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Control of Infectious Disease: Challenges to China's Public Health System

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Abstract

The 2003 SARS breakout in China forcefully demonstrated the global importance of controlling for infectious diseases. This paper reviews major problems in China's public health system and in its ability to deal with a biomedical threat such as an influenza pandemic. We first examine the H5N1 avian influenza outbreak during the 2005 season and the government's strategy to control the disease. The relatively mild strength of the 2005 avian influenza breakout provided an opportunity for the Chinese government to test its capability of controlling an influenza pandemic. We then describe the current disease surveillance system that has been significantly enhanced after the SARS breakout. We further analyze two problems in China's disease control system: the split in the structure between financing and administration, and health care among rural floating labor. Finally, we illustrate challenges to control infectious diseases in rural China and conclude that the primary challenges facing the government are (1) to ensure adequate funding to improve disease control at the front lines in rural areas, especially in underdeveloped regions, and (2) to improve administrative efficiency in government agencies.

Key words: Avian influenza, infectious disease, China, floating rural labors

JEL code: I18

1. SARS outbreak and global control for infectious diseases

In Spring 2003, Severe Acute Respiratory Syndrome (SARS) shocked China with its sudden appearance, rapid transmission, and lethality. Beijing was hit the hardest. According to reports published at the People's Net,[1] during the 110 days between March 6, when the first SARS case was officially reported, and June 24, when the World Health Organization (WHO) removed Beijing from the list of infected regions, government officials, health-care workers, and indeed everyone in Beijing was caught up in the epidemic and the response it provoked. All elementary and middle schools were closed; college courses were suspended; more than 30,000 people were quarantined[2]; restaurants, bars, and theaters were closed; and the weeklong labor-day holiday was canceled. Nationwide, 5327 people were infected and 348 people died by June 26, 2003.[3] The resulting economic loss has been estimated to be about 5 billion RMB ($610 million) for Beijing[4] and 22 billion RMB ($2.7 billion) for the entire People's Republic of China.[5]

It did not take long for the SARS virus to cross national borders. A medical doctor from Guangdong, where SARS first appeared, brought the virus to Hong Kong on February 21, 2003. Within 4 months, 4000 cases and 550 deaths of SARS outside China and Taiwan could be traced to this man. By the end of June of that year, SARS had infected 8456 people in 30 counties, and had caused 809 deaths.[3] The SARS epidemic forcefully reminded the world that infectious diseases can pose a threat at any time, and that modern medicine has limited power to prevent their spread. Furthermore, the ubiquity of international trade and air travel has accelerated the speed with which infections disperse across the world. The control of infectious diseases is truly an international problem. The SARS epidemic also confirmed claims made by public-health authorities that the best strategy to overcome infectious-disease outbreaks is to control them at the origin as rapidly as possible. Local control strategies save both money and lives. Just as the risks extend across national borders, so do the benefits of rapid control.

Recognizing the importance of global control for infectious diseases, many countries are seeking greater cooperation in such endeavors. The Centers for Disease Control (CDC) in the United States stated, in its 2002 global infectious-disease strategy, "Because U.S. and international health are inextricably linked, fulfilling CDC's domestic mission — to protect the health of the U.S. population — requires global awareness and strategic thinking."[6] This global strategy on infectious disease control has been reflected by increasing international collaborations, including support of U.S. health agencies for China's infectious disease control efforts. In 2002, the National Institute of Allergy and Infectious Diseases (NIAID) awarded a Comprehensive International Program for Research on AIDS (CIPRA) grant to China's Center for Disease Control and Prevention. In May 2003, Secretary Tommy G. Thompson of the U.S. Department of Health and Human Services (HHS) announced an agreement with Chinese Vice Premier and Health Minister Wu Yi to increase collaboration with China toward improved detection and management of infectious diseases.[7]

The SARS epidemic exposed fundamental weaknesses in China's long-neglected public-health system. The incidence of infectious diseases in China has been rising since 1990 (Figure 1), a time when the country's gross domestic product (GDP) has grown at an 8% annual rate. Diseases previously thought to have been contained have reemerged as significant threats. Schistosomiasis, a parasitic disease that was thought to have been eliminated during 1970s, reemerged, spreading from 391 counties in 1995 to 434 counties by 2004.[8] Since the SARS outbreak, the government has committed more funds to public health. The national disease surveillance system has been upgraded with advanced technology and a center for disease control and prevention was established. Although the SARS epidemic has substantially improved the capability of China's disease control system and fundamentally changed the attitude of government officials in handling a disease outbreak, it is uncertain whether the current system is sufficient to deal with other biomedical threats such as an influenza pandemic.

[Insert Figure 1 here]

In the last century, influenza A virus with a novel hemagglutinin (HA) or NA subtype introduced four pandemics in human population: the 1918 flu (H1N1), the 1957 flu (H2N2), the 1968 flu (H3N2), and the 1977 flu (H1N1). These pandemic strains were either partially or entirely derived from the viruses of avian origin[9-11] and the last three all originated from southern China. Since 2003, China and some Asian countries have experienced outbreaks of avian flu with H5N1, H5N2, and H7N7 viruses, and the highly pathogenic H5N1 influenza virus has subsequently spread to humans. According to the WHO's report on April 27, 2006, 205 people were infected with avian flu and 113 of those were fatal.[12] Another influenza virus, H9N2, also has the potential to infect humans.[13-15] Interspecies transmission can occur when the virus spreads from aquatic birds to terrestrial birds or to mammals. Recent genetic analyses of the H9N2 influenza viruses isolated from domestic ducks in southern China during 2000 and 2001 provided evidence that the N9N2 influenza virus lineages established in chicken and quail have been transmitted back to domestic ducks, leading to multiple reassortants with new aquatic gene segments. [16] As shown in Figure 2 by Li and colleagues,[17] this may be a mechanism by which the next pandemic virus will emerge.

[Insert Figure 2 here]

2. The 2005 H5N1 avian influenza outbreak in China

To understand the geographic distribution of disease outbreak, it is useful to review China's administrative structure. The mainland China consists of 31 administrative divisions. These divisions include four municipalities directly under the central government, five minority autonomous regions, and 22 provinces. Each of the four municipalities — Beijing, Shanghai, Tianjin, and Chongqing — administers multiple suburban counties. The five minority autonomous regions are Guangxi, Inner Mongolia, Ningxia, Tibet, and Xinjiang. Because the 31 administrative divisions have similar structures and responsibilities for health care, we refer to all of them as *provinces* in this paper.

According to the press release by Mr. Jia Youling, Director of the Veterinary Bureau of the Ministry of Agriculture, China had 30 H5N1 avian influenza outbreaks across 11 provinces in 2005[18]. Of those outbreaks, 158,200 chicken or other domestic birds were infected and 151,200 died; 22,225,800 birds were culled. In fact, 26 of the 30 disease outbreaks occurred between October and December when the influenza season started [18]. The latest H5N1 avian influenza outbreak was reported at Quanyang, Shanxi province where about 15,000 chickens died in a poultry farm within two days. An area covering 3 kilometers of the chicken farm was quarantined and 187,745 chickens were culled [19]. The quarantine was lifted after 21 days from culling the last chicken in the infected area when there was no new disease on animals or humans detected [20]. By April 28 of 2006, China confirmed by laboratory testing that 18 people were infected by H5N1 and 12 of those resulted in fatalities. Although the H5N1 outbreak in chickens had spread to Xinjiang, Tibet, Qinghai, and Inner Mongolia, all human infections occurred in the south and east provinces where population density is high. The Chinese Center for Disease Control and Prevention published a geographic distribution of H5N1 avian influenza outbreaks and confirmed cases of human infections (Figure 3).

[Insert Figure 3 here]

The Chinese government has learned from the experience of controlling avian influenza through 2005. During this period, the Ministries of Agriculture, Health, Finance, and the State Council have implemented a series of policies to control avian influenza.[21] These policies addressed three major issues. The first set of policies addressed containment and immediate management of an outbreak of avian influenza. Included were an emergency plan to control the outbreak and protocol for culling birds and performing laboratory tests.[22-24] The second set of policies and regulations addressed compensation and assistance for the poultry industry.[25, 26] The most recent policy was issued by State Council and published on February 27, 2006.[27] This is a comprehensive plan to deal with a disease outbreak in animals. This plan emphasizes collaboration

among different government agencies and incorporates lessons from the avian influenza outbreak of 2005. China also employs prevention as a primary strategy to fight avian influenza. In 2005, China vaccinated 6.85 billion chickens and other birds, reaching about 80% of domestic birds [18]. Most importantly, the H5N1 avian influenza outbreak of 2005 revealed two main problems. First, a national surveillance system must effectively cover all of the provinces because the disease can reach as far as Xinjiang and Tibet, the two remote provinces. Second, timely reporting of disease outbreaks in underdeveloped rural areas is a difficult but important challenge because rural laborers can transmit diseases quickly to other regions. The first issue requires technical improvement in remote and underdeveloped regions and the second issue requires managerial improvement in rural and underdeveloped regions.

3. The surveillance system for influenza

China's national influenza surveillance center was established in 1957. In 1981, China joined the WHO Global Influenza Surveillance Network. In collaboration with WHO, China's Ministry of Health initiated a five-year influenza surveillance project in 2000 that established a network to collect data on influenza and to isolate viruses in 23 provinces. After the SARS outbreak, China enhanced its disease surveillance system. A new national disease surveillance data processing center was built and started operation on January 1, 2004. According to the Chinese Center for Disease Control and Prevention (China CDC)'s website, updated on June 30 of 2005, 93% of county- or higher-level hospitals and 43% of township hospitals across the country have directly reported disease information through the internet to the national surveillance database.[28] On average, about 5000 clients report disease information through the network. More than 4.1 million infectious disease cases were reported directly through the internet in a year; one infectious disease report is received every 3 minutes. On April 26 of 2004, hospitals started reporting cause of death directly through the network. In 2005, the system started collecting data on tuberculosis and HIV.

The Ministry of Health has developed plans to deal with influenza. The latest version of the influenza/human-avian influenza surveillance plan was published in 2005 for comment.[29] The plan establishes an influenza/human-avian influenza surveillance network and specifies case report protocol and virus isolation procedures. The surveillance network consists of 185 hospitals in 31 provinces as national disease surveillance points. In addition to those 185 hospitals, 155 hospitals have been selected by province as province-level surveillance points. Those hospitals are in charge of collecting influenza specimens. The plan includes detailed specifications about how to collect and transport influenza specimens and how to isolate and report influenza viruses. The influenza surveillance year runs from April 1 through March 31 of next year. The 31 provinces are divided into 16 northern provinces and 15 southern provinces. All of the 15 southern provinces and 3 northern provinces (Tianjin, Liaoning, and Gansu) have influenza surveillance around the year and the other 13 northern provinces have influenza surveillance from October 1 through March 31 during each surveillance year.

The plan also specifies procedures for monitoring influenza outbreaks. An influenza outbreak is defined as 30 or more influenza cases (or 10% of the local population) occurring within a limited area such as a school or a village within a week. According to the plan, an influenza outbreak should be immediately reported to the nearest disease control center or division. After receiving a report of an influenza outbreak, the disease control center should investigate the disease, and collect and transport specimens for laboratory testing. The local influenza surveillance laboratory should report test results within 24 hours after finishing testing to the national influenza/human-avian influenza test result table. The plan suggests how to quarantine patients and control disease spread, including closing schools, business, etc.

The plan includes a specific section for human-avian influenza. Because so little is known about human-avian influenza, the plan only serves as a guideline for each province. Surveillance for human-avian influenza should be immediately initiated if any of three situations occurs: (1) emergence of highly

transmitted avian influenza, (2) emergence of suspected human infection with avian influenza, and (3) emergence of highly contagious avian influenza or human infection in nearby regions. For an avian influenza outbreak, a radius of 3 kilometers from where the disease is identified is defined as an infected region. For human infected cases, if two or more infected humans are under investigation, any areas where the patients have stayed during the 10 days preceding the onset of symptoms should be investigated and monitored for possible disease spread.

It appears that China's data collection and processing capability for disease surveillance has dramatically improved since the SARS outbreak. The influenza and human-avian influenza surveillance plan also provides a specific protocol to deal with an influenza outbreak. A critical question is whether the procedures specified in the plan can be effectively implemented in all areas, which requires substantial resources as well as trained health workers. There are two fundamental challenges to China's disease control plan: securing adequate financing and addressing the spread of disease by migrant laborers.

4. Financing structure of the disease control system

An important issue in management of controlling infectious diseases is the mode of financing. Services for preventing and controlling infectious diseases are managed by the central government under either the Ministry of Health or the Ministry of Agriculture. Financing those services, however, is the responsibility of local governments. Because of the wide variation in economic development across provinces, resources allocated to disease control teams vary across provinces. Hence, the ability to control infectious diseases also varies across provinces.

4.1 Administrative structure of the disease-control system

Figure 4 shows the organizational structure of China's human disease control system. The Bureau of Disease Control at the Ministry of Health is the highest level government agency devoted to control of infectious diseases. This agency has four main tasks. First, it writes regulations and develops strategies for

disease prevention and control. Although most of the target diseases are infectious, it also has responsibility for the prevention and control of regional and occupational diseases. Second, it develops plans and policies to improve the living environment, such as drinking water and sanitation systems in rural areas. The third main function of this office is to monitor outbreaks of infectious diseases and to coordinate emergency action in the event of a sudden outbreak of an infectious disease. The final primary function of this office is to direct local agencies in disease control.

[Insert Figure 4 here]

To mirror the administrative structure at the Ministry of Health, each province has a department of disease control in a bureau of health. Those provincial agencies further direct disease control tasks at their associate agencies in a county and a city government. For cities, there are community clinics within each city district. Similarly, there are clinics in rural villages. Some of the disease control tasks such as immunization are carried out by people in those clinics. Usually, people who work in community or village clinics are not under the government budget. They provide disease control and prevention services through a contract with disease control agencies in a city or a county.

4.2 Financing structure of the disease control system

As described above, control of infectious diseases is managed by the Bureau of Disease Control from the Ministry of Health through its vertical managerial hierarchy down to communities and villages. The financing structure for disease control, in contrast, is organized horizontally. Local agencies are funded by local governments, not the Ministry of Health. Thus the disease control teams working in the field — health workers at disease control stations/divisions--depend on adequate funding from county or city governments. This public financing structure can be traced back to the reform of government finance in 1980.[30] To give incentives to local governments for economic development, the central government initiated a fiscal decentralization policy. After sending a fixed payment to the next level of government,

local governments can keep all the remaining revenue. However, local governments were also responsible for providing public goods and services. This method of public financing significantly limits the ability to transfer funds between counties, cities, and provinces. Although the tax reform of 1994 changed the method of tax collection at each level of government from a fixed amount to a fixed percentage of gross revenue, the horizontal financing structure remained the same. The fiscal decentralization has exacerbated inequalities in public spending because of the imbalance between revenues and responsibilities of local governments.[31]

Financing disparities across regions under such a fiscal policy appear in two ways. First, fiscal capacity varies greatly across the 31 provinces. Foreign investment has spurred China's economic growth since 1980, and both government policies and geographic advantages have made the coastal regions the most attractive sites for foreign investment, so economic growth has not been shared equally among the 31 provinces. Per capita GDP for China as a whole was $1,107 in 2003 but, as Figure 5 demonstrates, varied greatly by province. Shanghai led the nation, with a per capita GDP of $4,455 in 2003. In Guizhou, the poorest province, per capita GDP was only $427, less than one-tenth of that in Shanghai. With such dramatic variation in economic activity, funding for disease-control teams also differed significantly across provinces.

[Insert Figure 5 here]

Fiscal capacity also varies greatly between rural and urban areas. Within a region, much more funding is available in urban areas. Rural counties lack large-scale industrial production and commercial trading, which are sources of substantial tax revenues. Furthermore, collecting tax from agricultural sources is more costly than from industrial entities. A recent study found that local governments in regions where agriculture was the major economic activity spent most of their funds on government operations, leaving little for public investment.[32] The lack of funds for other government activities is reflected in differences

between supply of healthcare services in rural and urban areas. By one important measure, availability of hospital beds and physicians, urban areas have much larger supplies (Table 1).

[Insert Table 1 here]

4.3 Consequence of financing disparities in disease control

When the Ministry of Health has little control of funding for disease control in the field, implementation of any new initiatives is limited by local budgets. Under such a financing structure, it is difficult for the central government to enforce disease-control programs across the nation, especially in rural areas of under-developed provinces. Before the SARS outbreak, public health was a low priority for local governments. A recent study showed that the number of public employees per 10,000 RMB of local revenue was 1.83 in coastal regions and 3.54 in inland regions.[32] As a result of fiscal decentralization, most local governments could only fund personnel costs (i.e., wages and salaries) of disease control stations. The other costs of services (e.g., printed materials needed for education for disease prevention, presentation equipment, and transportation) must be raised by each station. Thus, the more services they provide, the more revenue they have to raise. Because of insufficient funding, disease-control stations have to charge fees for such services as immunization. In poor areas, even small fees may be enough to deter the use of preventive services. Furthermore, when a disease-control station cannot raise enough revenue, plans for disease prevention and control from the Ministry of Health cannot be effectively implemented. This problem is reflected by the recent document from the Ministry of Health. With approval from the Ministry of Finance, the document emphasizes that local governments should fund their disease-control stations or divisions strictly following the planned scale and should fund operating costs of disease control tasks.[33]

5. Rural "floating" laborers

Mobile rural laborers who work in cities often lack regular healthcare and pose another challenge to the control of disease transmission. China's rapid economic growth in urban areas provides job

opportunities to hundreds of millions of rural laborers. Because these people travel frequently among large cities, they are often called *floating rural laborers.* When the budget for a disease-control station is based on the number of permanent residents that the station serves, floating rural laborers consume resources without contributing to revenues. These laborers are entitled to receive all preventive care and treatment for infectious diseases in their rural home villages or towns. But because they are away from home most of the time, they constitute the population least likely to receive preventive care and most likely to transmit diseases. Understanding the magnitude and patterns of rural-laborer migration and health-care conditions is an important prerequisite to improvement of the disease-control system.

5.1 Rural-laborer migration

China's rural-laborer migration occurred in two stages. In the first stage, rural laborers left agricultural production to work in businesses owned by villages and townships. They did not travel far from home. The second-stage migration started in the middle of 1990s, when many rural laborers traveled long distances to large cities to find work.

There were three major reasons for the large-scale rural-laborer migration of the 1990s. First, there was a large labor surplus in rural areas. Since the economic reform, the expansion of cities for residential housing and private enterprises led to a reduction in the total area of China devoted to agriculture, diminishing the demand for labor in rural areas. Another factor contributing to the labor surplus was the increase in productivity under the family-responsibility system in agricultural production. Before the economic reform, a village was the basic unit for agricultural production and distribution. Individuals had no incentive to work hard, because they were not rewarded directly. When the economic reform assigned land to each family, productivity improved dramatically, and fewer agricultural workers were needed. The second reason for the large-scale rural-laborer migration was the disparity in income between rural and urban areas. With fast economic growth in cities, many relatively high-paying jobs that urban residents

eschewed — such as in construction and certain services — became available to rural laborers. A third factor was the elimination of regulations that previously had made it difficult for rural residents to move to cities.

The number of rural floating laborers is large. According to data from the fifth national census survey conducted on November 1, 2000, the number of people who spent more than 6 months away from their permanent residence exceeded 127 million. Of that floating population, 78% were from rural areas. In the past 5 years, the number of rural floating laborers increased by 5 million per year. In the first half of 2003, there were 90 million rural laborers working in large cities.[34] Given the facts that economic growth is expected to continue and that 60% of China's population is still living in rural areas, this trend of increasing rural-laborer migration is unlikely to end soon.

5.2 Health insurance for rural floating laborers

Employers do not provide health insurance for most rural workers. A survey of rural laborers in Beijing revealed that 93% do not have any health insurance, and only 5.7% of them have insurance for work-related injuries. Without health insurance, many rural workers cannot afford medical treatment in cities. The survey showed that, among those who were sick during the last 12 months, 55% of workers had not seen a doctor. Most of these people treated their illnesses by themselves, using medicine purchased from a drug store. For any communicable disease, of course, delays in medical detection and treatment could promote disease transmission. For example, a recent report indicated that in Guangzhou, the largest city in Guangdong province, almost one-half of the people infected with tuberculosis were rural workers.[34] Fast rising health-care costs in cities also prevent rural workers from obtaining appropriate treatment. The survey reported that 70% of these workers said that, if they required care, they would use private clinics or community clinics and hospitals that are usually less expensive although those facilities may not have skilled physicians and necessary technology to treat infectious diseases. Another factor that increases the

vulnerability of rural workers to infectious diseases is their living environment: most rural workers live in densely packed housing provided by their employers. With many workers sharing a single room, the conditions are ideal for the rapid transmission of disease.

6. Disease control in rural areas

China's ability to control and prevent infectious diseases is weak in rural areas, especially within underdeveloped provinces where local governments have the most limited resources. Although the Ministry of Finance approved the Ministry of Health's recent request to guarantee the funding to disease-control stations/divisions[33] and all 2800 counties in China now have a direct connection to the disease surveillance system of the Ministry of Agriculture for reporting disease outbreak in poultry and other home-raised animals, effective implementation of this new policy will require commitments from both local and central governments. Uncertainty in funding to rural areas opens a door to an influenza outbreak that could disrupt economic activity and threaten health in China and the rest of the world.

6.1 Education on disease control

New infectious diseases are most likely to emerge from rural areas, particularly if they originate by animal-human transmission. Expanded and intensified livestock farming has increased the risk that zoonotic diseases will emerge in rural areas. According to a WHO report, more than three-quarters of the new or re-emerging diseases seen at the beginning of the twenty-first century were caused by pathogens originating from animals or from products of animal origin.[35] The epidemic of avian influenza and the recent outbreak of human streptococcus suis infections in Sichuan province amply demonstrate this threat. Any weakness in disease-control and prevention strategies in rural areas increases the risk of global outbreaks of infectious disease. Streptococcus suis, which is a relatively rare disease in humans and is not easily transmitted from one person to another, infected 214 people and caused 39 deaths within a couple of months.[36] The disease spread rapidly because few farmers knew about, or effectively implemented, disease-prevention measures.

Instead of disposing of dead infected pigs according to infection control recommendations, many people processed and prepared the dead pigs for their own consumption, and became infected themselves. Widespread use – or overuse – of antibiotics in humans and livestock is also believed to have contributed to the high death rate (18%). It is a common practice for farmers to administer various antibiotics regularly as disease prophylaxis in livestock[37, 38], a practice that may have promoted the growth of streptococcus suis, which is resistant to most antibiotics. These problems revealed the failure of efforts to promote disease prevention and public health in rural areas. Although the central government has purchased hardware and has improved internet access to enhance its surveillance system (e.g., providing computers and internet connections), disease control and prevention are unlikely to succeed unless more and better-trained health workers are sent to rural areas to educate farmers and detect threats to public health. Local government support for these activities, especially in underdeveloped provinces, is often tepid or nonexistent.

6.2 Government efficiency

Government efficiency is critical to ensure timely control of a disease outbreak. Two conditions are necessary for government efficiency: freedom from corruption, and competence of government officials. Uncontrolled corruption in government agencies can jeopardize the entire public-health system. An ongoing study funded jointly by the World Bank and the Ministry of Health identified trustworthiness as a key ingredient for establishing a successful new cooperative medical scheme in rural areas. This study found that farmers' lack of trust in local government officials was a major cause of the failure of internationally funded projects to enhance rural health care in China.[39] As the report indicates, trust and corruption cannot coexist. There can be no assurance that funds designated for public health services will improve services if they fall under the control of corrupt officials.

The World Bank identified incompetence among government officials as another obstacle to effective health-care reform in rural areas. The SARS outbreak revealed incompetence at almost every level

of government. Government officials may try to cover up a disease outbreak simply because they want to protect local economy. Reporting an outbreak of infectious disease could lead to a quarantine of local areas, which would directly affect any investment in that region. Reimbursement from the government, at best, covers the financial loss from disease control measures. For example, when all the chickens in an infected village were killed, the reimbursement only covered the market value of the chickens. The total impact on the village's economy exceeds the total value of the chickens. For chicken farms and poultry processing business, the cost of idled equipments and building are not reimbursed when the production was interrupted by a disease outbreak. Therefore, how to assist people in an infected region to reestablish their economy after a disease outbreak should be considered by both local and central governments.

The Chinese government has realized the importance of assisting the poultry industry through the 2005 H5N1 outbreaks. The State Council issued a new policy to assist poultry production. The cost of reimbursing the birds culled for avian influenza is shared by central, provincial, and local governments. The central government will contribute 20% of the cost for east regions, 50% for central regions, and 80% for west regions. The central government will pay 10% more for poor rural regions.[25] The government also waived various business taxes and fees for the poultry industry between November 1, 2005 and June 30, 2006. With the same ratio of reimbursing the loss of culled birds, central and local governments jointly subsidized half of the interests for loans in the poultry industry between October 1, 2005 and June 30, 2006. With those policies, the challenge again is how to ensure effective implementation, which heavily depends on local government officials.

Improving competence of government officials, however, is not an easy task. Even after the SARS outbreak, some government officials covered up disease outbreaks. For example, newspapers reported that a cover-up occurred during the outbreak of streptococcus suis in pigs. Several officials of the infected county, including the director of the livestock bureau, the deputy director and the head of the regulation-

enforcement division of the county animal disease-prevention department, and the chief of a livestock clinic all conspired to report false information about how dead pigs infected by this disease were processed, and later impeded investigations from high-level health agencies.[40] Eliminating corruption and improving competence remains a challenge in China.

7. Concluding remarks

The SARS epidemic has forced the leaders in China to review their public-health policies and to re-assess the current system used to prevent and control infectious diseases. Government leaders have recognized the importance of investing in public health, and have taken action to strengthen the disease-control system. The primary challenges facing the government now and in the near future are (1) to ensure adequate funding to improve disease control at the front lines, especially in the rural areas of underdeveloped provinces, and (2) to improve efficiency of governments, particularly rural governments.

To ensure adequate funding to rural areas and underdeveloped provinces, the central government could play either a direct or an indirect role in resource allocation. Direct involvement would involve identifying key disease-control components and providing direct funding. For example, the disease-surveillance team could be completely funded, even at the local level, by the central government. This funding structure could also improve the quality of services, because the teams would be financially independent of local governments. The SARS outbreak demonstrated that an infectious disease could spread easily to the nation and the world. Hence, the dedication of national and international resources to strengthen weak points of the disease-control system would offer worldwide benefits. A continuing challenge for the central government is how to ensure that local governments will adequately fund disease control and prevention, especially in rural areas. Unless the central government provides additional support, and can ensure that the funds are used appropriately, the rural areas of underdeveloped provinces will be the weakest point in the disease control system.

Support from international organizations is also critical to improve China's ability to prevent and control infectious disease. After the SARS epidemic, the European Union and the Word Bank funded projects to investigate the rural public health system in China. The objective of the European Union's project is to understand the background and to identify the problems of China's public heath system in poor rural areas. This project might yield information that the government can use to enhance its disease-control system in those areas. The World Bank's own study, the China Rural Health Analytical and Advisory Activities (AAA), which is undertaken in collaboration with the Chinese Ministry of Health, contributes to the government's formulation of a coherent reform path for the rural health-care system. This project encompasses the entire health-care system of rural China, including the identification of problems in disease control and prevention.

Other international projects affect more directly the improvement of disease control and prevention in rural China. The newly established Chinese Center for Disease Control and Prevention (China CDC) has over 20 projects either funded by or undertaken in collaboration with international organizations.[41] For example, in August 2005, the China CDC initiated a 5-year project entitled Accelerate Actions in Tuberculosis Care and Detection in China through collaboration with the WHO, and another project on rapid assessment of drinking-water quality with the WHO and UNICEF. Increasingly, international collaboration on rural disease control and prevention in China is being recognized as critical both to China and to the world.

Experts believe that another influenza pandemic is inevitable and probably imminent.[42] The H5N1 strain that caused the current outbreak of avian influenza in poultry and other birds in Asian countries is highly pathogenic and could rapidly change into a form that spreads easily among humans. Now that the H5N1 virus has established an ecological niche in poultry, the risk of a human influenza pandemic will be with us for some time. Because influenza viruses change constantly, the timing and severity of the next

pandemic cannot be predicted. Early warning is critical when the virus makes the jump to humans and is transmitted from person to person. If disease control and prevention in rural areas and underdeveloped regions in China do not improve, a pandemic is both more likely to occur and likely to be more dangerous.

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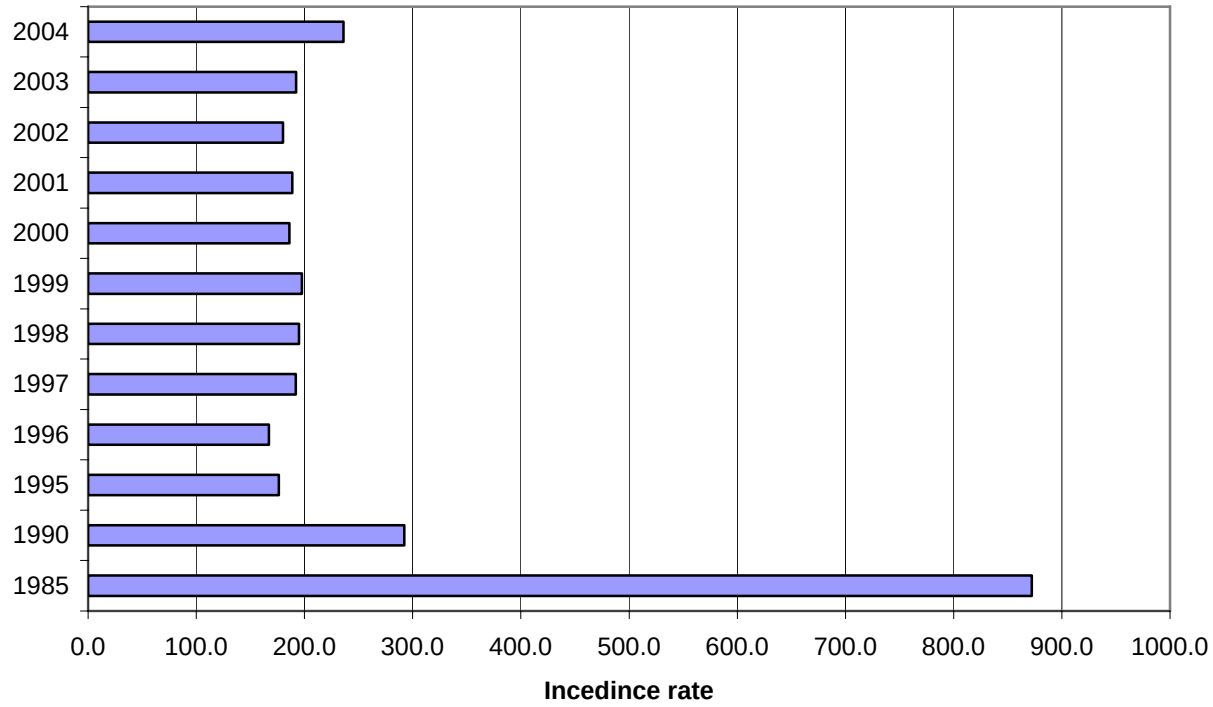

Figure 1 Total incidence rate of infectious diseases per 100,000, 1985 – 2004
Source: Health Statistics Digest 2005.

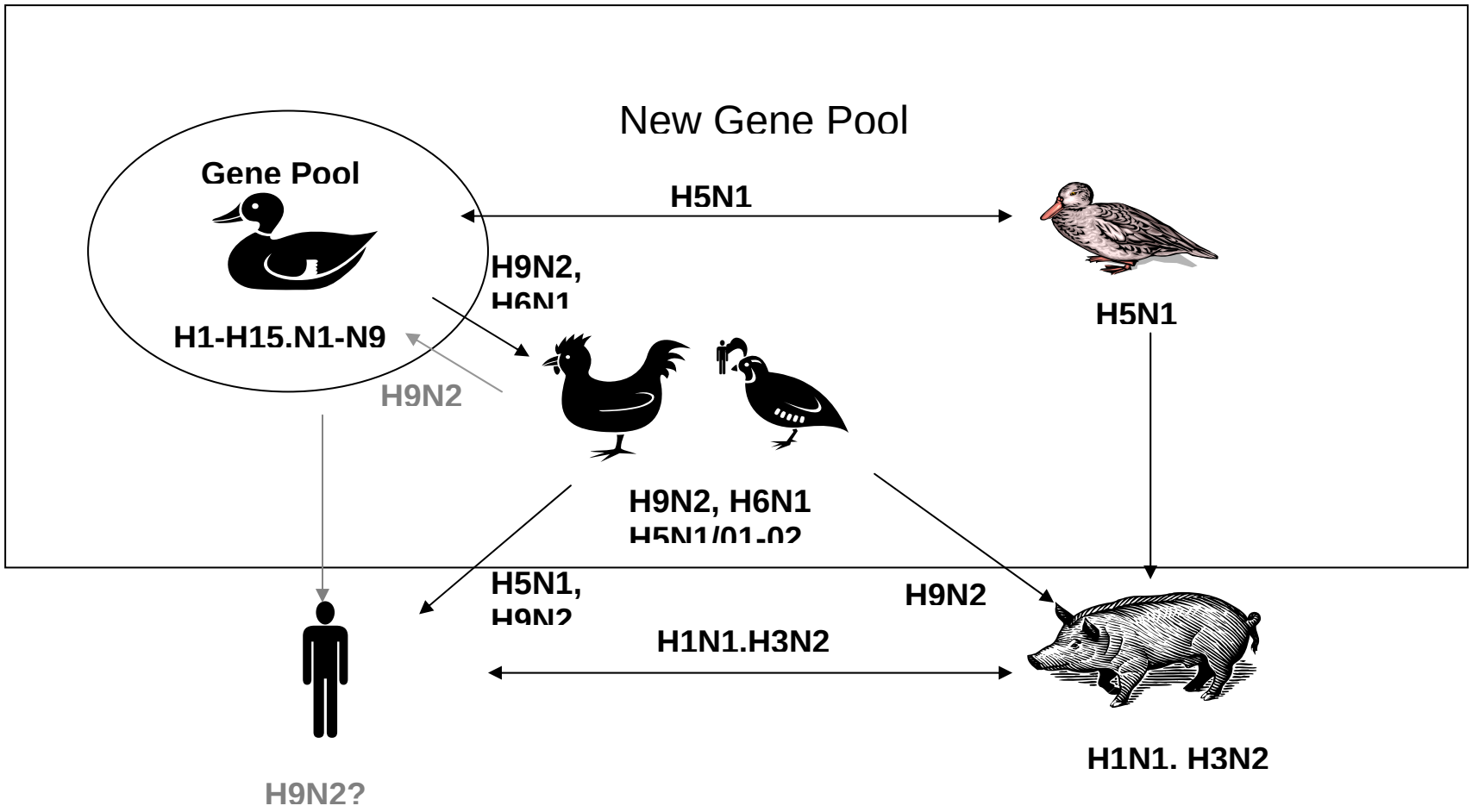

Figure 2. Current understanding of the ecology of influenza virus in Southern China that favors the emergence of H9N2 as a possible new pandemic influenza virus. [this figure is copied from the article by Li, et al. 2003 Journal of Virology page 6992]

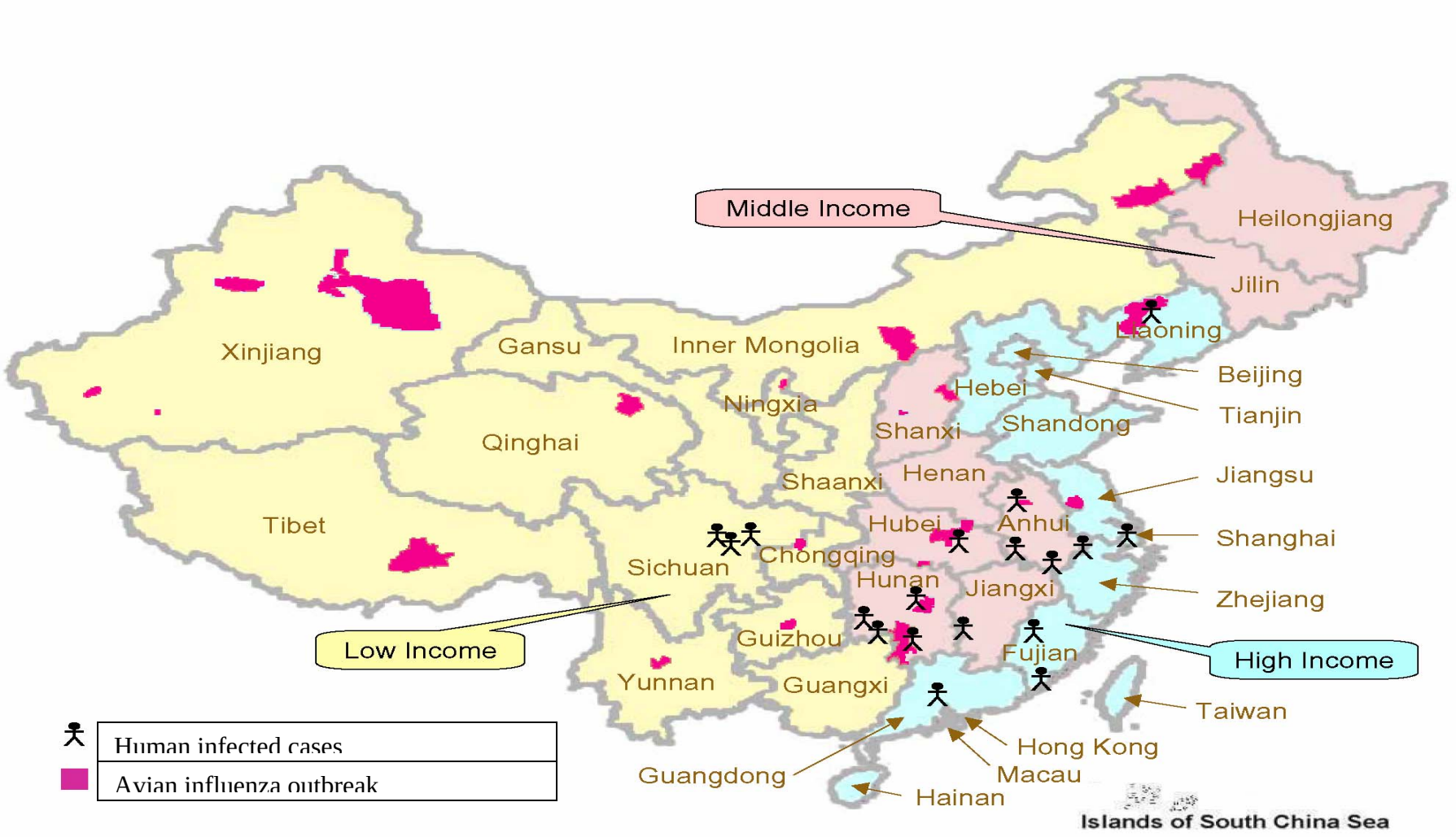

Figure 3. Avian influenza outbreak and human infected cases in China (data were updated on April 28, 2006)
Data source: China CDC website: http://www.chinacdc.net.cn/n272442/n272530/n273736/n273781/n305111/n3138373/10517.html. Accessed on April 29, 2006.

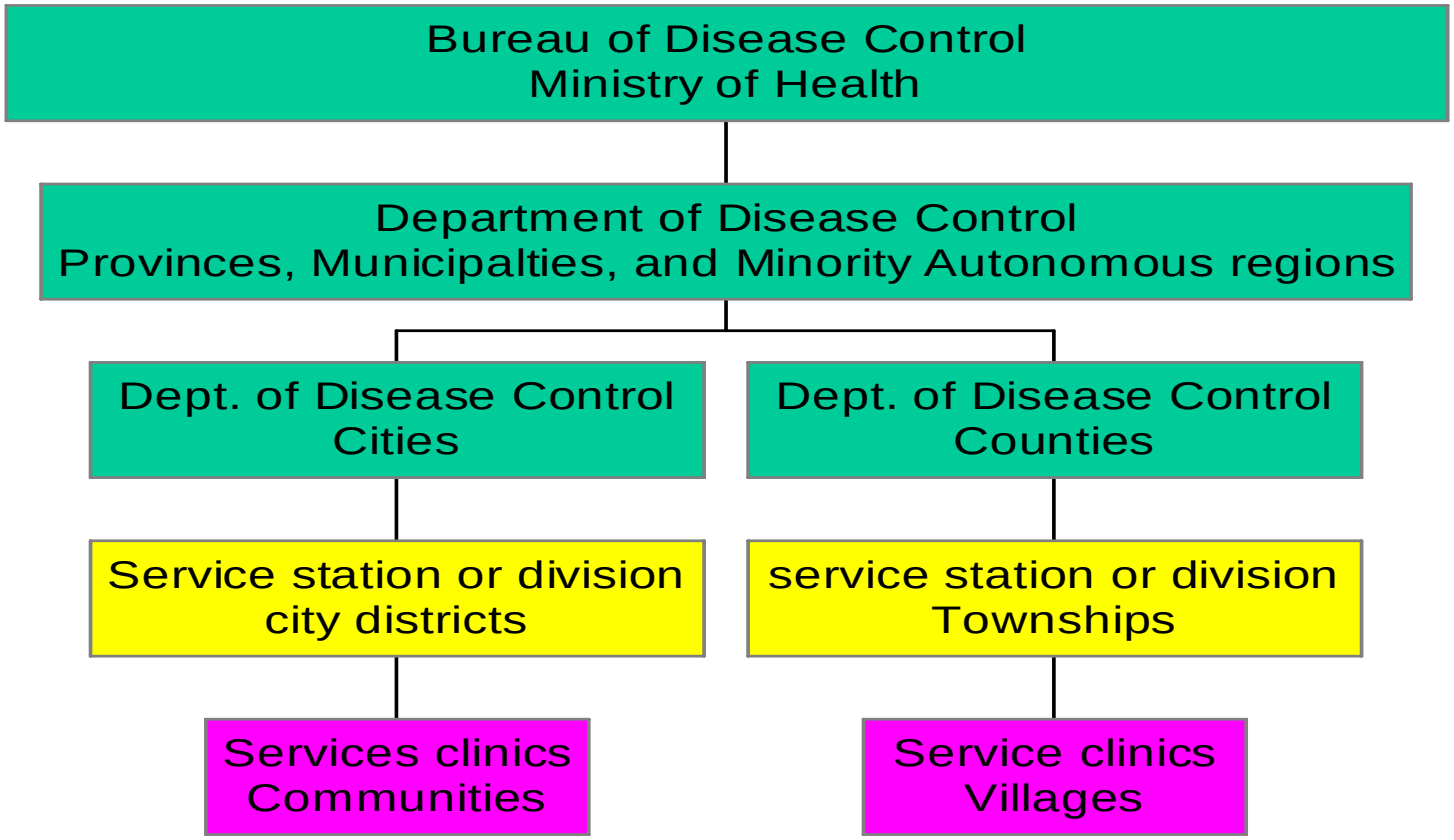

Figure 4. Organization structure of China's disease control system

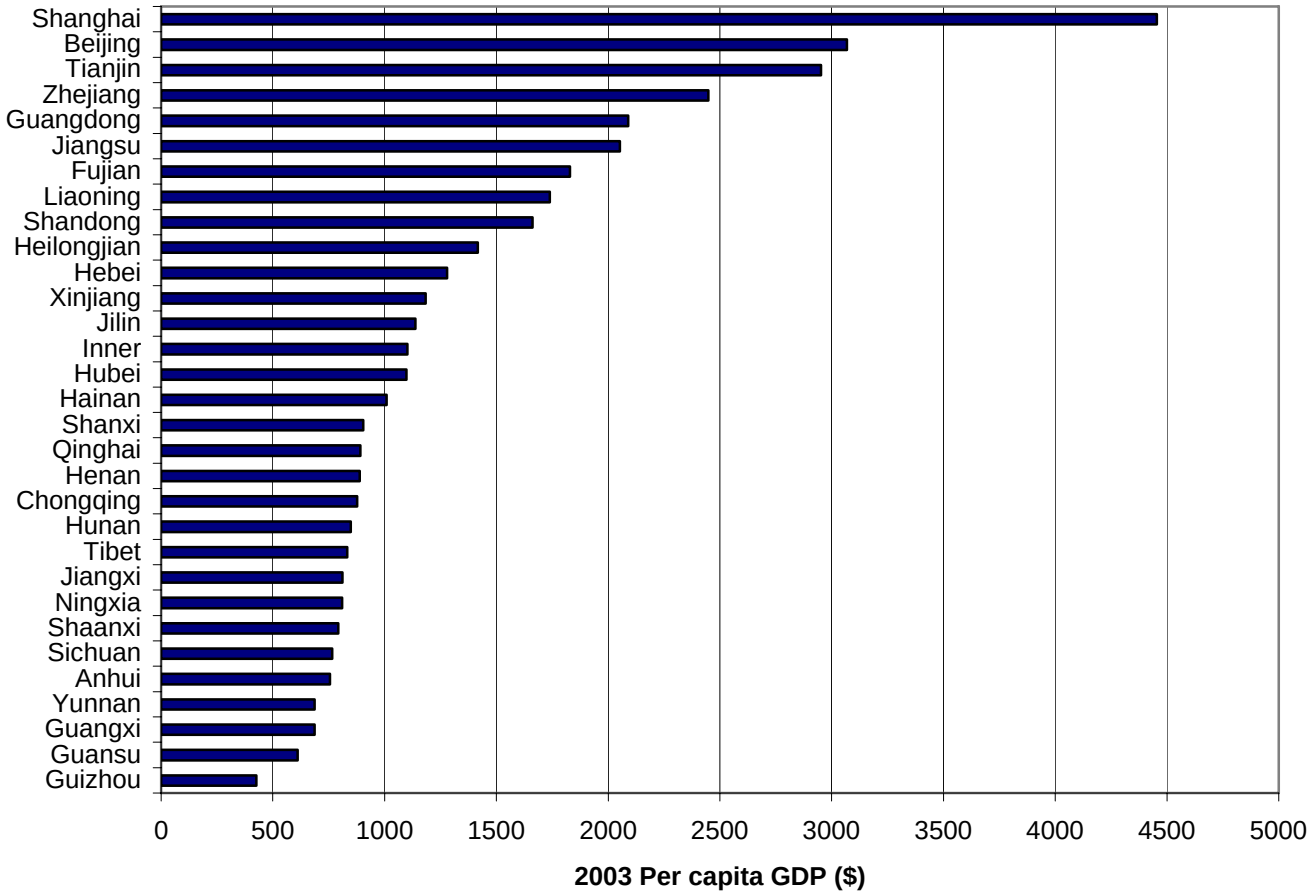

Figure 5. Per capita GDP 2003 by province (in U.S. dollars)

Data source: China Statistics Abstracts 2004

Table 1. Health care supply in city, county, and township[a]

	City	*County*	*Township[b]*
No. of hospital beds per 1000 people	*3.42*	*1.41*	*0.76*
No. of health technicians per 1000 people	*4.84*	*2.19*	*1.19*
No. of physicians per 1000 people	*2.08*	*0.97*	
No. of registered nurses per 1000 people	*1.59*	*0.50*	

Data source: 2004 China annual health statistics pp 26-27.

a. The numbers for city were calculated by dividing city hospital beds by city population; the numbers for county were calculated by dividing the hospital beds by the county population that included rural population. The numbers for township hospitals were calculated by dividing the number of hospital beds by township population that includes only rural population.

b. Because physicians, health technicians, and nurses in a township hospital often do not have formal training, they were not separately classified.