – than ever before (Huang, Wang, Zhi, Huang, & Rozelle, 2011; Park, Cai, & Du, 2007).

In contrast, there is abundant evidence of fundamental differences in educational performance between rural and urban students when examining metrics on performance in school and on standardized tests (Webster & Fisher, 2000; Young, 1998). The differences in scores on mathematics achievement tests indicate that students from rural areas are significantly behind students from urban areas in learning mathematics (Mohandas, 2000). Indeed in one study, the test scores of urban students were greater than one standard deviation above those of rural students when taking a standardized TIMSS test (Lai et al., 2011). As a whole, these results suggest that by the time rural students reach junior high school, they have already fallen behind academically to the point where they often cannot adequately compete with students from urban backgrounds and, in a competitive school system like that in China, are thus ineligible for many academic options.

Therefore, an even more fundamental question is why rural students – especially those from poor rural areas – are scoring so much lower than urban students on standardized tests and doing so poorly in school. There are many possible reasons. School facilities and teachers are systematically better in urban areas (World Bank, 2001). There is greater investment per capita in urban students relative to rural students (MOE and NBS (Ministry of Education and National Bureau of Statistics), 2004; Tsang & Ding, 2005). Parents of urban students also have higher education and more time and opportunities to help their children in their studies (Huang & Du, 2007).

There is one additional factor that may be affecting the educational performance (and scores) of students from poor rural areas: micronutrient deficiencies, and, in particular, iron deficiency anemia. Iron deficiency anemia (or simply anemia in the rest of the paper) is a debilitating health condition that affects hundreds of millions of people worldwide, mostly in developing countries, as the poor are often restricted to starch based diets with little vegetables or meat (Yip, 2001). A large body of research links anemia (as well as iron deficiency) with cognitive impairment and altered brain function; indeed iron deficiency and anemia have been shown to be negatively correlated with educational outcomes, such as grades, attendance and attainment (Bobonis, Miguel, & Puri-Sharma, 2006; Halterman, Kaczorowski, Aligne, Auinger, & Szilagyi, 2001; Stoltzfus, 2001; Stoltzfus et al., 2001).

Our recent work in three separate studies has established this relationship in rural China as well (Luo et al., 2012; Miller et al., 2012; Wong, Shi, Luo, Zhang, & Rozelle, 2012). According to a 2008–09 study in Shaanxi Province, children with anemia lagged behind their healthier peers academically, physically and psychologically (Luo et al., 2012). The study showed that iron supplementation was not only able to improve student nutrition (through increased hemoglobin levels) and health (through reduced anemia), it also improved the test scores of anemic students. Another study in the same province – but in a different set of counties – generated almost identical results in 2009–10; iron supplementation led to falling rates of anemia and higher test scores (Wong et al., 2012). A third study demonstrated similar results in two other provinces, Ningxia and Qinghai (Miller et al., 2012). From these studies, which all used data from the studies' randomized controlled trials and collectively involved more than 20,000 students, it can be concluded that anemia should be considered one of the main factors in China's poor rural areas that is leading to gaps in test scores and may ultimately be limiting opportunities for social and economic mobility.

Despite such clear findings, although academics and policy makers agree on the importance of treating micronutrient deficiencies and recognize the effectiveness of treating with supplementation, the government has been reluctant to adopt a policy of passing out vitamins in schools. After each of the studies (discussed in the paragraph above), the research team, as part of their role as policy advisors to the provincial governments in the provinces in which the studies were carried out, reported the study results to officials in the Department of Education as well as to top provincial leaders in Shaanxi and Ningxia. Public records show that provincial leaders acknowledged the reports and understood them (Zhang, 2009; Zhuan, 2010). However, in both cases (that is, in both Shaanxi and Ningxia), in response to the challenge of trying to improve the nutrition of students, instead of treating the students with iron supplements, eggs were chosen to treat the micronutrient deficiencies in the region. Across Shaanxi literally tens of millions of eggs per month were given out, starting in the fall of 2009 (Zhang, 2009). The same thing happened in the following year in Ningxia (Zhuan, 2010). Starting in the fall of 2010, 3 months after the completion of the supplementation study in Ningxia, students in poor rural Ningxia schools began to receive an egg per day. At the national level, in