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The Human Capital Roots of the Middle Income Trap: The Case of China

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Linxiu Zhang, Hongmei Yi,* Renfu Luo, Changfang Liu

Center for Chinese Agricultural Policy, Institute for Geographical Sciences and Natural Resources Research, Chinese Academy of Sciences

Scott Rozelle

Food Security and the Environment, Freeman Spogli Institue, Stanford University
LICOS, Katholic University of Leuven (adjunct professor)

* Corresponding Author

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Abstract

China, like other middle income countries, is facing the challenges of the next stage of development as its leaders seek to guide the nation into becoming a high income country. At this same point of development, however, other countries have faltered, raising the possibility of stagnation or collapse. The stagnation of growth after reaching a level of income high enough to be call "middle income" is a phenomenon which some observers call the Middle Income Trap. In this paper we explore one of the major challenges that nations, including China, must face in the transition from middle to high income: the management of inequality. In particular, we explore the possible roots of future inequality that is associated with a nation's underinvestment in the human capital of broad segments of its population. To meet this goal we first look at several benchmarks of successful transitions from middle to high income (e.g., the case of South Korea) and not-so-successful transitions (Mexico). We then exam more systematically the characteristics of countries that have successfully transitioned (or *graduated*) from middle to high income (Graduates) and those that are attempting to do so now (Aspirees). With this background, we describe the challenges that China faces in the light of rising wage rates and highly unequal income distribution today. We also document the high levels of human capital inequality in China today, a harbinger of high future inequality. In discussing the sources of the human capital inequality, in addition to the structural and institutional barriers that are discouraging many students (and their parents) from staying in school to achieve the levels of learning that we believe are necessary for preparing individuals for employment in the coming decades, we also identify severe nutritional and health problems. We believe that these nutrition and health problems, unless addressed, are creating serious China's human capital deficiencies in poor areas of rural China and locking in decades of hard-to-address inequality. The paper ends with a call for leaders in China (and countries at the same level of income of China) to launch immediately a war on poor education, health and nutrition as one step in helping such nations avoid the Middle Income Trap in the future.

The Human Capital Roots of the Middle Income Trap: The Case of China

In recent years the world has recognized the existence of a Middle Income Trap (Kharas and Kohli, 2011). The Middle Income Trap occurs when a country's growth slows and eventually plateaus after reaching a middle income level. The problem usually arises when developing economies find themselves stuck in the middle. On the one hand, with rising wages, the nations are less competitive with lesser-developed, low-wage economies in the cheap production of manufactured goods. On the other hand, they are unable to compete with advanced economies in high-skill innovations. A large number of paper recently have addressed how a nation should try to avoid the Middle Income Trap (e.g., Nallari et al., 2011; Yusuf and Nabeshima, 2009; Ohno, 2009).

The issue of whether China is headed towards the Middle Income Trap, and if so, how it can be avoided, has attracted attention in recent years. Perhaps the highest profile statement of this was issued jointly by the World Bank and the China Development Research Center (2012). This document states that the low-hanging fruit of state-driven industrialization is largely exhausted. As China has hit the World Bank's definition of middle income (that is, when GDP is greater than $4000/capita), there is a realization that China is entering a new phase of development. The document explicitly and implicitly warns that there are many new challenges facing China at this point in its development.

In addressing the sources of the Middle Income Trap, discussion inside and outside of China frequently focus on several different sources. Some researchers stress the importance of building domestic markets to replace export markets (Leung, 2010). Others discuss the need to boost the role of science and technology (Nallari et al., 2011). There are also those that stress the importance of infrastructure (Nag, 2011). Certainly all of these are important.

The goal of this paper, however, is not to reexamine these well-trod arguments. Rather, this paper seeks to examine China's development path and the prospects of falling into the Middle Income Trap from an angle that has not been discussed in much depth: the danger of growth without equity and the problems associated with serious underinvestment in rural education, health and nutrition in the nation's poor Western provinces. To meet this overall goal, we will proceed as follows. First, we look at one case of a successful middle-to-high income transition and one case of a not-so-successful one. We then examine more systematically the characteristics of countries that have successfully graduated from middle to high income (Graduates) and those that are attempting to do so now (Aspirees). With this background, we describe the challenges that China faces in the light of rising wage rates and highly unequal income distribution today. We also document the high levels of human capital inequality in China today, a harbinger of high future inequality. In discussing the sources of the human capital inequality, in addition to structural and institutional barriers that are discouraging many students (and their parents) from staying in school to achieve the levels of learning that we believe are necessary for preparing individuals for employment in the coming decades, we also identify severe nutritional and health problems, which we believe (unless addressed) are creating serious China's human capital deficiencies in poor areas of rural China and locking in decades of hard-to-address inequality. The paper ends with a discussion of what China (and other countries at the same level of income of China) should do to help avoid this source of the Middle Income Trap.

Rising Wages, Inequality and the Transition from Middle to High Income

The low wage rate in the 1980s and 1990s is one of the main reasons that China is the world's number one manufacturing base in the world today. In the1980s the unskilled wage rate was less than 50 cents US per hour (Meng and Kidd, 1997; Knight and Song, 2003). During the 1980s and 1990s, even as tens of millions of workers entered the labor market (de Brauw et al., 2002), the wage rate remained low (Yueh, 2004). The wage rate in China during the 1990s and early 2000s can be seen to be especially low when compared to wages in South Korea (during the same years); and Brazil; and Mexico (Blanchflower and Oswald, 1994; Fiszbein and Psacharopoulos, 1995). In the 1990s and 2000s, the unskilled wage in South Korea rose to more than US $10 per hour (Park et al., 2010). It was nearly US $4 dollars in Mexico. With such a low wage (among other things), it is not surprising that labor intensive manufacturing shifted to China in the 1980s and 1990s.

But, China has not always been the world's factory. During the 1970s and 1980s large volumes of low wage manufacturing was being carried out elsewhere in the world. For example, between 1970 and 1990, the value-added of its manufacturing sector grew by more than 20 times in South Korea (World Bank, 1991). Countries like Mexico—especially during the 1970s and the late 1980s—were expanding rapidly (Moreno-Brid et al., 2005). In the early years of the takeoff of manufacturing in those countries—especially in the 1970s—the unskilled wage rate was much lower than it would be in the 1990s and 2000s (Hanson and Harrison, 1999). The unskilled wage in the 1970s in South Korea, for example, was closer to that of China in the 1990s than it was to South Korea in the 1990s. Even Mexico in the 1990s was experiencing a rising wage that made its low wage manufacturing less competitive.

South Korea: A Story of Successful Development and Labor Market Transition

So what happened in South Korea between the 1970s and 2000s that allowed the country to transition from a poor country with wages near the bottom of the world's wage distribution to a country that enjoyed high wage rates and was able to join OECD—as a developed county—in the 1996? While many parts of South Korea's development policy contributed to the nation's rise economically, the management of human capital stands out. In a period of less than two to three decades, as the wage rate rose from less than US $1 dollar per hour to more than US $10 dollars per hour, large segments of the labor force shifted from one involved in low-wage, unskilled manufacturing into one that was skilled-based, high productivity and service-sector oriented. This means that many of the same workers that were staffing assembly lines in the 1970s and 1980s were working in much more high skilled positions in the 1990s and later.

How was South Korea able to make this labor force transition? In no small part it was likely due to the nature of the nation's education system during the early years of development. According to Ryoo (1993), almost everyone in South Korea received a high school level of education—even in the 1970s. Upper secondary school education matriculation rates were above 80 percent. Even those that did not go to formal high school received high school level training at nights and on weekends through their companies (Kwan, 2001). In short, there was almost no gap between levels of upper secondary education for urban and rural residents. Most everyone in the country received high school levels of training and were given training in high school-level skills in math, language and other disciplines. Such skills no doubt are needed by workers in their transition between low-wage, low-skilled jobs of the 1970s and the higher-wage, more-demanding jobs of the 2000s. During the 1990s, research shows that the returns to education in South Korea were high (Ryoo, 1993).

Mexico: Struggling with the Legacy of Under-Education

Not all countries have made the transition from low wage economy to high wage economy as smoothly as South Korea. This is true even though there have been other candidates for development success during the 1970s and 1980s and early 1990s. One such candidate was Mexico. Despite some variability in the economy's growth rates, between the 1970s and the early 1990s Mexico's economy grew (Moreno-Brid et al., 2005). The average growth rate during the late 1980s and early 1990s, in fact, rivaled those of East Asia (Barro, 1991). And, with that growth, Mexico's wage rates rose—in the same way that they did in

South Korea. In the early 1990s, the hourly unskilled wage in Mexico was nearly US $4 per hour (Park et al., 2010).

Rising wages in Mexico, as would be expected, created pressures in the economy to transition from one based on low wage manufacturing to a more high skill-based economy. In the 1990s, many low wage manufacturing left Mexico (Shaiken, 1994). At the same time, investment began in industries that were able to support higher wages—i.e., those industries that demanded high skills of their workers and that could afford to pay higher wages (Shaiken, 1994; Peters, 1996). The hope was that employers would be able to hire the workers who originally had been in the low-wage manufacturing sector, employing them at a higher wage rate. If a country wants to transition successfully from poor to middle income and begin its march to the status of high income country, such a transition is inevitable and necessary.

The transition in Mexico, however, was not as smooth as that in South Korea. There are many reasons for this. One very fundamental difference, however, may be the nature of Mexico's education system. Mexico's education system and its achievements could not be more different from those of South Korea's. While nearly all young workers in South Korea during the 1970s and 1980s were going to high school, there were much larger gaps among segments of the Mexico's population. The rates of educational attainment and matriculation to high school rose during the 1970s and 1980s. The gains, however, mainly came among the better off segments of society in the cities and suburbs (Lachler, 1998). The rates of upper secondary education for the better off urban residents were quite high (between 60 and 80 percent—World Bank, 2004). The share of children going to high school, however, fell off sharply in Mexico's poor urban and rural areas. According to the World Bank (2004), less than half of the school-aged individuals in poor urban and rural areas attended upper secondary school in the 1980s and early 1990s. Many did not attend junior high school.

While there are many reasons for the current political-economic-social problems and slow growth in Mexico today (the rate of growth since the mid-2000s has been only about 1 percent per year—World Bank, 2012), one factor that may be responsible for this slow rate of growth is the poor state of human capital among large segments of its population. After the Peso Crisis of the mid-1990s, millions of workers were laid off (World Bank, 2004). When the firms in Mexico began restructuring, many of these workers were not hired back. Employers almost certainly were unwilling to hire workers for the rising level of wages when they did not have the skills that were needed for the jobs. Mexico's formal unemployment rate rose and stayed high in the mid- and late-1990s (ILO, 2010).

Without prospects of finding a job in the high-wage, formal economy, there were only three options for millions of individuals. First, individuals could migrate legally or illegally to the US. Of course, as migration rose, the US in recent years has taken actions to increase the cost of migration and reduce the flow (Calavita, 1994). Second, those without jobs in the formal economy could search for work in the informal economy. Indeed, according to ILO (2011), more than 20 million Mexicans now are in the informal economy. Unfortunately, the prospect for wage growth and human capital accumulation is poor or nonexistent for those in the informal sector (ILO, 2010). In the longer run, a healthy development path almost certainly would mean that these individuals would have to move into formal sector, one with chances for higher incomes and more stable benefits and other social services. The problem is, however, that most of these individuals are in this sector because they do not have the skills that match employer needs in the formal sector and there are few prospects for adults to gain such skills—especially in developing countries.

The third alternative for individuals is, in part, a consequence of the absence of migration opportunities and the lack of a future in the low-paying, highly unstable informal sector. Many young Mexicans are, in fact, dropping out of the system and choosing to join organized crime. According to Magaloni (2012), millions of individuals are directly or indirectly involved in organized crime in Mexico today. Many—if not most—are young, poor and poorly educated individuals from poor urban and rural settings that have little hope for the future. In short, because they lack the skills that are needed for a high-wage, service-oriented economy, this large segment of the population has been more or less forced to find a way to survive.

Unfortunately, with the rise of organized crime may be force that creates enough pressure on the economy that it may lead to stagnation or a reversal of the development process. There are many counterproductive outcomes associated with large segments of the population being outside the organized system. There are new spending requirements fiscally. Instead of investing in productive infrastructure and income-producing activities, funds must be spent on policing and military. The rise of violence can discourage investment. Given an option individuals in a country beset by violence may decide to move their financial and human capital outside of the country.

Clearly, if growth continues to slow, a vicious cycle may emerge. With little growth, there are fewer jobs. Slow growth also may mean that there are less fiscal resources to invest in schools and other institutions that can improve human capital. With fewer jobs and a population that is beset with low levels of human capital, many individuals—especially those in poor urban and rural environments—may continue to have no option but to join organized crime or, at best, withdraw from the formal economy and subsist in the informal economy. No growth; no jobs; more dropping out; more violence; and less growth. This is clearly one potential path through which low levels of human capital investment in a large segment of its population at a time when an economy is still in its early development phase (e.g., early in the middle-income phase of development) can ultimately lead to stagnation at a point later in time. In other words, this is one of the hypothesized linkages between poor human capital and the Middle Income Trap.

Does Reaching Levels of Middle Income Ensure Success in Development?

The above discussion of South Korea and Mexico (especially) motivates a more fundamental question: Is it inevitable that developing countries that achieve middle income status will always continue to grow and become rich, industrialized nations? The question is important in and of its own right. But, almost equally important, it also motivates a further question: What are the characteristics of nations that have not only successfully reach middle income status but have been successful in continuing on to becoming a high income country.

In fact, as we see with the unfolding case of Mexico, it seems that the answer to the first question is no. Although Mexico's future is uncertain, there is a real possibility that the violence which is at least in part due to the inequality and poor levels of human capital that plague the nation, will slow down the nation's growth—perhaps to the point that the nation's growth will stagnate. In the past 10 years, growth has barely reached 1 percent per year.

Further scrutiny of history can turn up a number of countries that have reached middle income levels and then stagnated or collapsed. Argentina was one of the richest countries in the world in the early part of the 20th century (World Bank, 1991). Shortly after World War II, however, Argentina's growth slowed and collapsed. Today, its GDP per capita placed only 65th in the world (World Bank, 2012).

There are many other countries that have followed the path of Argentina. Uruguay's economy has reached middle income status at least twice in the past 50 years only to stall (World Bank, 2012). Venezuela's growth patterns have been similar. Outside of Latin America, Iraq was once one of the world's fastest growing economies before 1960. Between 1960 and 1990, however, its economy contracted by more than 1 percent per year (Gillis et al., 1996).

Growth With Equity: More than Luxury?

So what allows some countries to successfully transition from middle to high income? Certainly there are many factors that go into the management of an economy as it transition into a high income economy (World Bank, 1999). In the rest of this section we look at one empirical regularity that characterizes nearly every case of successful development (during the shift from middle to high income) in the last half of the 20th century.

Column 1 of Table 1 provides a list of all non-oil producing countries/regions of countries that have successfully graduated from middle income to high income since 1950.[1] In total, somewhat surprisingly, there are, according to our count, only 14 countries that can be considered *Graduates*. The list includes two East Asian countries/regions (South Korea and Taiwan); four Mediterranean countries (Portugal; Spain; Greece and Israel); six Eastern European countries (Croatia; Slovenia; Slovak Republic; Hungary; Czech Republic and Estonia; and two other countries (Ireland and New Zealand).

What is one characteristic that is true of all of the Graduates? Going back as early in their development paths as possible (as close as possible to the times when the 14 Graduates were still middle income countries, if possible), column 2 of Table 1 shows the estimates of the Gini ratios, a measure of consumption/income inequality, of the Graduates. As can be seen from the table, the average Gini ratio is only 33, a level of the Gini that is relative low. The range of the Gini measures is from 26 to 39. Not one of the Gini ratios is more than 40. Such a pattern of income distributions suggests that, on average, the Graduates not only share a common growth path which was successful in being able to transition from middle to high income, the Graduates all did it with fairy low levels of inequality.

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[1] In this list, we include Taiwan, although we recognize its status as a province of China. We do not include those countries in which oil production is the largest/dominant industry. We also exclude the nations that before World War II were high income, but, which after World War II had economies that were still recovering—such as Japan and Germany. We also do not include the city-states of Singapore or Hong Kong.

Such low levels of inequality for the successful Graduates can be seen to be in stark contrast to the countries in the world that are currently middle income—and aspiring to become high income (or *Aspirees*). From a list on the World Bank's websites, we selected 13 non-oil producing countries that are currently at the middle income level of development (Table 1, column 3). The countries are located in Latin America; Asia and Eastern/Central Europe.

Column 4 in Table 1 could not paint a more different picture in the terms of the level of inequality of the Aspirees relative to the Graduates. Whereas there were no Graduates with a Gini ratio over 40, there are no Aspirees with Gini ratios under 40. On average, the Gini ratio of the Aspirees is 46, a full 13 Gini measure points higher than the Graduates. Many of the Aspirees have Gini ratios of 50 and higher, including Brazil, Chile, Costa Rica and Mexico.

China's level of inequality, according to Li and Luo (2011), is among the highest in the world. As of 2007, it was 50 (or 49.7 to be precise). Moreover, between 2003 and 2007 it rose more than any country in the world. Hence, although China has attained middle income status in the past decade, it also is part of a group of Aspirees that trying to transition to high income status at levels of inequality which have not been associated with successful transition—at least in the past 60 years.

China, High Wages and the Nation's Future Challenge

The stories of South Korea and Mexico—as well as the analysis of Graduates and Aspirees—provide a backdrop for interpreting what is happening in China today. It also helps frame a discussion about the challenges the nation's economy is facing.

While low wages and labor intensive manufacturing fueled economic growth in China during the 1980s, 1990s and 2000s, China today is entering a new era. This new era is remarkably like the eras experienced by South Korea and Mexico in the 1970s and 1980s and early 1990s. It is the period of time in which the unskilled wage rate begins to rise and a country begins to lose its comparative advantage in unskilled, low-wage manufacturing.

In China, according to many sources, the era of low wages is over and the wage rate is rising rapidly. According to Cai and Du (2011), after languishing at a low level for two decades, since the early 2000s the unskilled wage rate began to rise. Park et al. (2010) document several other sources for the rise of wages. Li (2012) shows that wages are not only rising, they are quickly surpassing many other countries in Asia. With the exception of Japan, South Korea, Taiwan Province, Hong Kong, Singapore and Malaysia, China now has one of the highest in Asia and certainly one of the fastest growing in the world.

Of course, while this is welcome from the standpoint of rising income per capita (the only way to become a high income country is if most people in the nation, including wage-earners, have high income), there are fundamental challenges. One of the basic questions is if China's labor force is ready for higher wages. In a high wage economy, workers in factories and the service sector get paid ten or more dollars per hour. To be worth that level of wage to an employer, however, workers must have high levels of productivity (or an employer will not be willing to hire him/her). In other high wage economies (such as South Korea), most workers have fairly high levels of math; language, English and ICT skills. It is only when workers have such skills that employers can afford to pay them high wages.

Unfortunately, it is unclear if the workers in the work force in China in the 2020s (when wages will reach those levels—given China continues to grow radidly for the next decade) have those skills. The fundamental question is that if China is successful in continuing to grow and wages continue to rise, will the laborers who today staff the low-wage, unskilled factories be able to be productive (and be hired by an employer) in an environment with high wages where there are high demands on the skills of the employees. Another way to cast the question in light of the discussion above: Is China's work force more like that of South Korea? Or, is it more like that of Mexico?

Human Capital Inequality in China Today

The purpose of this section is to understand if China's work force is ready to accept the challenge of becoming a high-wage, high-skill work force. To do so, we will focus on the level of human capital of workers and students (that is, workers-to-be) in China's poor rural areas. We focus on this part of the labor force because this is not only a large segment of the future labor force, it is a part of the (future) labor force about which the least is known. We know the students of Shanghai score as high as any students in the world on international PISA tests (New York Times, 2010). We know that increasingly larger shares (up to 70 and 80 percent) of students in large Municipalities, such as Beijng, go to college and that college is expanding rapidly (Li, 2012). However, much less is known about the other part of China's education system—the education system in poor, rural, Western provinces, and the students/graduates it produces.

Before examining the nature of the nature of human capital in poor rural areas of China, it is important to understand what is included in the definition of "poor rural economy" and how large of a share of the labor force this is (or will be). In fact, it is not easy to define exactly how much of China's future labor force will come out of poor rural areas. However, there are two fairly easy ways to make assumptions about it. If one uses the poorest 500+ counties (the nationally-designated poor counties), about 20% of each age cohort that are in elementary school today (and who will be China's workers of 20 years from now) come from rural areas of these counties, about 3 million people per year. If a broader definition is taken, for example, rural counties in all Central and Western China, then more than 50% of each age cohort is included, around 8 million people per year. Hence, if one thinks about who will be the main labor force for China in the coming years, this means that over the next two decades (from 60 to 160 million members of the nation’s labor force (about 20% to 50% of the labor force) will come out of relatively poor rural areas.

While not every one in China needs to go to college, as the discussion on South Korea and Mexico above tried to motivate, we believe that everyone should have the skills that are taught in upper secondary school—competency in math, language, English and ICT skills. The bottom line of the reasoning (summarizing the arguments from above) is that in order for most of the labor force to be employable at the high wages that will inevitably be commanded should China continue its transition from middle to high income, individuals will need to have the skills that will make them productive enough to be worth $10 dollars (or more) per hour. If there are large segments that do not have such skills, there may be large shares of the cohort that can only find work in the informal economy. If so, and if, as is common in the rest of the world, expectations of living a better life may be dampened to the point that many individuals may decide to drop out of the system altogether and join organized crime or some other extra-formal organization.

Unfortunately, in the case of poor areas of rural China, the picture of matriculation to high school more resembles Mexico than South Korea. In fact, as argued in Wang et al. (2011a; 2011b), during the past 10 years, less than half of individuals of high school age in poor rural China matriculate to high school. The number is not much higher when including the new vocational education schools (Chu et al., 2012; Liu et al., 2012). In short, only approximately 60 percent of individuals who are in grade 3 of junior high end up matriculating into upper secondary school. If high school is the place in which a student gains command of the skills needed for getting a job in the formal economy after wages rise, China is producing millions of individuals who may not be able to join in the rising prosperity of the nation in the future.

In fact, there are many individuals that are coming out the school system of poor rural areas that have even fewer years of education (and presumably less skills). According to a number of papers by Yi et al. (2011) and Mo et al. (2011), the level of drop outs from junior high is as high as 25 percent in poor rural areas. In part due to high wage rates (among other things), in several different poor rural counties in Western China, student drop out rates are between 5 to 10 percent in each year of junior high school. If this is true of all of poor rural areas, then between 1 to 2 million individuals per year are leaving school before they have even graduated from junior high school. Again, if this is true, it means that are millions of new people every year that are entering the work force today that are barely numerate and literate. They have almost no English skills. They are without ICT skills (Yang et al., 2012). Clearly, students like this likely would have difficulty finding employment in a high-wage economy.

Reasons for Dropping Out

While a complete discussion of this issue is beyond the scope of this paper, there are three factors that have been shown to be responsible for inducing students to drop out immediately after and during junior high school (Mo, 2012; Liu et al., 2011). First, tuition for rural public high schools in China is arguably the highest of any country in the world. According to a study of more than 50 countries, China's tuition is more than four times the rate of the next highest country. Tuition and fees and other expenses can be up to 5 to 10 times per capita income of the poor. Two studies have shown that reducing tuition would increase matriculation to high school (Chen et al., 2011; Liu et al., 2012).

While the high tuition may be responsible for the low rates of matriculation to high school, it can not explain the high rates of drop out from junior high school. Tuition and fees in junior high school are more or less zero (Mo, 2012; Liu et al., 2011). There are expenses, but, in general the levels of such expenses are much lower that those that are needed to go to high school. However, there is still one high (and rising) cost of going to junior high school: the opportunity cost of going to school and staying out of the work force. With the unskilled wage approaching between 2,000 to 3,000 yuan per month, this means that in nominal terms, a worker that puts in 60 hours per week is making more than $2/hour. In PPP terms this is nearing $4 to $5 dollars per hour. Hence, staying in school has become an expensive proposition. Many 13 to 14 year olds can make more in one month as their parents do in one year on the farm (back in the village). Unfortunately, while they may be gaining in the short run, if individuals with poor human capital are segmented out of the formal labor force in the future years, there are high potential long run costs for both individuals and society. In Mo et al. (2012) it is shown that when the parents of students are offered a conditional cash transfer to keep their kids in school, the drop out rate falls sharply.

There is a third reason that individuals drop out of high school. It well known in the international literature that when school systems are competitive, there is a higher degree of drop out (Schultz, 1992). Higher dropouts in competitive school systems is thought to occur because the benefits of staying one extra year are reduced if one is unsure that one will be able to get into higher levels of schooling. It is well known that China's college entrance exam is competitive (CRI, 2012). What is less known is that China's high school entrance exam is every bit as competitive if not more so. In a recent survey of counties in poor areas of Northwest China, it was found that the number of slots available in academic high school is less than 40 percent of the number of students matriculating to junior high school. Obviously, students know that many of them will not be able to attend academic high school.

Sources of China's Human Capital Problem

While liquidity constraints and the lack of being competitive is clearly one of the sets of reasons why children are dropping out of junior high school and not matriculating to upper secondary school, there are good reasons to believe that the roots of the problem begin far before the junior high school years. There is evidence of statistically significant differences in educational performance between rural and urban students when examining standardized test scores (Young 1998; Webster and Fisher 2000). Mohandas (2000) finds that differences in scores on mathematics achievement tests indicate that students from rural areas are significantly behind students from urban areas in learning mathematics. China's government also recognizes that there are still policy challenges to reducing the rural-urban education gap in student achievement (Asia Society 2005). Lai et al. (2011) demonstrates that the TIMMS scores of fourth graders from rural schools are more than one standard deviation below those of fourth graders from urban schools.

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. There are many possible reasons. School facilities and teachers are systematically better in urban areas (World Bank 2001; Wang et al. 2011). There is greater investment per capita in urban students compared to rural students (Tsang and Ding, 2005; Ministry of Education and National Bureau of Statistics [MOE/NBS] 2004). Parents of urban students also have higher educational attainments and more time and opportunities to help their children in their studies (Huang and Du 2007). As we discussed in Rozelle et al. (2011), although all of this is true, in recent years then government has begun to allocate large amount of resources to this problem.

However, investment into teachers and facilities may not be enough. There are additional possible factors that may be affecting the educational performance (and scores) of students from poor rural areas. Specifically, one reason is that the students are not "ready" for public school because of nutrition and health problems that may be hurting the human capital accumulation of children in poor rural areas. If students are not healthy or are malnourished, it could be that no matter how good (or improved) the facilities and teachers are, the students may still not be able to learn.

In the rest of this paper, as a way to illustrate the seriousness of the human capital problem, we examine two possible reasons for poor human capital. In the next section we examine anemia. In the following section we look at intestinal worms. There are many others that could be discussed (e.g., infant malnutrition; myopia; hepatitis; etc.). Space constraints limits the discussions of these.

Anemia

One of the problems that potentially is creating part of the gap in educational performance between rural and urban students is iron deficiency anemia. Iron deficiency anemia is a debilitating health condition that affects hundreds of millions of people worldwide, mostly in developing countries (Yip, 2001). Prolonged iron deficiency impairs hemoglobin production, limiting the amount of oxygen that red blood cells carry to the body and brain. As a consequence, anemia leads to lethargy, fatigue, poor attention and prolonged physical impairment. A large body of research links anemia (as well as iron deficiency not serious enough to impair hemoglobin synthesis) with cognitive impairment and altered brain function (Yip, 2001). Hence, anemia is doubly burdensome because it also has been shown to have serious implications for the educational performance of those with the disease; indeed, iron deficiency and anemia have been shown to be negatively correlated with educational outcomes, such as grades, attendance and attainment. Improvements in language and motor development have been observed among pre-school age children in East Africa following increased levels of iron (Stoltzfus et al. 2001).

Programs to overcome iron deficiency anemia also have been shown to increase pre-school participation in India (Bobonis et al. 2006). Lower standardized math test scores among school-age children and adolescents in the U.S. have been attributed to iron deficiency, even to non-severe iron deficiency (Halterman et al. 2001). School-age children and adolescents deficient in iron register lower scores on various mental performance and educational achievement tests (Nokes et al. 1998 and references therein). Yet, treating the iron deficiency of school-age children and adolescents can improve and may even reverse the diminished cognitive and educational performance iron deficiency causes (Nokes et al. 1998 and references therein). As shown from a study of adults in Indonesia (using the Indonesia Family Life Survey), treatment of iron deficiency at latter stages of the life cycle may also be effective for improving health and human capital; participants were more likely to lose less time due to illness, be more energetic, have better psycho-social health, be working and earn more. Therefore, to the extent that anemia is a problem in China's poor rural areas, it may be one of the factors that is leading to poor educational performance.

In almost all countries of the world the prevalence of anemia falls when incomes rise. Indeed, the World Health Organization's "Global Database on Anemia" and a number of other studies reveal that countries with higher income levels tend to have lower levels of prevalence of iron deficiency anemia (Gwatkin et al. 2007; de Benoist et al. 2008). Incomes across China have risen, even in rural areas. Yet despite growing wealth and the growing commitment of China's government to providing quality education, a number of (local, sometimes dated) studies show that a significant share of children across rural China are so severely iron deficient as to be classified as anemic. For example, a recent study in Shaanxi Province run by the provincial Center for Disease Control found anemia in as many as 40 percent of freshmen in a rural junior high school (Xue et al. 2007). A study in Guizhou found anemia rates to be as high as 50 to 60 percent (Chen et al. 2005). Although these studies are small-scale and non-representative, they still give rise to concerns that anemia may be a serious problem in rural China, at least for a segment of the population. Such a finding would be important since China in the past has been shown to have a highly unequal distribution of income (Khan and Riskin 2001). If a large share of China's rural population is still suffering from a nutritional deficiency, such as anemia, and only a small share of the urban population is (as is clear from Fu et al., 2003), it would suggest that the efforts of the government in recent years to reduce inequality still have not been sufficient and more effort is needed in targeting nutritional deficiencies.

The overall goal of this part of this section of the paper is to understand if poor nutrition—in particular, anemia—is negatively affecting the educational performance of students in poor areas of rural China. To show the prevalence of anemia, we rely on student- and school-level data that were collected on third, fourth and fifth grade elementary school students from 41 nationally designated poor counties in the four provinces, Ningxia, Qinghai, Shaanxi and Sichuan between October 2008 and April 2010. Conducting the study in four western China provinces allows us to identify anemia prevalence across widespread regions of the impoverished rural west. Over 737 million people live in rural regions of China, accounting for 56% of the population. Even if we only consider the rural populations of the poor counties in our four sample provinces, the results in this paper are relevant for the school aged children of between 10 to 15 million people.

The four study provinces are among the poorest in China, based on per capita income (Luo et al., 2011). In Ningxia, the average per capita income is 3,180 RMB (where 7.62 RMB = 1 US Dollar), falling 23% below the mean national income. Qinghai's average per capita income (2,683 RMB) is even lower, 35% below the mean national income. Shaanxi's per capita income is 3,546 RMB, 14% below the mean national income. Lowest among our sample provinces, Sichuan has an average per capita income of 2,644 RMB, or 36% below the mean national income.

In choosing our sample observations, we followed a uniform selection procedure. First, we obtained a list of all poor counties in each of the study regions. In China a poor county is a designation given by the National Statistics Bureau as a way of identifying counties that contain significant concentrations of people that live under the poverty line. There are 592 poor counties in China, making up about one third of the number of counties in which lives 20 percent of the population (PALGO, 2012). There are 109 poor counties in the four study provinces. From these poor counties we took a random sample of 41 counties.

Inside each sample poor county, the survey team obtained a list of all townships and in each township we then obtained a list of all *wanxiao* (rural elementary schools with six full grades, grades 1-6). Sampled schools had over 400 students and at least 50 boarding students. With the implementation of school merger programs in rural China, more and more jiaoxuedian (small branch schools that still offer teaching services to younger first or second grade students in remote villages) are disappearing. Across rural areas, jiaoxuedian students are moving to dormitories of wanxiao. Many townships now have only one or two primary schools. Since boarding schools are becoming the main providers of education services in rural China, we specifically used the criteria of including only wanxiao, and schools with at least a certain number of total students as well as boarding students in this study. The students in the schools that are in our sampling frame account for most of the grade three, four and five students in the study areas. In total, we identified 368 schools that met our criteria and randomly chose 283 schools for inclusion into our study. The location, size, date and other information about the survey are summarized and grouped by province and study year in Table 2.

Data were collected by eight enumerator teams. In each team one person collected data on the school from principals and third, fourth and fifth-grade homeroom teachers, while others collected individual and household socio-economic information from students. Trained nurses from the Xi'an Jiaotong University's School of Medicine measured hemoglobin levels on-site using a Hemocue Hb 201+ system.

Results of the Study of Anemia Prevalence.

Across all of the schools surveyed (combining all 41 counties), we found the overall mean hemoglobin average was 124.6 g/L. Hemoglobin levels were normally distributed across all seven datasets, with a standard deviation of 12.5 (Table 3, row 1, column 3). In our sample, 4303 of the 12,768 students we surveyed had hemoglobin levels lower than 120g/L, resulting in a population anemia prevalence of 33.7% (row 9, column 3). Although we do not show the results here, given the frequency of students with hemoglobin counts between 115g/L and 120g/L is high, if we were to instead use an anemia cutoff of 115g/L, anemia prevalence would be lower but still significantly high at 21%.

There was considerable variation in anemia prevalence (<120g/L) across the sample, ranging from 25.4 percent in Ningxia to 51.1 percent in Qinghai. From a multiple regression of county dummies on anemia levels (results not shown for brevity), the p-value of the test (an F-test of the joint significance of the dummies) indicated that there was a significant county effect ($p < 0.001$) within provinces. In other words, different counties in our sample had significant differences in anemia prevalence.

Beyond the variation observed among provinces and counties, we also observed significant variation among schools. Prevalence of anemia ranged widely across schools, for example more than 90% of 165 students in each of the four sample schools were anemic in Qinghai province while in another four schools in Ningxia province less than 10% of the 203 students were anemic. The differences between the prevalence of anemia in different schools are statistically significant, as evident from a multiple regression analysis with school dummies (results not shown for brevity).

According to the WHO, anemia should be considered a serious problem in populations with a 5% or greater prevalence of anemia. Of the 283 schools we sampled only

4 had anemia levels below 5%. Although there was significant variation across the sample, all 41 counties contained schools with anemia levels above this cutoff.

In summary, then, Even if we only consider the rural populations of the poor counties in our four sample provinces, the results in this paper are relevant for the school aged children of between 10 to 15 million people.

Intestinal Worms

In this part of the paper we focus on another neglected disease (beyond anemia) in China: intestinal roundworms. Intestinal roundworms have a devastating effect on a population, siphoning valuable nutrients away from the host and leading to malnutrition and delayed growth (Stephenson et al., 1980; Stephenson et al., 1989). Heavy roundworm burdens can leave children feeling fatigued and nauseous. Infection with intestinal roundworms has also been associated with poor performance on tests of memory and intelligence (Ezeamama et al., 2005; Jardim-Botelho et al., 2008). These effects have been documented extensively and the WHO has approved a variety of cheap, simple and effective medications to treat such infections (World Health Organization, 2006).

At one time China's government seemed to understand the severe consequences of intestinal roundworms and took action to control them. As recently as the 1960s many development experts applauded China's health care system for its effective delivery of basic health services, including roundworm control, in rural populations (Wagstaff et al., 2009a). Minimally-trained "barefoot doctors" lived in and visited remote villages, offering free treatment of common diseases and educating the population about disease prevention and healthy behaviors. Local health personnel often treated large numbers of children in schools, since schools have a concentration of the targeted population, making care fairly inexpensive (Montresor et al, 2002). Treating intestinal roundworms was among their list of priorities (Li et al., 2010).

In the 1980s, however, public funding for rural health declined precipitously (Wagstaff et al., 2009b). The barefoot doctor system collapsed and rural residents were largely left to fend for themselves. It is only in the past several years that China has once again turned its attention to rural health. In the interim, many diseases that had been nearly eradicated (or at least well-controlled) appear to have re-emerged. Intestinal roundworms—perhaps due to their nearly invisible nature and prevalence that is highest in remote, out-of-the-spotlight rural areas—may be one of these re-emerging conditions. Researchers have found high roundworm prevalence in various regions of the country from Yunnan (Steinmann et al., 2008) to Fujian (Xu et al., 2000) to Hunan (Zhou et al., 2007). However, nearly all of these studies have been small in size, typically limited to a single township or even a single village. The notable exception to this otherwise fragmented look at helminths across China is a large-scale national survey conducted by the Chinese Ministry of Health nearly ten years ago, from 2001 to 2004 (Coordinating Office of the National Survey on the Important Human Parasitic Diseases, 2005). This survey included 356,629 individuals across China, however it failed to rigorously identify the correlates of roundworm infection in rural China, information that could help explain why certain areas have higher roundworm infection rates than others. Without further definition of roundworm correlates, it is impossible to move forward with a solution.

In this part of the paper we aim to supplement the literature by reporting the results of a recent large-scale survey of over 1700 preschool and elementary school children in six randomly selected counties in Sichuan and Guizhou provinces. We will document the roundworm prevalence in the study areas, thus better defining the roundworm problem across a fairly large area of rural China. Our large sample size allows us to conduct regression and decomposition analyses, which we will use to identify the correlates of infection and explain variance in the data.

Data and Survey Methodology

The data used in this part of the report were collected by the authors in April and June of 2010 as part of a wide-scale survey of preschool and elementary school-aged children in Guizhou and Sichuan provinces, in the southwestern region of China. A total of six rural counties—three in each province—were randomly selected based on income level. The average net per capita incomes in the surveyed counties in Guizhou and Sichan are 2750 RMB and 4750 RMB per year (412 USD and 713 USD), respectively, putting the individuals surveyed in the bottom quartile of China's rural income distribution (CNSB, 2010). A total of 1,707 children were surveyed. Preschool-aged children were aged 3-5 years and elementary school-aged children were aged 8-10 years. In the rest of the report we call this the Intestinal Worms Survey.

The sampling strategy was as follows. In each county, we ranked all towns according to net income per capita, then randomly chose four towns: two with income per capita above the median level of income, and two with income per capita below the median-level of income. In each town, the central primary school (there is one per town, which also serves as the local Bureau of Education's administrative representative for all educational affairs in the town) and one additional primary school were chosen to be sample schools. In each school, we classified the 8-10 year old students in grades 3 and 4 (henceforth called *school-aged children*) by their home villages and chose sample students from two of the villages (11 students per village—henceforth called *sample villages*). Next, we obtained a list of all the 3-5 year old children in the two sample villages from the Register of Child Immunization (which is recorded and stored in the town's health center) and randomly chose 11 3-5 year old children from each of the two sample villages (henceforth called *preschool-aged children*). Overall then, in each sample village we randomly sampled 11 preschool-aged children aged 3-5 and 11 school-aged children aged 8-10. In each school, 22 students from two villages (11 students per sample village) were surveyed. A total of 95 villages and 46 schools were included in the survey. Because some parents and students refused to produce fecal samples, some sample villages had fewer than 22 observations with fecal samples. In no case, however, were there fewer than 8 preschool-aged children and 8 elementary school-aged children. On average, there were 9.75 school-aged children per sample village and 9.09 preschool-aged children per sample village.

The survey was composed of three parts: anthropometric measurements; data from a socio-economic survey; and fecal samples. Children were measured for height and weight by nurses from Xi'an Jiaotong University. The socioeconomic survey collected data on each child's age and gender, parental levels of education, health and sanitation behavior and other household characteristics. The survey also asked whether the child had taken anti-helminth medication in the past 18 months. The school-aged children completed the survey themselves under the direct supervision of trained enumerators from the Chinese Academy of Sciences. The preschool-aged children did not fill out the survey themselves; instead, their parents were interviewed by enumerators. All children in the final sample submitted a fecal sample, which was sent to the lab at the local Center for Disease Control (CDC) for testing using the Kato-Katz smear method for *Ascaris lumbricoides* (ascariasis), *Ancylostoma duodenale* (hookworm), and *Trichuris trichuria* (whipworm).

A total of 817 preschool-aged children and 890 school-aged children were tested for ascariasis, hookworm and whipworm. A total of 1707 children were surveyed. The survey of preschool-aged children took place in their homes, while the survey of school-aged children took place in their schools. The data can thus be divided into two groups: home, or *village*-based data, and *school*-based data.

Results: Intestinal roundworm prevalence in China

Roundworm infection occurs by ingesting worm eggs, usually through fecal contamination. In the case of hookworms, infection occurs not via egg ingestion, but by contact with soil infected with the filariform larvae, which penetrate the skin, usually when someone steps on them. The eggs hatch and grow within the body, eventually becoming full-grown roundworms. Adult roundworms cannot reproduce within the body; instead, their eggs are expelled in the feces of the host, where they can easily be re-ingested by another (or even the same) host.

There are two main measures of roundworm infection within a population: prevalence and intensity. Roundworm prevalence refers to the percentage of the population with any sign of roundworm infection. It is the measure upon which the WHO community treatment guidelines are based (World Health Organization, 2006). According to these guidelines, any population with over 50 percent prevalence should be mass-treated twice annually with albendazole or mebendazole. Likewise, any population with between 20 and 50 percent prevalence should be mass-treated once annually. Populations with prevalence below 20 percent should be treated on a case-by-case basis.

Infections in Guizhou and Sichuan. Our data indicate high rates of infection in the survey areas, with wide variation according to age, location and type of roundworm. Overall, 21.2 percent of preschool-aged children and 22.9 percent of school-aged children were infected with one or more of the three types of roundworms tested for in the survey (Table 4). These infection rates are high enough to qualify for mass treatment, according to the WHO guidelines. The average rates are driven by high rates of infection in Guizhou province, where 33.9 percent of preschool-aged children and 40.1 percent of school-aged children tested positive for infection with one or more types of intestinal roundworm. Prevalence among preschool-aged and school-aged children was lower in Sichuan province, at only 9.7 percent and 6.6 percent, respectively.

A closer look at Ascaris, hookworm, and whipworm infection rates by age group reveals a pattern. In Guizhou fewer preschool-aged children are infected than school-aged children, suggesting that prevalence increases as children age. In Sichuan the opposite is true: fewer school-aged children are infected than preschool-aged children. The reasons behind these opposing trends are unclear. One possibility is that schools in Sichuan have a better health education curriculum. This would explain why the infection rate drops as children age into school and would also explain the lower overall rates in Sichuan versus Guizhou. Alternatively, it may be the case that in Guizhou, schools have higher rates of transmission relative to students' home environments, leading to the spike in infection rates among school-aged children there.

It is important to note that even though prevalence is comparatively low in Sichuan on average, there is significant variation across both villages and schools (Figure 1). Seven of the 48 sample villages and two of the 23 sample schools have prevalence of 20 percent or higher. About half of both sample schools and sample villages show some evidence of roundworm infection.

Infection rates in Guizhou also vary by village and school, but high rates of infection were found in all sample villages and schools. Nearly a quarter of sample villages and a third of sample schools have infection rates of over 50 percent. This further confirms our initial findings that intestinal roundworms are endemic in Guizhou and are still a major public health concern deserving attention from the CDC.

In addition to considering prevalence, it is also important to look at the roundworm burden in the sample, which gives an approximate indicator of the number of roundworms per child. The results of the worm burden (egg) testing are shown in Figure 2. The WHO classifications for the intensity of infection vary by type of roundworm; the cutoffs are listed below the figures. The highest infection intensity rates appear among preschool-aged children with ascariasis in both Guizhou and Sichuan, at 23,568 and 17,064 epg, respectively. These worm burdens put preschool-aged children firmly in the WHO classification of “moderate infection intensity.” By the time these children reach school age, however, burdens drop in both provinces. In Guizhou the infection intensity remains high enough to remain “moderate”, while in Sichuan the infection intensity drops to “low.” The intensity of infection in both provinces for both age groups is lowest for whipworm, with all groups classified as “low infection intensity” according to WHO guidelines. Infection intensity is also low for hookworm, with only school-aged children in Sichuan suffering from worm burdens high enough to classify as “moderate infection intensity.”

Conclusions

This report began with a review of the China’s modernization successes and challenges. Our premise was that to become a modern nation with an innovation-based economy China’s industrial/service sector would have to experience rapidly rising wages and would need to restructure its economy into one that can afford to pay high wages and be competitive internationally. We conjectured that one of the key constraints to this transformation might be the low level of human capital of its labor force (especially the labor force coming out of poor rural areas). It is possible that growth could wane and instability rise if expectations are not met—because sizeable parts of the population (who are currently not endowed with or not being endowed with sufficient levels of human capital) are not able to find employment in an economy that is high wage and demand highly productive worker.

The rest of the report then examined the nature of human capital from poor rural areas and what can be done to improve it. Specifically, we examined the current symptoms of the failure of rural education. The report focused mostly on the low levels of matriculation into college and high school. It was shown that there are few barriers for rural students once they enter high school. When poor rural students are in high school, they are as competitive as urban students.

So what is the barrier to education? There are likely two major sources. One is the China may be a victim of its own success. With rising wages, the opportunity cost of going to high school (and staying in junior high school) is high and rising. This is especially true considering the high cost of high school in China and the competitive nature of China's system of education.

Although we believe (and show in other work) that high tuition in high school is one of the barriers to educational achievement in poor rural areas, the paper argues that the key source of the noncompetitiveness lay in the years before secondary school. It is true that the government has been investing heavily in facilities and teacher training/salaries in recent years. However, we try to show that more is needed. In particular, one of the very real problem of students in poor rural areas is that they are unhealthy and lack nutrition. Thus, even if the state provides better facilities and teachers, if students are sick or malnourished, they will not be able to take advantage of the new investments. In the paper we demonstrate that anemia and intestinal worms (as well as other diseases) are common. Indeed, it is not too strong of a statement to say that there is an epidemic of diseases that are keeping poor rural students down. These diseases were shown to have truly profound negative effects on education performance.

In conclusion, if the Middle Income Trap is truly related in inequality in an economy, our paper suggests China needs to be on guard. China has high and rising levels of income inequality. China's high levels of human capital inequality today raise grave concerns that there will be high income inequality in the coming decades. To be clear, we are not saying that there is an absolute causal link between inequality and stagnation in growth when a country reaches middle income. However, we are saying that if in the very near future China does not address income inequality and—even more so—human capital inequality, China will have to try to accomplish what no successful Graduate has ever done since World War II: make the transition from middle to high income with high levels of inequality.

Because of this danger (though not inevitability), we believe one of the most key sets of actions that can be taken is to take action now. Indeed, as we argue more fully in Rozelle et al., 2011, we believe that China has exactly enough time starting now. There is a crisis. The crisis is so large that it may threaten the future of China's growth and stability. But, if China starts now, there is time to remedy the problem. But, the response should not be tentative or piecemeal. Indeed, China's leaders need to declare an all out war on poor human capital. The nation needs to take draconian steps to improve health, nutrition and rural education. If so, we believe that China will raise the probability of a smooth transition to the high income country. Most individuals in the labor force in 2030 (especially the young and middle aged individuals) would then have the skills which employers demand in order to pay the high wages that are needed in a high income country that can grow sustainably over decades.

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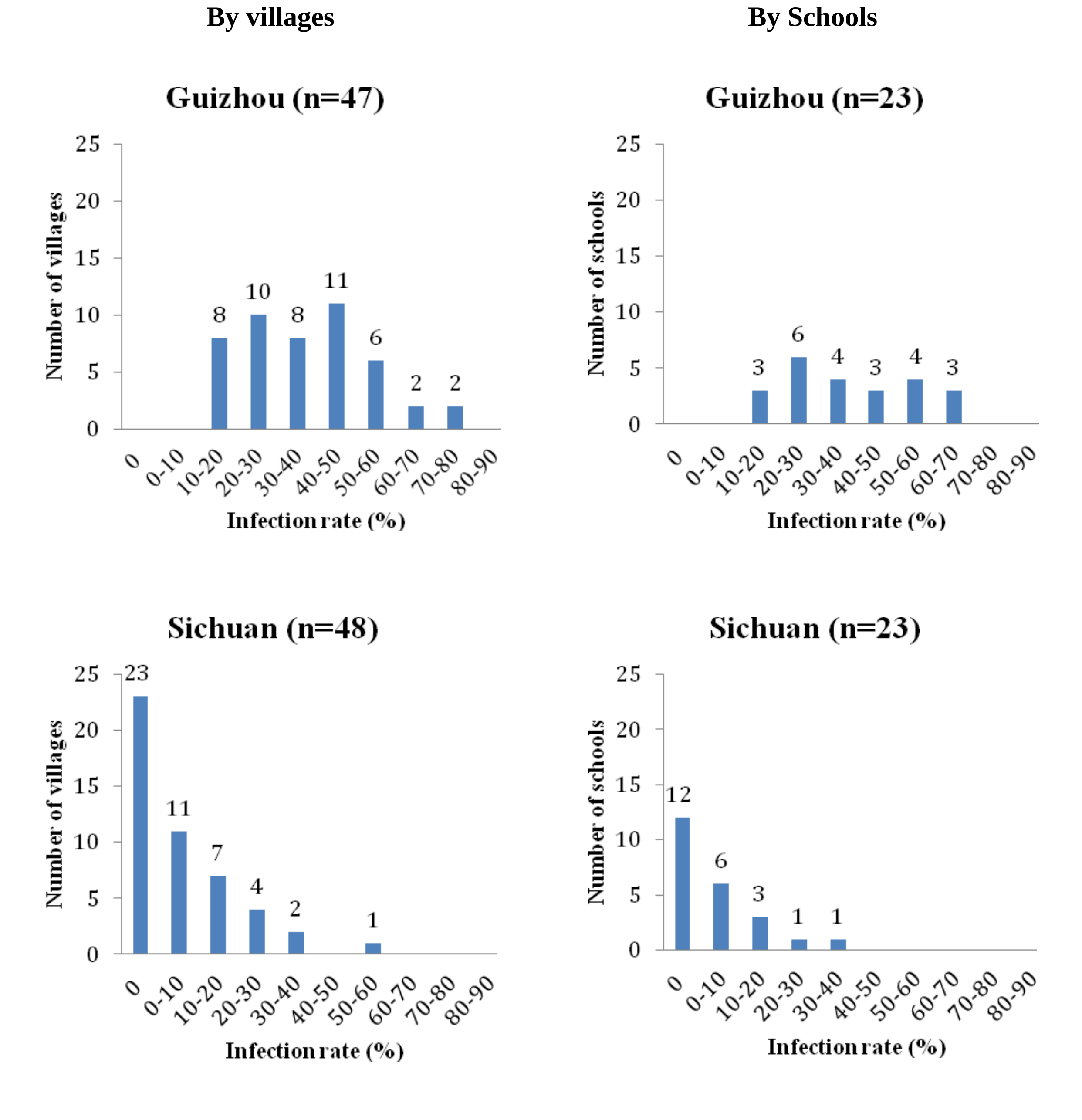
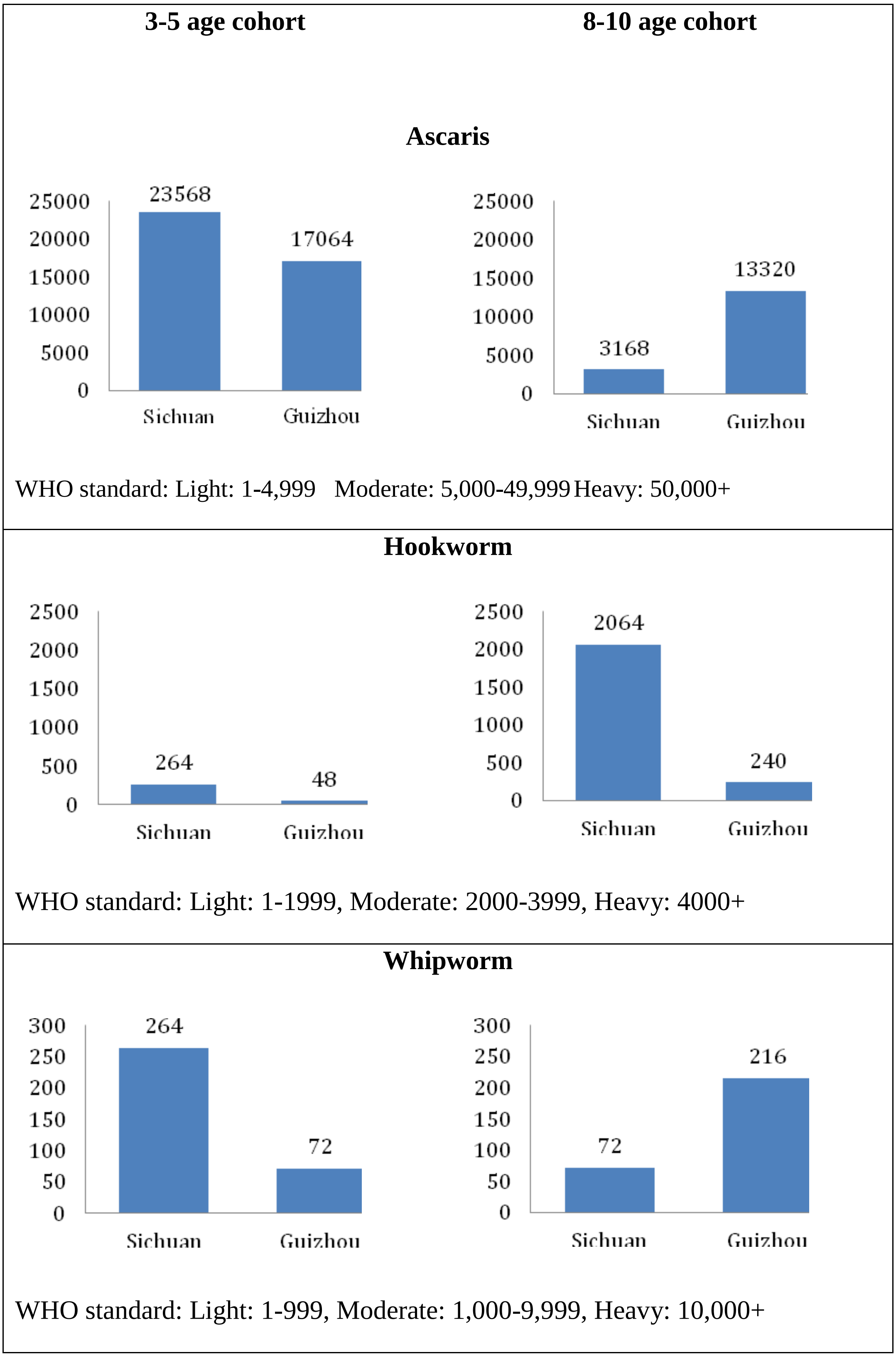
Figure 1. Villages and schools by prevalence of infection with Ascaris, hookworm, whipworm, or any combination thereof in Guizhou and Sichuan, 2010



Data Source: Authors' survey as described in Wang et al., 2012.

Figure 2. Eggs per gram in stool sample, by Ascaris, hookworm and whipworm for two age cohorts in Sichuan and Guizhou, 2010.



Data Source: Authors' survey as described in Wang et al., 2012.

Table 1. Gini Ratios of Countries/Regions that Have Moved from Middle Income to High Income After WWII (Graduates) and of Countries/Regions that Aspire to Move from Middle Income to High Income (Aspirees).

Graduates (those countries that have transitioned from middle income to high income since 1950) [a]		Aspirees (those countries that are currently at levels of middle income and aspire to become high income nations) [a]	
South Korea	32	Argentina	46
Taiwan	32	Brazil	52
Portugal	38	Chile	52
Spain	35	China	50
Greece	34	Costa Rice	50
Israel	39	Malaysia	46
Croatia	34	Mexico	52
Slovenia	31	Russia	42
Slovakia	26	Thailand	42
Hungary	31	Tunisia	41
Czech	26	Turkey	43
Estonia	36	Uruguay	42
Ireland	34	Venezuela	44
New Zealand	36		
Average	33	Average	46

[a] Does not include oil-producing countries.

Table 2. Description of sample populations of Data Sets that are used in the Anemia Studies

	Sample province	Number of sampled counties	Per capita income of sample area (PPP-adjusted, in USD) [a]	Number of sampled schools	Number of sampled students	Survey date
Dataset 1	Shaanxi	9	683.48	70	4151	October 2008
Dataset 2	Shaanxi	8	660.20	24	1476	June 2009
Dataset 3	Shaanxi	10	769.14	66	2066	October 2009
Dataset 4	Qinghai	5	813.91	37	1474	October 2009
Dataset 5	Ningxia	5	794.21	37	2658	October 2009
Dataset 6	Sichuan	3	1085.81	21	516	April 2010
Dataset 7	Shaanxi	1	579.02	28	427	April 2010
Total/ Avg	---	41	769.44	283	12768	---

Data sources: Authors' surveys.

[a] All values are reported in US dollars in real PPP terms by dividing all figures that were initially reported in yuan (Chinese currency) by the official exchange rate (7.62 yuan : 1 dollar in 2007) and multiplying by the purchasing power parity multiplier (1 : 2.27543).[32,33]

Table 3. Hemoglobin counts and anemia (Hb < 120g/L) prevalence of sample students

	Below 12 years old	Above 12 years old	Total
Hemoglobin (g/L)			
Total[a]	124.5 (12.3)	125.4 (14.3)	124.6 (12.5)
Shaanxi—2008 (Dataset 1)	122.8	124.6	122.9
Shaanxi—2009a (Dataset 2)	124.7	125.1	124.8
Shaanxi—2009b (Dataset 3)	126.7	131.0	126.9
Qinghai—2009 (Dataset 4)	119.2	118.0	118.9
Ningxia—2009 (Dataset 5)	128.2	131.7	128.7
Sichuan—2010 (Dataset 6)	126.1	N.A.	126.1
Shaanxi—2010 (Dataset 7)	125.2	124.6	125.2
Anemia (%)			
Total	33.8	33.2	33.7
Shaanxi—2008 (Dataset 1)	37.7	33.0	37.5
Shaanxi—2009a (Dataset 2)	31.6	31.3	31.6
Shaanxi—2009b (Dataset 3)	26.8	15.5	26.2
Qinghai—2009 (Dataset 4)	50.3	53.1	51.1
Ningxia—2009 (Dataset 5)	26.3	19.8	25.4
Sichuan—2010 (Dataset 6)	24.8	N.A.	24.8
Shaanxi—2010 (Dataset 7)	33.2	32.1	33.1

Data source: Authors' surveys. See Table 2 for more information about the data sets.

[a] Numbers in parentheses indicate the standard deviation of hemoglobin count distribution.

Table 4. Infection rates of Ascaris, hookworm, and whipworm for two age cohorts in Guizhou and Sichuan, 2010

	3-5 years old			8-10 years old		
	Total	Guizhou	Sichuan	**Total**	Guizhou	Sichuan
Sample size	**817**	386	431	**890**	437	453
Infection with any of the three types of roundworms (%)	**21.2**	33.9	9.7	**22.9**	40.1	6.6
Ascaris (%)	**16.5**	29.5	4.9	**17.2**	32.7	2.4
Hookworm (%)	**2.9**	1.6	4.2	**4.6**	6.5	2.9
Whipworm (%)	**4.8**	6.7	3.0	**8.1**	14.3	2.2
Sample size	**235**	149	86	**259**	168	91

Source: Authors' data (Data Set 9).