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The Effects of Economic Transition on Mortality in Shanghai, China

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Abstract

Much research has linked an increase in adult mortality with the socioeconomic transition of former European socialist societies after 1989. Few studies examine corresponding experiences in China, however. Using the death certificates of Shanghai residents, we examined any such sudden mortality change and crisis when China went through economic transformation. We explored trends in life expectancy at birth and age-specific mortality in Shanghai. We applied Arriaga's decomposition method to analyze the contributions of specific ages and the causes to the changes in life expectancy. We used harmonic regression models to assess the statistical significance of rising and falling mortality over time. The analysis shows that, coinciding with the economic transition of 1992–1996, the previously steady improvement of life expectancy in Shanghai slowed down. Mortality among working-age males (20–44 years old) increased ($P<.001$) in Shanghai, largely due to rising cardiovascular disease (CVD) ($P<.05$) and injury ($P<.001$). Suicide and liver disease remained stable or fell, while transportation deaths increased in Shanghai. The economic reform in Shanghai seems to include the privatization of state-owned enterprises, economic growth, and initial increases in working-age male mortality in the 1990s.

Introduction

Adult mortality changed rapidly after the collapse of former socialist countries in Europe in 1989 (Brainerd, 1998; Notle, Shkolnikov & McKee, 2000a; Stuckler, King & McKee, 2009). Those studies of former socialist economies (FSE) in Central and Eastern Europe found that transition to the market economy and democracy in the 1990s caused a dramatic increase in mortality, shortened life expectancy, and led to depopulation; economic reform of public ownership especially correlated initially with rising adult death rates. After some time this trend reversed and death rates fell (Brainerd, 1998; Notle, Shkolnikov & McKee, 2000b; Stuckler, King & McKee, 2009). Initially, the risk of mortality was higher among males and workers than among females and non-workers during the post-communist socioeconomic transformation (Leon, 2011; Notle, Shkolnikov & McKee, 2000a; Notle, Shkolnikov & McKee, 2000b). The higher mortality among working men was attributed partly to economic uncertainty (i.e., job loss) with disruption of the traditional breadwinner role, psychological stress, and an increase in alcohol consumption (Shkolnikov, Cornia, Leon & Melse, 1998; Weidner & Cain, 2003).

Reversal of high mortality seems to have occurred with economic stabilization, adaptation of the population to the new social and economic environment, changes in diet patterns (more fruit and vegetables), and improvements in medical care (Gavrilova, Semyonova, Evdokushkina & Garvilov; Leon, 2011; Notle, Shkolnikov & McKee, 2000a; Zagozdzon, Zaborski & Ejsmont, 2009). However, one rise-and-fall mortality cycle can be followed by another, as the Russian experience shows (Leon, 2011). After an initial rise and fall in the early 1990s, adult mortality went up again from 1998 to 2003, coinciding with a second economic crisis (Men, Brennan, Boffetta

& Zaridze, 2003; Zaridze et al., 2009).

In Russia, during the first stage of economic transformation, from 1990 to 1994, male life expectancy dropped by six years (Leon, 2011). Several transition economies, such as Poland, East Germany, and the Czech Republic implemented socioeconomic reforms with much smaller falls in male life expectancy of only about one year or less (Leon, 2011; Notle, Shkolnikov & McKee, 2000a; Cornia & Panniccia). Stuckler and colleagues explored such variation in reform-related mortality effects among 25 central and eastern European countries. They found a statistical relationship between the extent of privatization and a short-term increase in adult male mortality rates; unemployment rates were a significant mediating link between privatization and mortality (Stuckler, King & McKee, 2009). The negative effect of privatization on mortality was attenuated by high social capital (Kennedy, Kawachi, & Brainerd, 1998; Stuckler, King & McKee, 2009). Mortality was worse, with high crime rates under struggling reform, and mortality was better with reform success, as indicated by GDP growth and inflation rates (Brainerd, 1998).

In contrast to a relatively large body of literature on FSE mortality during the transition era, little is known about corresponding mortality changes in China since 1978, when it went through substantial systematic transformations from a centrally planned economy to a more market-oriented one. This study attempts to examine whether the effect of this transition is similar to that of those former socialist countries in central and eastern Europe—that is, a sudden mortality crisis, in which there is a substantial increase in deaths that is well above the normal fluctuations.

Life expectancy in China as a whole has continuously increased since 1949, except in 1959–1961, when it encountered a food shortage. Life expectancy notably improved further during China's economic reform period (Banister & Zhang, 2005).

However, the positive trend at the national level may not be reflected absolutely at the regional level, at the provincial level, and in urban or rural areas (Banister & Zhang, 2005), because the starting time and pace of the reform were not geographically uniform in China (Jefferson & Singh, 1998). Moreover, steeper declines in life expectancy may occur in the urban areas, during the economic transition (Leon & Shkolnikov, 1998; Walberg, McKee, Shkolnikov, Chenet & Leon, 1998), because of stress factors caused by social dislocation leading to increased labor turnover, sudden loss of employment, divorce, and income inequalities. Additionally, national cause-of-death statistics in China were questioned and criticized regarding their completeness and the content validity of each cause of death (Rao et al., 2005; Banister & Zhang, 2005) due to the lack of a vital registration system. Therefore, the analysis of such an important issue could be based on a selected Chinese population that is sizable enough for mortality assessment and that has up-to-date parallel reforms and reliable death information for this period. After reviewing many areas, we concluded that Shanghai, China's economic center, fits these criteria. It has reliable, quality death statistics and a relatively large population as a city, and it has undergone economic reform and open policy since the early 1980s but has jumped to privatization reform dramatically since 1992.

To better understand the effect of economic transition on mortality changes, we chose to use the East Germany, Poland, the Czech Republic, and Russia experiences as reference points that might provide useful hints for examining mortality changes in Shanghai. These populations had representative diverse mortality patterns and different policy approaches during the transitions (Cornia & Panniccia, 2000). Their drastic social and economic changes during the transition from a centrally planned economy to a market economy, their greater uncertainty and unemployment, and the

details of the reforms plan accounted for differences in the mortality changes. Their patterns of changes, major factors, and consequences could help us to examine selected variables and to expand our knowledge on the hitherto neglected changes in mortality associated with Chinese economic reform.

China's Transition to a Market Economy and the Experience of Shanghai: A Historical Perspective

Since 1978, China has experienced extraordinary institutional change, which has proven to be effective in promoting its economic growth and is advancing its international status. China has achieved institutional change in a steady systematic and staged manner. This has altered its economic system substantially. At the same time, the structure of its political system has hardly changed. It remains a one-party state that relies heavily on the guidance of the leadership of the Communist Party for its direction. The Chinese transition involved several policy changes, including an opening-up policy and economic growth; enterprise reform and labor market reform; and the evolution of a health care system and changes in health care insurance.

The Opening-Up Policy and GDP Growth

When the Chinese government decided to implement reforms on the economic system in 1978, a step-by-step opening-up policy was introduced concurrently. From 1980 on, five special economic zones (SEZ)—in Shenzhen, Zhuhai, Shantou of Guangdong Province, Xiamen of Fujian Province, and Hainan Province—were commissioned. Special economic policies and management mechanisms were adopted in these zones.

In 1984, China opened up an additional fourteen coastal cities, including Shanghai, to grant them "open coastal city" status in order for them to offer essentially all the preferential policies toward foreign investment of an SEZ except for the special income tax rates. Then in 1985, the Changjiang delta area, the Pearl River delta area, the Minnan triangle, Shandong Peninsula, Liaodong Peninsula, Hebei, and Guangxi were made open economic areas. A massive coastal economic open belt was brought into being. In 1990, Pudong in Shanghai and a number of cities along Changjiang form the Changjiang open belt. In 1992, a number of frontier cities and all inland provincial capitals and capitals of autonomous regions were opened up. Fifteen bonded areas, 32 national-level Economic and Technological Development Zones, and 53 high-tech industrial development zones were established in a number of large and medium-sized cities. China has succeeded in opening itself up to the world in all directions, in multilayered ways and in a massive scale covering the coast, the rivers, and the frontier and inland regions.

Prior to 1949, Shanghai was the center of China and the Far East in economics, trade, and banking. Since then, it has been reconstructed as the leading industrial base and one of the centers of education, science, and technology in China. However, Shanghai's economic growth was even lower than the national average after it joined the economic reform in 1984 (Goodman, 1997; Perkins, 1999). It is because Shanghai had remained one of the most centrally controlled provincial-level governments in China from 1984 to the early 1990s, lacking in facilitating the entry of nonstate firms, encouraging foreign direct investment, deregulating trade and prices, liberalizing the labor and capital market, and expanding enterprise autonomy (Perkins, 1999). After Deng Xiaoping's January 1992 Southern Inspection Tour and his influential speech, Shanghai has been emerging as the hub of a key region for open economic

development in China. There has been a two-digit annual growth in gross domestic output (GDP) since 1992, with a surge in foreign direct investments and the concomitant increase in income, which raised the population's living standards (Zhang, 2003; Fig. 1).

(Fig. 1 here)

The distribution of income in Shanghai became more unequal beginning in 1992, and the Gini coefficient increased from 0.16 in 1991 to 0.22 in 1996. Around this time, inflation in Shanghai climbed, peaking at 23.9% in 1994, and falling to 2.8% in 1997. The peak of inflation rate in Shanghai in 1994 was still relatively lower than most of FSE during the corresponding period (World Bank, 1960-2011). The increase in inflation rate may raise mortality by increasing poverty, especially among the low-income population (Brainerd, 1998).

Enterprise Reform and Labor Market Reform

Institutional changes in the Chinese labor market include those from socialist ideology, direct allocation of jobs, provisions from "cradle-to-grave", centralized state-owned enterprises, lifelong employment, tools for full employment, and workers as "masters" in the pre-reform era; to market principles, job search facilitation, individual self-reliance, decentralization of state-owned enterprises, contract terms, layoffs for efficiency, and workers as "proletarians" in the post-reform era. In other words, during the prereform era, job mobility was minimal and would occur mostly as the result of workers' reassignments or transfers to satisfy the need of state-run organizations (Walder, 1986:8). Under those circumstances, where individuals are discouraged from searching for jobs, information about jobs is unimportant and

meaningless.

Around 1992 and 1993, the policy of state job assignment was largely abolished (Davis, 1999). With the increase in private enterprises, foreign-funded firms, and other non–state-controlled businesses, the operation of labor markets made it legitimate for individuals to use all kinds of channels to search for jobs. These changes point to the decline of job assignments and the growth of labor markets in Chinese cities (Bian & Huang, 2009). However, the abolition of the state allocation system also meant that concerns about state and collective sector inefficiency began to override concerns about dismissals and layoffs. Enterprise reforms replaced the "iron rice bowl" with performance-based hiring, firing, and compensation. State-owned enterprises began to use labor contracts, adopt wage reform, and decentralize labor management. The effects were profound. The security once enjoyed by urban workers rapidly eroded. Chinese urban workers are no longer shielded from market forces. They bear the brunt of the adjustment costs as enterprises shed redundant workers in their attempts to become more efficient and profitable. Laid-off workers experience substantial periods of unemployment with minimal stipends.

In Shanghai, despite the promulgation of the four landmark labor regulations in 1986, the "iron rice bowl" (guaranteed tenure employment system) lingered on in the 1980s (Lee & Warner, 2004). But it has begun to be effectively replaced by a contractual employment system based on a market-oriented set of labor and personnel reforms since the early 1990s. Systemic transition in Shanghai has systemic privatized state and collective enterprises since 1992. Many state-owned or collective firms became bankrupt or were restructured. The labor turnover directly affected more than one-third of the working population (Shanghai Municipal Statistical Bureau, 1983–2011; Shanghai Municipal Statistical Bureau, National Bureau of Statistics Survey

(Shanghai Groups), 2009; Zhu & Yuan, 2001). From 1992 to 1996, over one million staffs in state-owned or collective enterprises were laid off (Zhu & Yuan, 2001). The unemployment rate rose from the bottom (0.2%) in 1985 to 1.4% in 1991, and continued increasing to 2.7% in 1996 (Figure 1). Unemployment from 1992 actually underestimated job loss in Shanghai because laid-off employees remained registered with former enterprises (Lee & Warner, 2004). The proportion of employees working in state-owned or collective enterprises slightly decreased from 99% in 1985 to 96% in 1991, but it dropped substantially to 82% in 1996, reaching 22% in 2007 (Fig. 1).

Evolution of the Health Care System and Health Care Insurance Reform

Heath care insurance coverage was associated with enterprise reform (Du 2009; Hu, Ong, Lin, & Li, 1999). Before the reform, health services for state-owned and collective enterprise workers were financed mainly through the Labour Insurance Medical Insurance System in urban China (Gao, Tang, Tolhurst, & Rao, 2001; Liu & Hsiao, 1995; Hu, Ong, Lin, & Li, 1999). Since the economic reform accelerated, less profitable enterprises have no longer been able to guarantee full health insurance coverage for all of its beneficiaries. In urban China, there was a significant decline in the population covered by health insurance, while the proportion of the population who had to pay for services out-of-pocket rose from 28% in 1993 to 44% in 1998 (Gao, Tang, Tolhurst, & Rao, 2001).

In order to solve the problem, the pilot urban health insurance reform in China was initiated in the cities of ZhenJiang and Jiujiang in 1994. Similar reforms were extended to 57 other cities in 1996, and a nationwide reform was carried out in 1998 (Liu et al. 2002). The reform had some key features: ensuring access to basic care,

wide coverage, joint premium contributions by employers and employees, and the integration of individual medical savings accounts (MSAs) and social pooling accounts (SPAs). Shanghai began the health insurance reform in 1996. Since then, the expenditure of hospitalization has been gradually paid by the combined MSA and SPA accounts.

Since the 1980s, health care has become less affordable due to health care reforms involving the reduction of governmental support for health care systems and the permission to earn profit margins of 15 percent or more from new drugs and new technologies (Blumenthal & Hisao, 2005). As a result, the decrease in health insurance coverage and the increase in out-of-pocket payment have deteriorated the accessibility to health care (Gao, Tang, Tolhurst, & Rao, 2001). In Shanghai, the annual average number of visits to hospitals decreased from 6.9 per person in 1985 to 6.2 per person in 1991, and then suddenly dropped to 4.2 per person in 1996, although medical resources (e.g., beds per person) remained stable (Fig. 1). The annual average number of visits to hospitals has begun to increase since 1998.

Effect of Economic Transition on Mortality in China: Theoretical Perspectives

Economic transformation in China included enterprise reform and labor reform, the evolution of a health care system, the opening-up policy, and GDP growth. Several sequential causal factors resulting from these changes may affect mortality patterns and changes in China.

Enterprise reform and labor reform may have raised mortality through the following sequential channels during the transformation (Fig. 2): Initially, people faced brutal layoffs from state-owned or collective enterprises, which led to escalation

in unemployment and job insecurity (Stuckler, King & McKee 2009); such disruption to the established social order, job loss, and uncertainty generated psychological stress (Brainerd, 1998; Shkolnikov, Cornia, Leon & Melse, 1998; Cohen, Janicki-Deverts & Miller, 2007; Weidner & Cain, 2003); one of the most popular approaches to dealing with such stress was to rely more on certain kinds of hazardous materials, such as alcohol, drugs, and tobacco (Shkolnikov, Cornia, Leon & Melse, 1998); finally, given the deterioration of the degree of social security and reduction of the coverage of health insurance, and the rising difficulties in accessing health care and hospitalization, all of these together naturally led to short-term increases in adult mortality rates, in mortality from cardiovascular disease (CVD), and alcohol-related deaths (such as liver disease, violence, and suicide), in addition to suicide and homicide (Balabanova, McKee, Pomerleau, Rose, & Haerpfer, 2004). If unemployment and job turnover are important mediated factors, the increase in mortality may hit working-age populations the most severely.

The evolution of the health care system, with the reduction in governmental support, increased medical costs as hospitals were forced to earn profits from new drugs, new tests, and technology (Blumenthal & Hisao, 2005). This occurrence, combined with the reduction of health insurance coverage, reduced the affordability of the health care system and increased inequity of access to health care, which may contribute to the increase in mortality (Gao, Tang, Tolhurst, & Rao, 2001).

In order to quickly recover from the negative effects generated from such institutional changes, Shanghai was the pioneer in establishing the Re-employment Service Centre in 1996 (Lee & Warner, 2004). The combination of welfare provision, employment service, and a retraining program was recognized by the central government as a “learning model” for other local governments. These changes

exemplify the notion that state institutions constantly readjust and revise themselves in response to new demands and circumstances—an important feature of the transitional economy (Solinger, 1999).

The opening-up policy, with economic take-off, indicated by the rapid growth of GDP, may have both negative and positive effect on mortality (Liu, Rao & Fei, 1998). Increasing exposure to risk factors associated with income growth, motorization, and an imbalance of infrastructure development and safety controls increased the risks of injury mortality, especially for mortality from transportation accidents (Zhao, Tu, McMurray & Sleigh, 2012). In addition, changes in diet due to income growth may raise the risk of CVD and other chronic disease mortality (Popkin, 1994). The opening-up policy was associated with a decrease in the health insurance coverage, which was attributed to increases in employees in private or foreign enterprise without necessary insurance and the deficit of state-owned or collective enterprise in a more competitive market (Du, 2009). However, GDP growth, which is an indicator of economic success and social stability, may offset the negative effect of economic reform on mortality (Brainerd, 1998).

Data

To examine mortality changes during the economic transition in China, we use mortality data for Shanghai, which were obtained from the official registration system. Before 1991, annual mortality data were aggregated by sex, age, and cause; after 1991, individual data were available. Causes of death from 1974 to 2007 were based on various codes: the Chinese classification of disease for 1974–1988, the Ninth Revision of the International Classification of Diseases (ICD-9) for 1989–2001, and the Tenth Revision (ICD-10) for 2002–2007. We classified causes of death into seven

categories from 1974–2007: infectious diseases, neoplasms, cardiovascular disease (CVD), respiratory disease, digestive disease, injury, and other diseases. After 1991, we used more detailed cause-of-death analyses, because individual monthly death certificates became available.

Death certificates are completed by community doctors for natural deaths at home or by hospital doctors for natural deaths in hospitals or by coroners for unnatural deaths. Deaths are recorded by the local police, based on the household registration (Hukou) and are reported to the health bureau for coding. Burial proceeds cannot be conducted until the deceased person is recorded in the Hukou system, ensuring complete and accurate mortality data for permanent residents. It is the reason why Shanghai mortality data covers only permanent residents who are identified as having "Shanghai" Hukou. The floating population does not contribute to these death reports. Mortality data based on residents with "Shanghai Hukou" avoid the impact of selective migrants, especially with the huge increase in the floating population since the 1990s (very few before 1985, 1.06 million in 1988, and 3.87 million in 2000) (Census Office in Shanghai, 2002). Quality measures for mortality data include physician training, registration guidelines, case review for nonspecific causes, special hospital procedures to detect child deaths, and computer checks.

The completeness of mortality data and validation of cause-of-death is generally reliable in Shanghai. We compared the number of deaths based on the official registration system with that from the 1982 census and the 1990 census. Though the number of deaths according to the censuses includes the floating population, the ratio of number of deaths by each age group for official death registration to census ranged from 0.95 to 1.02 for age groups except for 0–4 years (0.83 for age 0 and 0.92 for 1–4 years) in 1982 (Appendix 1). The ratio in 1990 for ages 15–64 is slightly lower in

1982, which was due to the increase in the floating population covered in the 1990 census, rather than deterioration of data quality. When the death rates were compared based on registration data with the first (1973–1975) and third (2004–2005) national cause-of death survey, there were no significant differences in mortality rate (Zhou et al. 1986; Shanghai Municipal Center for Disease Control & Prevention, 2007). Compared to the third national cause-of-death survey, the registration is 99% completed and 98% accurate (Shanghai Municipal Center for Disease Control & Prevention, 2007). Moreover, deaths coded as ill-defined were always less than 6%, based on our calculation.

The denominators (the total resident population in Shanghai) for computing death rates were obtained from the household registration system. Age- and sex-specific populations were obtained from the household registration system for the years 1974, 1979, 1985, 1992, 1996, 1999, 2001, 2006, and 2007. We also adopted age- and sex-specific populations from the 1982 census, because the proportion of the floating population was less than 0.5%. The population for inter-data years was estimated by the Cohort-Component Method (Smith, Tayman, & Swanson, 2001). We derived the monthly population from the Inter-Census estimation by assuming that the population change between two dates of two years' end is linear (Shryock & Siegel, 1973). We standardized the mortality by multiplying the World Health Organization (WHO) standard population for the observed Shanghai age-specific rates (Ahmad et al., 2001).

Statistical Analysis

We applied Arriaga's decomposition method to analyze the contribution of specific ages and causes to the change in life expectancy (Arriaga, 1984), as well as to

examine trends in life expectancy at birth and age-specific mortality patterns in Shanghai. Decomposition revealed the major causes of death trends among various age cohorts. To assess the statistical significance of rising and falling mortality over time during the reform, we employed log-linear regression analyses for total mortality and for certain cause-specific mortality (neoplasms, CVD, injury, and liver disease). Separate regressions covered the periods of 1992–1996 and 1997–2007. To account for seasonal fluctuation, harmonic regression models were used as follows, since the information retained on the connection of time periods described the seasonal pattern as one sine and one cosine (Stolwijk, Straatman & Zielhuis, 1999):

$$\log(Y_t) = \beta_0 + \beta_1 t + \beta_2 \sin\left(\frac{2\pi t}{T}\right) + \beta_3 \cos\left(\frac{2\pi t}{T}\right) + \varepsilon_t$$

T indicated month (T = 12). The value of β1 showed the rate of mortality changes. For example, β1 = 0.0296 implied that the mortality rate increased annually by a factor of exp(0.0296) = 1.03, that is, a 3% increase in mortality rate in 1 year. By contrast, β1 = -0.0296 indicates a decrease in the mortality rate by 3% (exp(-0.0296)) annually. A mixture of cosine function (β2, β3) is used to describe the seasonal pattern (Stolwijk, Straatman & Zielhuis, 1999).

Results

Trends in Mortality and Longevity in Shanghai, 1974–2007

Overall life expectancy in Shanghai increased relatively consistently from 1974 to 2007 (Fig. 3). The increase in life expectancy differed in the following periods: 0.22 years for males and 0.17 years for females in 1974–1985, 0.31 years for both males

and females in 1986–1991, 0.08 years for males and 0.14 years for female in 1992–1996, and 0.42 years for both males and females in 1997–2007, respectively. The slowest decrease for both males and females occurred from 1992 to 1996, coinciding with the economic transition in Shanghai.

(Fig. 3 Here)

The populations were grouped into four age categories: children and adolescents (0–19 years); young working adults (20–44 years), older working adults (45–64 years), and seniors (65 years and older). During the period of 1974–1991, based on annual data, death became less likely for all age groups (Fig. 4). The largest drop for adults (32 to 29%) was for ages 20–64 years; the smallest drop was for ages 65–79 years.

(Fig. 4 here)

During the period of 1992–1996, the probability of dying, among males, rose substantially (by 14%) for young adults aged 20–44 years ($p<.001$) (Appendix 2), but decreased for males in the older age groups and for adult females. The probability of dying dropped remarkably for both males and females in almost all the age groups for the period 1997–2007. However, infant mortality showed an obvious increase because, beginning in 2002, institutional deaths were included for the first time. The most notable change was the falling mortality for young working males aged 20–44 years (Figure 4; Appendix 2).

Causes of Death

A cause-of-death analysis could provide further insight into mortality and associated longevity trends. Figure 5 shows the annual contribution to changes in life

expectancy of deaths at various ages by various causes over three periods (1974–1991, 1992–1996, and 1997–2007) in Shanghai. Before 1992, the annual increase in life expectancy (0.25 per year for males; 0.22 per year for females) was a result of mortality reduction from all major causes of death.

(Fig. 5 here)

Over the period of 1974–1991, mortality reduction from all major causes of death contributed to the increase in life expectancy. For example, the falling CVD mortality contributed about 15% to Shanghai's increase in life expectancy.

By contrast, during the period of 1992–1996, although overall mortality still fell but not so dramatically, mortality from some causes of death increased (Appendix 2). For example, CVD mortality went up during 1992–1996, operating primarily for 20–44-year-old males, and contributed a negative component of minus 0.031 per year to overall male life expectancy; for females, the corresponding negative component was 0.005 per year (Fig 5.). Also, each year, males experienced another negative component of 0.018 years due to injury, partly as a result of increased transportation accidents. However, for the period of 1992–1996, mortality from neoplasms and liver disease fell for both sexes, and suicide mortality remained stable for males aged 20–44 years but fell for older males and for all female age groups. The net effect of these diverse cause-of-death trends was a small decline in population mortality and a slight increase in longevity during the early reform period of 1992–1996.

From 1997 to 2007, mortality in Shanghai fell rapidly for all major causes of death (CVD, neoplasms, respiratory diseases, digestive diseases, and injury), leading to a large annual increase in life expectancy of 0.42 years (Fig. 5). Reduced CVD mortality contributed 29 percent of the gain in life expectancy for males and 33 percent for females. Declines in transportation and suicide mortality were also

remarkable (Appendix 2).

Comparison of Reform-Associated Mortality Patterns of Shanghai and FSE

As an international city before 1949 and after the 1990s, do the changes in Shanghai mortality during the transitional period share any experience with central and eastern Europe, even if it is not a proper comparison. Mortality trends from the 1970s until 1991 in Shanghai differed from that during the pre-reform period in the Czech Republic, East Germany, Poland, and Russia. For example, from 1974 to 1991, Shanghai life expectancy increased steadily, but it improved very slowly in East Germany and the Czech Republic and even declined for male life expectancy in Poland and Russia (Blazek & Dzurova, 2000; Notle, Shkolnikov & McKee, 2000b; Leon 2011; Melse & Vallin 2011). Falling CVD mortality contributed about 15% to Shanghai's improved life expectancy over this period, and rising CVD mortality was a principal part of the worsening pattern in Poland and Russia (Notle, Shkolnikov & McKee, 2000b; Melse, 2004).

Shanghai life expectancy actually rose during the period of 1992–1996: 0.08 years for males and 0.14 years for females, in contrast to a fall in longevity in FSE, especially for males. For example, male life expectancy fell 0.95 years for 1990 and 1991 in East Germany, 0.58 years from 1989 to 1990 in the Czech Republic, 0.40 years from 1989 to 1991 in Poland, and 2.01 years from 1992 to 1994 in Russia. Over corresponding periods, each year, female life expectancy in Germany increased 0.11 years and stagnated in the Czech Republic, but went down 0.15 years in Poland and 1.05 years in Russia. However, mortality improvement in Shanghai was slower during 1992 to 1996, compared with years before and after this period. The annual increase in years of life expectancy differed in the three sequential periods for males and

females: 0.25 and 0.22 in 1974–1991, 0.08 and 0.14 in 1992–1996, and 0.42 and 0.42 in 1997–2007.

Reform-associated longevity changes occurred mostly for 20–44-year-old males, and this age-sex group therefore acts as a sentinel for major mortality effects of economic reform. Mortality patterns for this age group are compared for FSE and Shanghai in Table 1. The probability of dying increased by 14% for 20–44 year olds in Shanghai, while the corresponding figure was 10% in the Czech Republic (Table 1). An even steeper increase in mortality was noted in East Germany (29%), Poland (18%), and Russia (68%) during the initial transitions. In all settings, the transition-associated mortality increase was largely due to CVD and injury.

(Table 1 here)

A noted mortality difference between Russia and Shanghai was observed because of major differences related to alcohol, suicide, and liver disease. Hazardous alcohol consumption increased mortality from suicide and liver disease in Russia (Leon et al., 1997; Shkolnikov, McKee, Leon, 2001). The alcohol intake rose, coinciding with a mortality surge in Russia, while the consumption increased moderately in the Czech Republic, fluctuated in Poland, and fell in East Germany (Cornia & Panniccia, 2000; Riphahn & Zimmermann, 2000). Alcohol consumption in China, especially in Shanghai, was much lower than in FSE (World Health Organization, 2004).

Eventually, it led to a significant increase in mortality from transportation in Shanghai, especially among young adults, since automobiles have become extremely popular. The similar pattern of automobile mortality took place in the Czech Republic and East Germany (Blazek & Dzurova, 2000; McCarthy, 1999; Winston et al., 1999). In East Germany, death rates for automobile occupants increased fourfold from 1989 to 1991 due to the sudden economic change and to the availability of cars, resulting in

both a rise in vehicle ownership and a rise in the number of inexperienced drivers on the roads (Winston et al., 1999). In contrast, deaths from transportation in Russia went down during 1991–1994, due to a fall in the volume of road traffic because of a rapid increase in fuel costs and a decrease in economic activities (Shkolnikov, McKee, Leon, 2001).

Life expectancy rose remarkably in Shanghai, East Germany, the Czech Republic, and Poland after the initial surge (Fihel, 2011; Melse, 2004; Melse & Vallin 2011; Vogt & Kluesener, 2011). The improvement of life expectancy was mainly attributable to the decrease in deaths among those aged 50 and older (Fihel, 2011; Melse, 2004; Melse & Vallin 2011; Notle, Shkolnikov & McKee, 2000a). Also, CVD and injury mortality fell. In contrast, Russian life expectancy fell again during a second economic crisis (1998–2003), but rose from 2004 (Leon, 2011; Melse & Vallin, 2011).

Discussions

Coinciding with economic transition during the period of 1992–1996, the previously stable improvement of life expectancy in Shanghai either slowed down or was no longer improving. Similar to Russia, East Germany, the Czech Republic, and Poland, mortality among working-age males (20–44 years old) in Shanghai became worse due to CVD and injury. However, in contrast to Russia, suicide and liver disease in Shanghai remained stable or fell. But as with East Germany and the Czech Republic, transportation deaths increased in Shanghai.

Countries with stronger institutions, either democratic (like the Czech Republic) or authoritarian (like China and Vietnam), tend to cope with the side effects of transition better than other socialist economies. Besides, only authoritarian regimes

(China is the number-one example) managed to choose and implement the strategy of gradual transition, that allowed to stretch the required restructuring—reallocation of capital and labor—over a considerable period of time and thus to mitigate stress associated with unemployment, migration, and labor turnover (Popov, 2009; Popov, 2012). Countries that proceeded with a more gradual transition (from China to Uzbekistan and Belarus) tended to preserve institutional capacity and to completely avoid or at least mitigate the collapse of output and the increase in mortality (Popov, 2009; Popov, 2012). China and Vietnam did not have any transformational recession during the transition, and life expectancy in these countries was growing constantly.

China's economic transformation began in about 1978 and involved privatization of state-owned enterprises and simultaneous economic growth (Jefferson & Singh, 1999). In Shanghai, economic reform officially began in 1984 under a stable political environment and led to increased economic production, without seriously disrupting the social order or increasing crime rates (Liu, Rao & Fei, 1998; Shanghai Yearbook Editorial Board, 1996). The mortality outcome was considerably better than that noted for corresponding periods in Russia, East Germany, and Poland. However, at the beginning of the reform in Shanghai, working-age (20–44-year-old) males experienced increased mortality due to CVD and injury. But unlike Russia, hazardous alcohol consumption did not play a role in reform-associated mortality in Shanghai (Yuan et al., 1997).

In Shanghai, with a change from a centrally planned economy to a market economy, people were subjected to a major sudden shock in 1984, with dramatic impact after 1991 (Riphahn & Zimmermann, 1997). Job loss and uncertainty about the future, due to systemic transformation and labor market reform, produced a sharp rising level of psychological stress (Shkolnikov, Cornia, Leon & Melse, 1998;

Stuckler, King & McKee, 2009). The stress was generated from those people who had lost a job or were confronted with unfamiliar market conditions or both (Stuckler, King & McKee, 2009). Many people experienced major changes in the established working and living conditions, such as the growing and hitherto unknown uncertainty, and the rapid obsolescence of learned behavior (Riphahn & Zimmerman, 2000). Thus, stress was unavoidable, particularly among working-age populations (Cornia & Panniccia, 2000).

Most notably, psychological stress tends to be associated with CVD (Cohen, Janicki-Deverts & Miller, 2007; Riphahn & Zimmerman, 2000). Evidences derived from both animal studies and prospective observational studies are consistently providing considerable support for a link between psychological stress and CVD morbidity and mortality in general (Cohen, Janicki-Deverts & Miller, 2007; Iso et al., 2002; DeVries et al., 2001; Rozanski, Blumenthal & Kaplan, 1999). Psychological stress can increase mortality through the neuroendocrine pathways, increasing cardiovascular responsiveness, altering plasma lipids, and increasing blood coagulability and a tendency toward central adiposity or alterations in endothelial and immune functions (Marmot & Bobak, 2000).

Playing the traditional breadwinner role in their families, males were more likely to bear more serious stress than females in facing job loss and uncertainty. Additionally, as the economic transformation made the economic structure shift from the manufacturing industry to the service industry, females were more likely and more easily to adjust to a new occupation in the service industry (Sun, 1998). By contrast, males were less likely to engage in service occupations, such as waiter, or did so with more difficulty (Sun, 1998). These potential grounds can partly help to explain why the mortality crisis was most striking among working-age males in Shanghai.

Psychological stress played a role in the gender gap in heart disease in eastern Europe during the initial phase of economic transition (Weidner & Cain, 2003; Riphahn & Zimmerman, 2000; Cornia & Panniccia, 2000). Thus, it is no surprise that mortality from CVD increased significantly among males, but insignificantly among females, during the transformation period in Shanghai. It is fortunate that, as with some central European countries (e.g., Poland), new foreign investments in Shanghai provided economic opportunities that helped combat unemployment (Stuckler, King & McKee, 2009).

An alternative possibility for the initially unfavorable mortality pattern associated with economic reform in Shanghai might be widely spread job losses resulting from an inequitable lack of financial access to the residual health care system (Blumenthal & Hsiao, 2005; Liu, Hsiao & Eggleston, 1999; Liu, Rao & Fei, 1998; Stuckler, King & McKee, 2009). Downsizing enterprises could not reimburse large medical bills for their employees and retirees, who thus had to pay out-of-pocket for their health care costs (Hu, Ong, Lin & Li, 1999; Liu et al., 2002). Health care evolution also accelerated the cost of medical care, which made the health care less affordable (Blumenthal & Hisao, 2005). Insurance coverage and health service use declined when they were urgently needed (Fig. 1) (Gao, Tang, Tolhurst & Rao, 2001).

Fortunately, the improvements of the social security system in Shanghai after 1996 might offset the negative influence of unemployment, as was noted for non-Soviet reforming European countries (e.g., the Czech Republic) (Blazek & Dzurova, 2000; Stuckler, King & McKee, 2009). In order to deal with the negative effects of such institutional changes, Shanghai established the Re-employment Service Centre in 1996 to combine welfare provision, employment services, and a retraining program to constantly readjust and revise themselves in response to new demands and

circumstances (Solinger, 1999; Lee and Warner, 2004; Zhu & Yuan, 2001). Since then, the worst effects of reforms have begun to recede. In addition, fees for hospital services and drugs in Shanghai have been progressively subsidized by an array of other government supports since 1996 (Wang, 2008). In 2003, the health insurance coverage further expanded to people in counties in Shanghai (Wang, 2008).

The upward trend of injury mortality during the reform in Shanghai was an outcome of poor preparation of safety control (e.g., work safety and transportation safety) during fast socioeconomic development, and increasing exposure to injury risk factors associated with a growth in income, labor-intensive manufacturing, intensive construction, and motorization (Zhao, Tu, McMurray & Sleigh, 2012). The transportation mortality increased during the reform in Shanghai due to poor preparation for increasing motorization and determination by the Chinese government to rapidly develop the car industry. From 1992 to 1996, the number of vehicles doubled, from 170 to 321 per 10,000 population, without the corresponding commensurate development of highway and driver safety (Shanghai Municipal Statistical Bureau, National Bureau of Statistics Survey [Shanghai Groups], 2009). This outcome was similar to the Czech and East Germany experience

Could the increased mortality in 1990s Shanghai result in part from the effect on CVD of the transition to modern diets? This seems unlikely, because changes in diet cannot plausibly account for the short-term fluctuation of mortality related to economic reform, as noted particularly among males. Additionally, although smoking is a major risk factor for mortality in China (Gu et al., 2009), there is no plausible mechanism that would convert rapid changes in smoking habits to an immediate mortality increase (Stuckler, King & McKee, 2009). Because of the complex time-lags structure that links changes in smoking to those in health status, it is not possible

to make a robust inference about the role of smoking in the mortality changes during the transition (Blazek & Dzurova, 2000).

Our study did not attempt to formally demonstrate causal association between economic transition and observed mortality trends. However, there is no reason to suppose that we overlooked an alternative cause to explain the mortality trends. The mortality patterns from 1992 to 1996 in Shanghai are plausible and consistent with many aspects of the FSE experience when they went through economic transition. We do not intend to conduct a comparative study between Shanghai and entire countries in Central and Eastern Europe. But some of the similarities in terms of patterns of mortality changes do provide strong evidence of the impact of economic transition on mortality in Shanghai.

Data quality such as completeness and comparability of cause of death over time is an important concern. Underreported death at a very young age (<5 years) was a problem in the early 1980s. However, the completeness of death statistics among adults overall is satisfactory in Shanghai. Thus, the increasing adult mortality will not be distorted because of relatively complete mortality statistics. Variation in coding causes of death should be considered when different coding rules are used over time. However, as such differences are more likely to cause comparability problems where more precise categories are used, by using broad diagnostic groups, such negative outcome can be minimized (Notle, Shkolnikov & McKee, 2000a; Notle, Shkolnikov & McKee, 2000b). In addition, such variation may be more problematic during the crucial timing when the coding rules are in the process of being revised and improved (e.g., 1988–1989; 2001–2002), but such dramatic revision in coding rules is less likely to affect variations of mortality during the period under the same coding rule. Victims of suicide and homicide may be potentially hidden in the injury categories due to

social stigma, similar to eastern European statistics (Riphahn & Zimmermann, 1998).

Conclusions

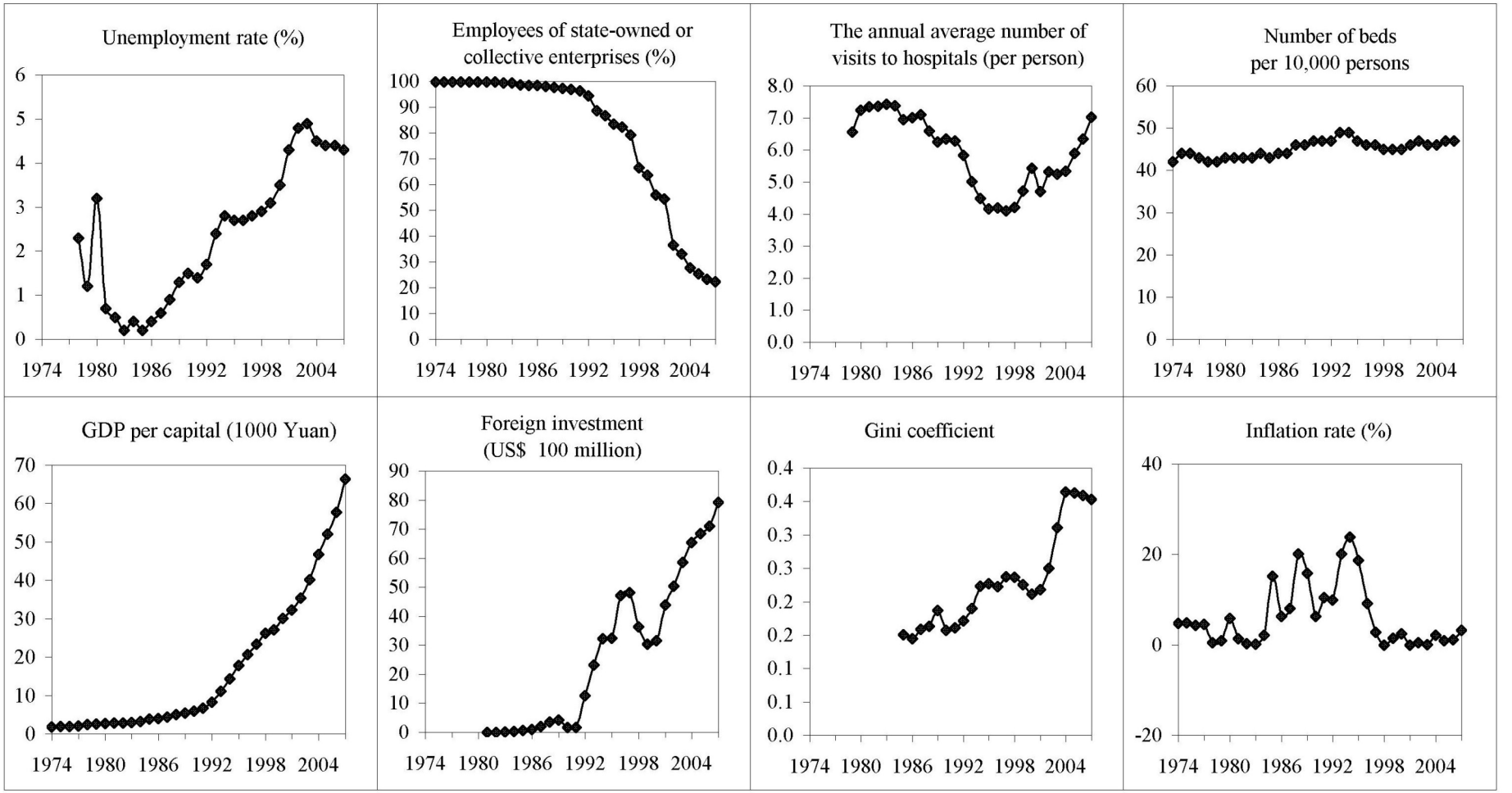
Overall, our mortality study focusing on Shanghai suggests that economic transformation from a planned to a market economy initially increased the risk of death, especially among working-age males during the period 1992–1996. However, income growth effectively compensates for loss of job security under economic reform in a stable social and political environment, which leads to a net reduction in mortality. Hence, social safety and order is maintained. In Shanghai, this transformation process succeeded except for an avoidable increase in traffic injury.

As noted, the hazardous consumption of alcohol was a major proximate factor of the mortality crisis in Russia during the reform. Further research could examine the effect of alcohol on mortality in high-alcohol areas in China, especially those provinces with deep state-owned enterprise reform and a high prevalence of hazardous drinking (e.g., Liaoning) during the transformation period. In addition, further examination can focus on changes in mortality differentials by education, employment status, and marital status. Also, sociopolitical reform has a long march ahead of it in China, and there will certainly be other episodes of major change in the future, such as further political and economic reform (BBC, 2012), that deserve further mortality studies.

Table 1 Selected features of male mortality during economic transition in Shanghai, Czech Republic, East Germany, Poland, and Russia

Economies	Mortality transition period	Change in probability of dying (age 20–44 years)	Causes of death contributing to changes in LE[a]
Initial surge in mortality due to transition			
Shanghai	1992–1996	Increased by 14%	CVD, Injury
Czech Republic	1989–1990	Increased by 10%	CVD, Injury
East Germany	1989–1991	Increased by 29%	CVD, Injury
Poland	1989–1991	Increased by 18%	CVD, Injury
Russia	1992–1994	Increased by 68%	CVD, Injury
The period after the initial surge			
Shanghai	1997–2007	Steadily decreased by 38%	CVD, Respiratory Disease
Czech Republic	1991–2007	Steadily decreased by 34%	CVD
East Germany	1992–2007	Steadily decreased by 55%	CVD
Poland	1992–2007	Decreased by 34%	CVD
Russia	1995–2007	Decreased by 15% overall, but experienced second peak 1998–2003	CVD, Injury

Note: [a]Major causes of death producing the loss of life expectancy during the early phase of reform, or contributing to increase in LE during the late phase of reform.
Source: The Human Mortality Database; Nolte, Shkolnikov & McKee, 2000a, 2000b; Meslé & Vallin 2011; Meslé 2004; Vogt & Kluesener, 2011; Fihel, 2011.



Data Source: Shanghai Municipal Statistical Bureau, 1983–2011; Shanghai Municipal Statistical Bureau, National Bureau of Statistics Survey (Shanghai Groups), 2009.

Fig. 1. Changes in socioeconomic indicators in Shanghai: 1974–2007

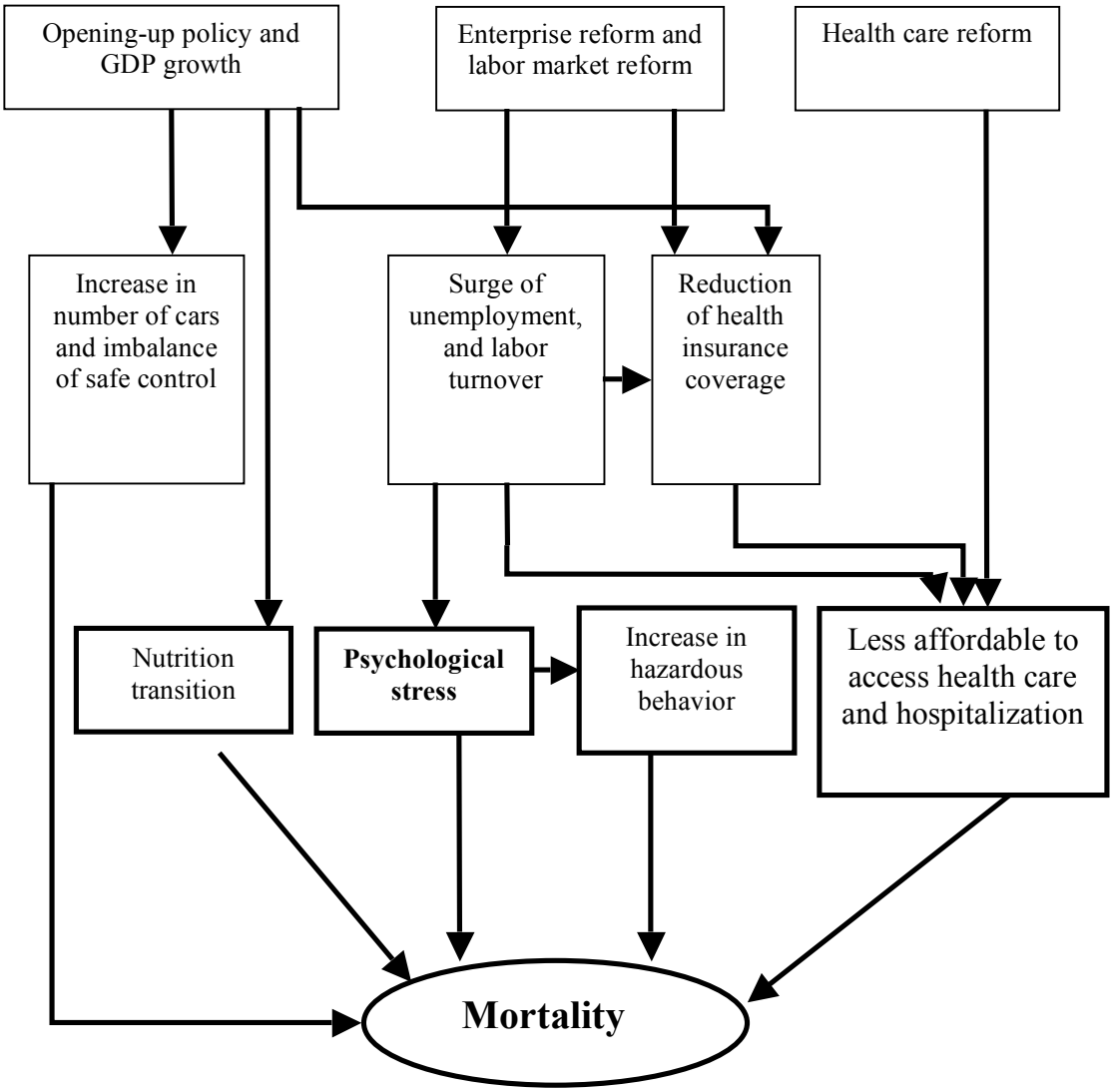


Fig. 2. Summary of the side effects of reforms on mortality

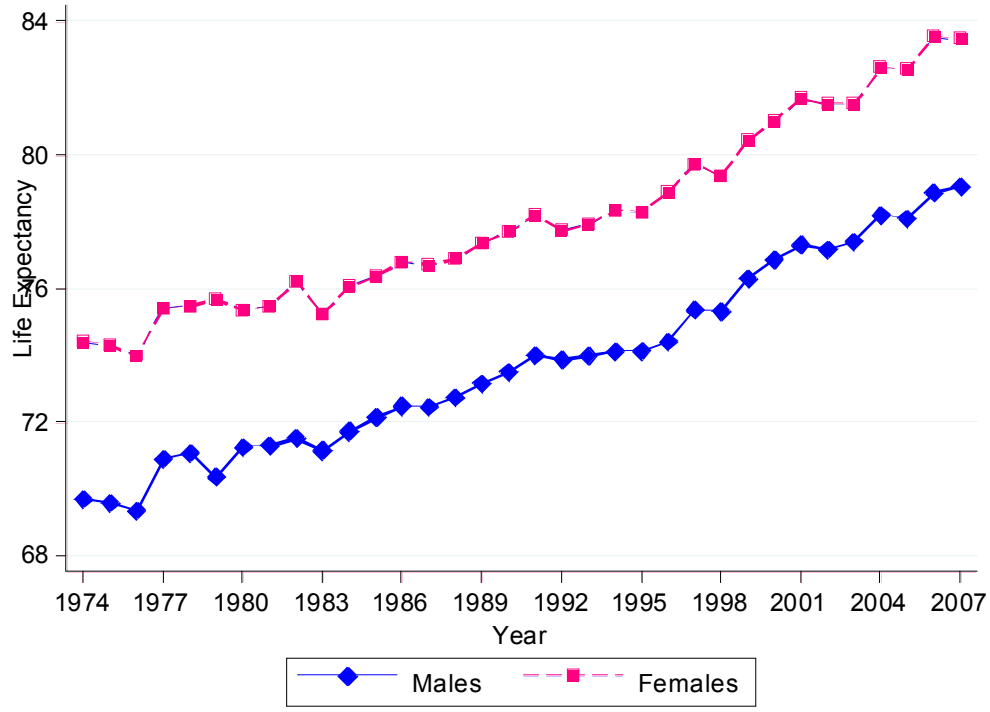


Fig. 3. Life expectancy (LE) at birth in Shanghai: 1974–2007

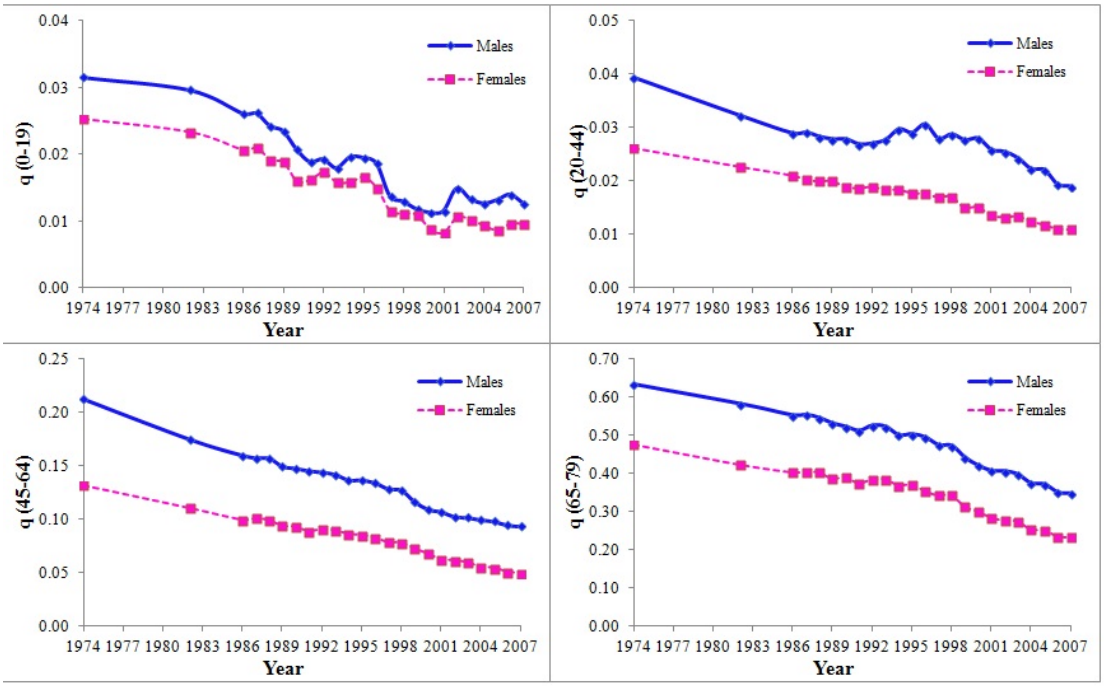


Fig. 4. Trends in probabilities of dying (q(x)) for broad age groups in Shanghai

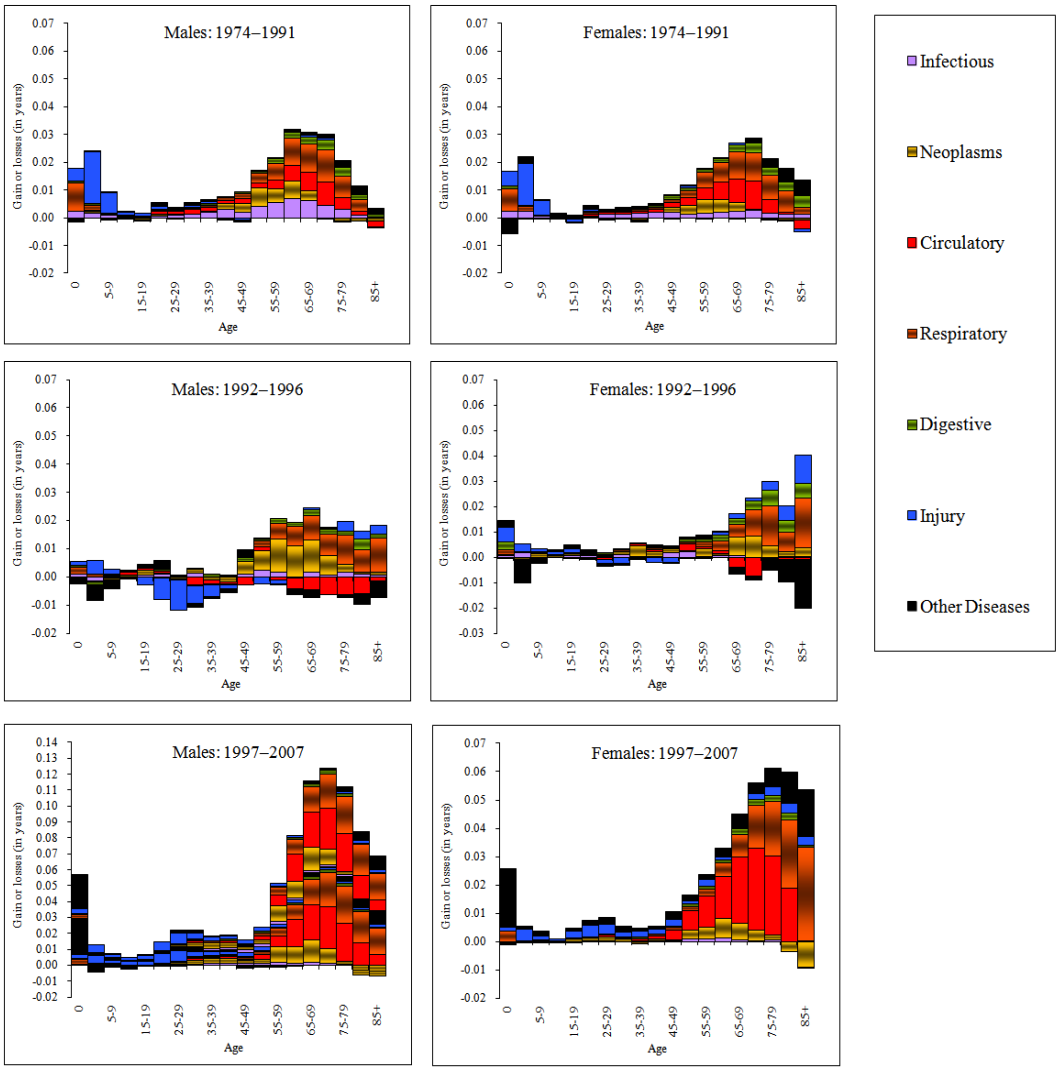
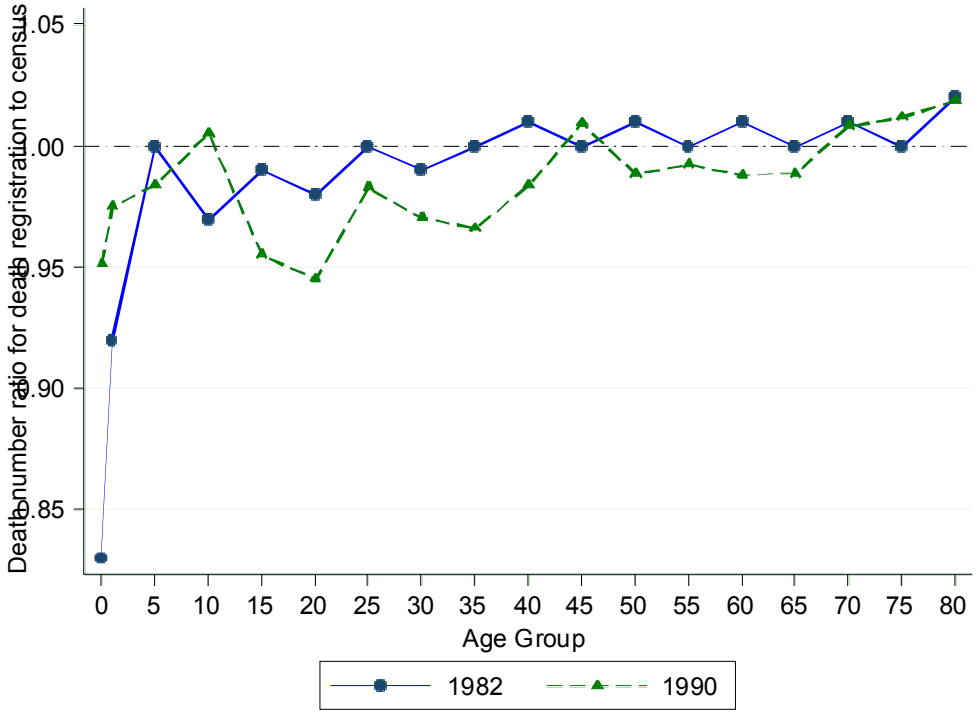


Fig. 5. Contribution of changes in mortality by age and causes of death to gains and losses in life expectancy (per year) over three phases (1974–1991; 1992–1996; and 1997–2007)

Appendix 1 Death number ratio for death registration to census in Shanghai: 1982, 1990



Appendix 2 Parameter estimate (β_1) for trends in monthly mortality in Shanghai: 1992–2007

Age Group	Causes of death	1992-1996				1997-2007			
		Males		Females		Males		Females	
0-19	Total	0.0136		-0.0022		0.0179	***	-0.0063	
	Neoplasms	-0.0015		-0.0306		-0.0129		0.0012	
	Lung cancer	-0.0075		0.0060		-0.0031		-0.0096	
	CVD	-0.0242		-0.0329		-0.0057		-0.0044	
	Liver Diseases	-0.0650	.	-0.1768	*	-0.0238	**	-0.0089	
	Injury	0.0093		-0.0256		-0.0666	***	-0.1017	***
	Traffic	0.0636		0.0057		-0.0162		-0.0694	***
	Suicide	-0.0048		-0.0315		-0.0250	*	-0.0571	***
20-44	Total	0.0296	***	-0.0147	**	-0.0443	***	-0.0496	***
	Neoplasms	-0.0039		-0.0278	***	-0.0394	***	-0.0190	***
	Lung cancer	0.0773	***	0.0176		-0.0319	*	-0.0199	
	CVD	0.0342	*	-0.0177		-0.0376	***	-0.0522	***
	Liver Diseases	-0.0120		-0.0151		-0.1022	***	-0.1173	***
	Injury	0.0824	***	0.0219	*	-0.0380	***	-0.0695	***
	Traffic	0.1255	***	0.0788	***	-0.0471	***	-0.0635	***
	Suicide	0.0175		-0.0577	***	-0.0547	***	-0.0854	***
45-64	Total	-0.0173	***	-0.0171	***	-0.0338	***	-0.0488	***
	Neoplasms	-0.0283	***	-0.0104	*	-0.0196	***	-0.0158	***
	Lung cancer	-0.0269	***	0.0120		-0.0138	***	-0.0109	*
	CVD	0.0145	*	-0.0088		-0.0492	***	-0.1010	***
	Liver Diseases	-0.0228	*	-0.0493	**	-0.0605	***	-0.0756	***
	Injury	0.0216	*	0.0191		-0.0231	***	-0.0436	***
	Traffic	0.0735	***	0.1317	***	-0.0309	***	-0.0429	***
	Suicide	-0.0289		-0.0504	*	-0.0338	***	-0.0383	***
65+	Total	-0.0126	*	-0.0147	*	-0.0370	***	-0.0379	***
	Neoplasms	-0.0130	***	-0.0208	***	-0.0065	***	0.0005	
	Lung cancer	0.0028		-0.0089		-0.0058	**	0.0108	***
	CVD	0.0093	*	0.0039		-0.0383	***	-0.0363	***
	Liver Diseases	-0.0222	*	-0.0317	*	-0.0571	***	-0.0301	***
	Injury	-0.0477	***	-0.0608	***	-0.0419	***	-0.0415	***
	Traffic	0.0404	*	0.0114		-0.0341	***	-0.0326	***
	Suicide	-0.0723	**	-0.0903	***	-0.0873	***	-0.0626	***

Significant codes: "*"=P<.05, "**"=P<.01 , "***"=P <.001

Note: Mortality rates for each age-sex group (0–19, 20–44, 45–64, 65+) were standardized according to the five-year-age-sex structure of the WHO standard population (Ahmad, 2001).

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