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Cohort profile: protocol and baseline survey for the Shanghai Suburban Adult Cohort and Biobank (SSACB) study

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ABSTRACT

Purpose The Shanghai Suburban Adult Cohort and Biobank (SSACB) was established to identify environmental, lifestyle and genetic risk factors for non-communicable chronic diseases (NCDs) in adults (20–74 years old) living in a suburban area of Shanghai with rapid urbanisation.

Participants Two of eight suburban district were purposely selected according to participant willingness, health service facilities, population, geographic region and electronic medical record system. From these suburban districts, four communities were selected based on economic level and population size. At stage three, one-third of the committees/villages were randomly selected from each community. All residents aged 20–74 years old were invited as study participants.

Findings to date The baseline data on demographics, lifestyle and physical health-related factors were collected using a face-to-face questionnaire interview. All participants completed physical examinations and had blood and urine tests. Blood and urine samples from these tests were stored in a biobank. From 6 April 2016 through 31 October 2017, we conducted face-to-face interviews and clinical examinations in 44 887 participants: 35 727 from Songjiang District and 9160 from Jiading District. The average age of participants was 56.4±11.2 years in Songjiang and 56.6±10.5 years in Jiading. The prevalence of hypertension, diabetes and dyslipidaemia was 34.0%, 8.2% and 11.1%, respectively.

Future plans In-person surveys will be conducted every 5 years. For annual tracking, baseline data was linked to the local health information system, which was composed of an electronic medical record system, a chronic disease management system, a cancer registry system, an infectious disease report system and a death registry system. The data of the SSACB cohort is located in the School of Public Health, Fudan University. International and domestic collaborative research projects are encouraged and inherent in the project.

Strengths and limitations of this study

- The Shanghai Suburban Adult Cohort and Biobank (SSACB) study is a population-based, large-sized natural cohort study that uses a representative sample living in a suburban area with rapid urbanisation.
- The SSACB study was linked with a local population-based information system which consists of an electronic medical record system, a chronic disease management system, a cancer registry system, an infectious disease report system and a death registry system.
- During the baseline survey, blood and urine samples were collected at one time, thus limiting the ability to assess the effect of exposures to different risk factors.
- The assessment of health at baseline used a self-reported questionnaire which may lead to information bias. Such limitations associated with the use of this type of data for research are unavoidable.

INTRODUCTION

Increases in urbanisation and industrialisation, and the ageing population have led to major epidemiological changes, especially increases in the prevalence rates of non-communicable chronic diseases (NCDs) and their sequelae.[1] Rapid urbanisation is the main cause of the unplanned growth of cities, and has led to problems such as increased exposure to environmental risk factors and health disparities.[2] Extensive attention worldwide has been devoted to large-scale construction of urban agglomerations, as this has often accompanied serious cases of environmental contamination and increases in incidence rates of chronic diseases.[3] Several studies in low/middle-income countries (LMICs) found that rapid and unplanned urbanisation may increase the prevalence of NCDs, such as obesity, diabetes, hypertension, dyslipidaemia and chronic kidney disease.[4–6]

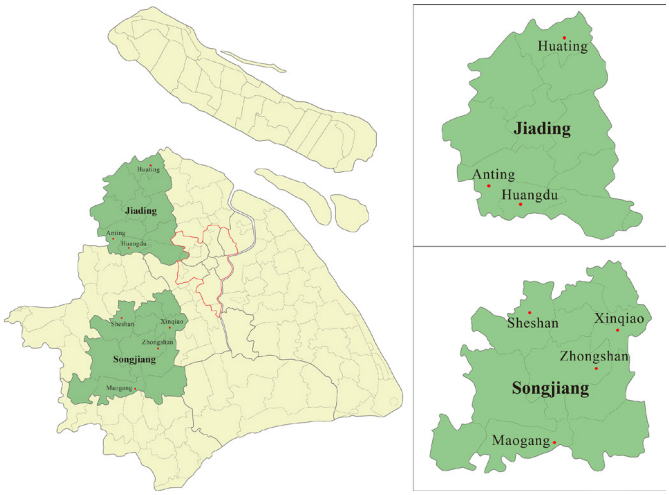

Figure 1 Sampling area of the Shanghai Suburban Adult Cohort and Biobank.

China, which has the largest population in the world, has experienced a burgeoning urbanisation and industrialisation. The percentage of the Chinese people living in urban areas has increased dramatically, from 26% in 1990 to 59.4% by the end of 2017.[7] China has also experienced the largest overflow of migrant workers, a long period of increasing house prices and growing infrastructure construction in many of its largest cities. All these changes accompanying the increasing urbanisation can lead to significant changes in lifestyles, and an increase of NCDs.[8–10] According to the Chinese Nutrition and Health Surveillance (CNHS) of 2010–2013, during 2013 the prevalence of overweight was 30.1% (32.0% greater than in 2002) and the prevalence of obesity was 11.9% (67.6% greater than in 2002) among Chinese adults (≥18 years old).[11] The prevalence of hypertension in Chinese adults (≥18 years old) rose from 18.8% in 2002 to 25.2% in 2012. The China Non-Communicable Disease Surveillance (CNCDS) of 2010 estimated that there were 113.9 million adults with diabetes and 493.4 million adults with pre-diabetes in China.[12]

Shanghai is one of the largest and most urbanized cities in China, and has also experienced a rapid growth of NCDs. From 2007 to 2010, the prevalence rates of overweight and obesity among Shanghai adults (18–69 years old) increased by 5.0% and 2.4%, respectively.[13] In addition, an estimated one-third of people in Shanghai were overweight or obese in 2010, and this number continues to increase. The prevalence of hypertension in Shanghai adults was 28.4% in 2013, higher than the national average (25.2%) and higher than the prevalence in urban residents (26.8%) of China.[14] From 1973 to 2010, the overall incidence of cancer for those living in urban Shanghai decreased slightly in men, but increased significantly in women.[15]

To lower the disease burden of NCDs, it is crucial to identify risk factors using large prospective cohort studies. Thus, China developed a surveillance network for NCDs, and launched several large nation-wide prospective cohort studies.[16–18] The China Health and Nutrition Survey (CHNS; which differs from the aforementioned CNHS) is an ongoing, prospective, open cohort study that began in 1989. CHNS currently covers 12 provinces and 3 municipal cities and accommodates all levels of socioeconomic development throughout China. The China Kadoorie Biobank (CKB) began a baseline survey of more than 0.5 million people during 2004–2008 in five urban and five rural geographically defined regions of China, and these study participants are currently undergoing long-term follow-up.[16] However, the impact of urbanisation and economic development on the health of people in China is complex. For example, Chen reported that the relationship of health with urbanisation had an inverted U-shape for high-income and middle-income people (with turning points at urbanisation rates of 0.0% and 49.2%, respectively).[5] The relationship of health with had an inverted U-shape for high-income and low-income people (with turning points at per capita GDP of 93 462 yuan and 71 333 yuan, respectively) and a linear relationship for middle-income people.[5]

Many studies have investigated the mechanisms through which urbanisation influences health. However, it is still unclear why economic development and urbanisation affect health in China, and how the relationship of

Table 1 Timeline of the Shanghai Suburban Adult Cohort and Biobank

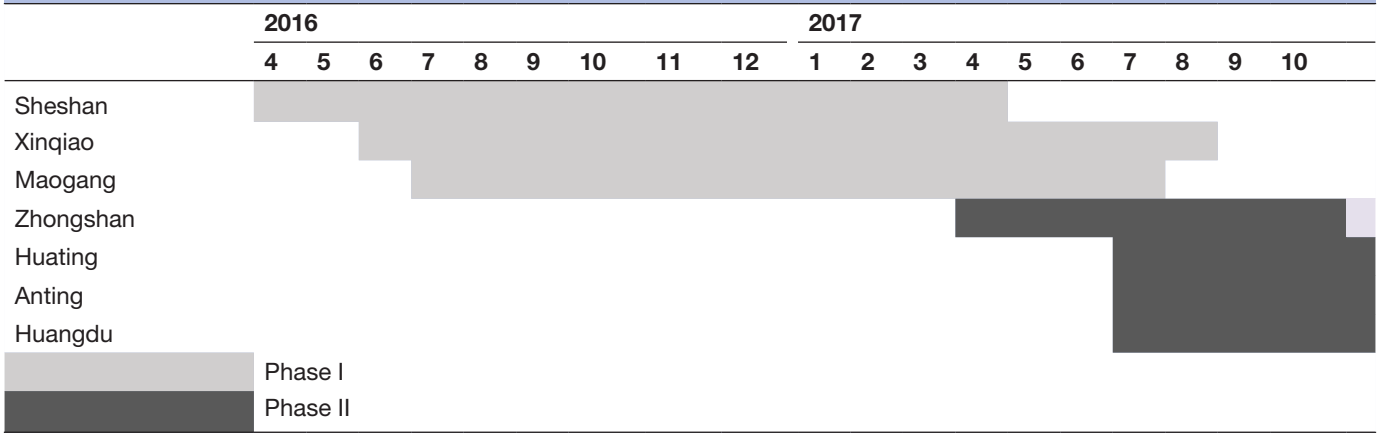

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Table 2 Data collected at baseline

Component	Measurements
Demographics	► Age, gender, education level, occupation, marital status, health insurance, birth weight, duration of breast feeding
Lifestyle	► Smoking, alcohol intake, tea, exercise, sleep disorder (Pittsburgh Sleep Quality Index (PSQI))
Family	► Family structure, family harmony, history of family diseases
Disease history and medical record	► Hypertension, diabetes, Cardiocascular disease, respiratory disease, Tuberculosis, cancer, gout, hyperlipidemia, gastritis, enteritis, hepatitis, intestinal polyps, fatty liver, cirrhosis, chronic kidney disorders, thyroid disorders, Parkinson's syndrome, Alzheimer's disease, depression, schizophrenia ► Surgery history
Food Frequency Questionnaire (FFQ)*	► Staple foods: rice, grains, tubers ► Eggs, milk, yoghurt ► Fruits and vegetables ► Meat, poultry, seafood ► Soy food, mushroom, nuts ► Processed foods, carbonated drinks, candy, cookies, etc
Living environment	► Drinking water source ► Occupational exposures ► Passive smoking exposure ► Cooking and heating fuels ► Distance to the nearest main road ► House renovation ► Air conditioning and air purification
Health status	► Self-evaluation
Economic status	► Family income
Reproductive history (women)	► Age at menarche, menstrual history, pregnancy history, hormone replacement therapy history

*Data were obtained regarding usual dietary intake over the past 12 months.

urbanisation and development with health varies among different income groups.[19] To bridge these gaps, the Shanghai Suburban Adult Cohort and Biobank (SSACB), as part of the prospective cohort of a natural population from East China and supported by the Ministry of Science and Technology (MOST), was established to identify environmental, lifestyle and genetic risk factors for NCDs in Chinese adults (20–74 years old) residing in newly urbanised areas in Shanghai. Shanghai has eight suburban districts which were rural areas 10–20 years ago. Residents in these districts have been experiencing rapid urbanisation and dramatic economic, environmental and lifestyle-related changes. In contrast to urban and rural residents, the residents of newly urbanised areas in China are experiencing more dramatic changes in their lives. For example, many residents of Shanghai suburban areas experienced the demolition of their houses and resettlement, for which the government provided large monetary compensation. Another example of these dramatic changes is that many young suburban residents work in urban areas, and experience an exhausting daily commute. These two factors can have a huge impact on the lifestyles and health of these residents. Existing research has looked at the prevalence of chronic disease in urban and/or rural residents, but data are scarce for this special population with ongoing rapid urbanisation. Our study helps lay a foundation for further investigation on the impact of urbanisation on health.

COHORT DESCRIPTION

Study setting and participants

A multi-stage, stratified, clustered sampling method was used to select study sites. Two of eight suburban district were purposely selected according to participant willingness, health service facilities, population, geographic region and electronic medical record system. Within these two suburban districts, we selected seven communities as the study sites of SSACB: four from Songjiang (Zhongshan, Xinqiao, Sheshan and Maogang) and three from Jiading (Anting, Huating and Huangdu) based on their economic level and population size (figure 1). One-third of the committees/villages were randomly selected from each community. In each committee, all residents who were 20–74 years old were invite as participants of the SSACB cohort.

Recruitment for the SSACB began in April 2016, and baseline interviews and examinations were subsequently

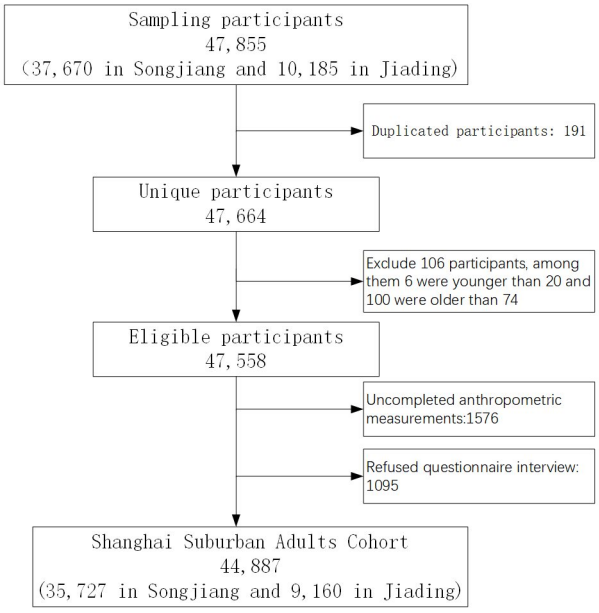

Figure 2 Disposition of enrolled participants.

conducted. This process was separated into two phases: Phase I was conducted from April 2016 to August 2017 in Xinqiao, Sheshan and Maogang, and phase II was from May 2017 to October 2017 in Zhongshan, Anting, Huating and Huangdu (table 1).

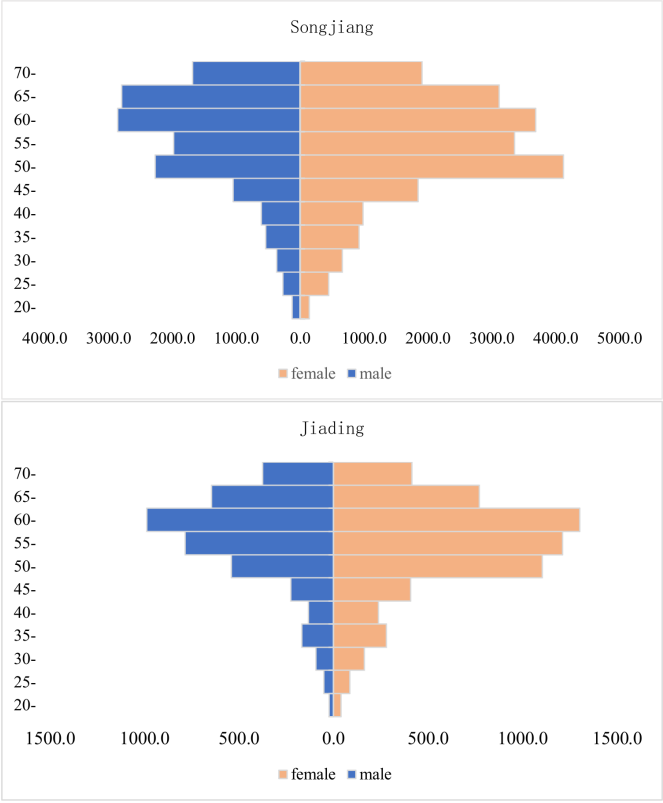

Figure 3 Age ranges of male and female participants in Songjiang district (up) and Jiading district (low).

Data collection

All participants were invited to receive a free physical examination at the local community health centre. Participants were also interviewed face-to-face by trained investigators after written informed consent was obtained. To allow valid comparisons with other studies, including the CKB,[16] CLHLS,[17] CHARLS,[18] CHCCS,[20] and national and international epidemiological studies, the SSACB used standardised and validated instruments for data collection (table 2).

The questionnaire interviews involved self-designed software with an Android tablet which provided paperless data input and audio records for subsequent review. The survey at each community had about 10 quality-control workers who were responsible for examining the quality of all uploaded questionnaires and audio files. On each day of the questionnaire survey, these individuals provided the interviewers feedback on the content quality and audio quality of the previous survey. Five percent of all audio-recording files were randomly selected and carefully checked to ensure the quality of the questionnaire interview process.

Each enrolled participant was invited to receive a free physical examination at the local community health centre. These exams recorded anthropometric measurements (height, weight, waist circumferences, heart rate and resting blood pressure), electrocardiography, and B-mode ultrasonography of the hepatobiliary system, pancreases and kidneys. Kidney size was determined by B ultrasonography. All measurements were performed according to standard protocol by licensed physicians in the communities. Anthropometric measurements were conducted with participants wearing light clothing and no footwear. Height was accurate to 0.1 cm and weight was accurate to 0.1 kg. BMI (kg/m^2) was classified into four categories: underweight (<18.5), normal (18.5–23.9), overweight (24–27.9) and obese (>28), according to the reference standard of Chinese body mass index.[21 22] Waist circumference was measured using a flexible tape at the mid-point between the iliac crest and the last rib while the subject was at minimal respiration. Blood pressure was measured on the right arm in a sitting position using a digital sphygmomanometer after 5 min of rest. Three measurements were taken and the mean value was recorded. Smoking was defined as having smoked at least one cigarette per day for a period of 6 months or longer. Alcohol intake was defined as drinking at least three times per week for a period of 6 months or longer. Tea drinking was also defined as drinking tea at least three times per week for a period of 6 months or longer. We collected information about types and duration of participants' weekly physical activities in detail. Exercise was defined as performing physical activity (lasting at least 10 min) per week. Anxiety state was divided into no anxiety, moderate and extreme anxiety, and was according to participants' self-report. The diagnosis of chronic diseases was was reported by the participants himself/herself included

Table 3 Demographic data and lifestyle factors of participants (N, %)

	Songjiang			Jiading			Total		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
Age, years									
<40	1307 (9.0)	2176 (10.3)	3483 (9.7)	342 (9.2)	577 (10.6)	919 (10.0)	1649 (9.1)	2753 (10.3)	4402 (9.8)
40~60	6428 (44.3)	11 014 (51.9)	17 442 (48.8)	1682 (45.4)	2901 (53.2)	4583 (50.0)	8110 (44.5)	13915 (52.2)	22025 (49.1)
>60	6779 (46.7)	8023 (37.8)	14 802 (41.4)	1681 (45.4)	1977 (36.2)	3658 (39.9)	8460 (46.4)	10000 (37.5)	18460 (41.1)
Education									
Primary school	5690 (39.2)	11 026 (52.0)	16 716 (46.8)	833 (22.5)	1705 (31.3)	2538 (27.7)	6523 (35.8)	12731 (47.7)	19254 (42.9)
Middle school	5863 (40.4)	6815 (32.1)	12 678 (35.5)	1990 (53.7)	2495 (45.7)	4485 (49.0)	7853 (43.1)	9310 (34.9)	17163 (38.2)
High school	1617 (11.1)	1574 (7.4)	3191 (8.9)	477 (12.9)	708 (13.0)	1185 (12.9)	2094 (11.5)	2282 (8.6)	4376 (9.7)
College and above	884 (6.1)	284 (6.1)	2168 (6.1)	266 (7.2)	406 (7.4)	672 (7.3)	1150 (6.3)	690 (2.6)	1840 (4.1)
Other	460 (3.2)	514 (2.4)	974 (2.7)	139 (3.8)	141 (2.6)	280 (3.1)	599 (3.3)	655 (2.5)	1254 (2.8)
Occupation									
Worker	1670 (11.5)	2175 (10.3)	3845 (10.8)	441 (11.9)	394 (7.2)	835 (9.1)	2111 (11.6)	2569 (9.6)	4680 (10.4)
Farmer	406 (2.8)	575 (2.7)	981 (2.7)	107 (2.9)	106 (1.9)	213 (2.3)	513 (2.8)	681 (2.6)	1194 (2.7)
Officer	2253 (11.5)	2354 (11.1)	4607 (12.9)	600 (16.2)	600 (11.0)	1200 (13.1)	2853 (15.7)	2954 (11.1)	5807 (12.9)
Professional	969 (6.7)	439 (2.1)	1408 (3.9)	284 (7.7)	128 (2.3)	412 (4.5)	1253 (6.9)	567 (2.1)	1820 (4.1)
Retired	7463 (51.4)	13 494 (36.6)	21 314 (59.7)	1873 (49.6)	3926 (72.0)	5799 (63.3)	9336 (51.2)	17420 (65.3)	26756 (59.6)
Other	1753 (12.1)	2176 (10.3)	3929 (11.0)	400 (10.8)	301 (5.5)	701 (7.7)	2153 (11.8)	2477 (9.3)	4630 (10.3)
Marital status									
Married	13 761 (94.8)	19 431 (91.6)	33 192 (92.9)	3498 (94.4)	4980 (91.3)	8478 (92.6)	17259 (94.7)	24411 (91.5)	41670 (92.8)
Divorced/widowed	485 (3.3)	1588 (7.5)	2073 (5.8)	157 (4.2)	411 (7.5)	568 (6.2)	642 (3.5)	1999 (7.5)	2641 (5.9)
Never married	268 (1.8)	190 (0.9)	458 (1.3)	50 (1.3)	64 (1.2)	114 (1.2)	318 (1.7)	254 (1.0)	572 (1.3)
Smoking									
Yes	8354 (57.6)	63 (0.3)	8417 (23.6)	2463 (66.2)	9 (0.2)	2463 (26.9)	10817 (59.4)	72 (0.3)	10889 (24.3)
Alcohol intake									
Yes	4657 (32.1)	160 (0.8)	4817 (13.5)	1151 (31.1)	50 (0.9)	1201 (13.1)	5808 (31.9)	210 (0.8)	6018 (13.4)
Tea drinking									
Yes	8618 (59.4)	2064 (9.7)	10 682 (29.9)	2048 (55.3)	662 (12.1)	2710 (29.6)	10666 (58.5)	2726 (10.2)	13392 (29.8)
Physical exercise									
Yes	4660 (32.2)	6727 (31.8)	11 387 (32.0)	1481 (40.0)	2454(45)	3935 (43.0)	6141 (33.7)	9181 (34.4)	15322 (34.1)
BMI*									
Underweight	263 (1.8)	635 (3.0)	898 (2.5)	120 (3.2)	256 (4.7)	376 (4.1)	383 (2.1)	891 (3.3)	1274 (2.8)

Continued

Table 3 Continued

	Songjiang			Jiading			Total		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
Normal	5675 (39.1)	10 028 (47.3)	15 703 (44.0)	1636 (44.2)	2947 (54.0)	4583 (50.0)	7311 (40.1)	12 975 (48.7)	20 286 (45.2)
Overweight	6439 (44.4)	7759 (36.6)	14 198 (39.7)	1553 (41.9)	1697 (31.1)	3250 (35.5)	7992 (43.9)	9456 (35.5)	17 448 (38.9)
Obesity	2137 (14.7)	2791 (13.2)	4928 (13.8)	396 (10.7)	555 (10.2)	951 (10.4)	2533 (13.9)	3346 (12.5)	5879 (13.1)

*Body mass index (BMI) values were divided into four categorical levels based on the Working Group on Obesity in China: underweight, BMI<18.5 kg/m^2; normal, BMI 18.5–23.9 kg/m^2; overweight, BMI 24.0–27.9 kg/m^2 and obesity, BMI≥28 kg/m^2.

date of diagnosed, hospital of diagnosed and usage of medication.

For each participant, a 15 mL spot urine sample was collected and separated into a 5 mL tube and a 10 mL tube; the 5 mL tube was sent to the clinical diagnosis laboratory for testing, and the 10 mL tube was stored at −20°C for future use. A 16 mL fasting blood sample was drawn into four vacutainers; 2 mL was drawn into a tube containing EDTA and 4 mL was drawn using serum-separating tubes, both of which were sent to the clinical laboratories for testing; the other 10 mL was centrifuged, serum and blood clotting factors were aliquoted, and the sample was stored at −80°C for future use/biobank.

Follow-up schedule

The cohort follow-ups will consist of in-person surveys and annual checks of local health information system. The in-person surveys will be conducted every 5 years, and will be used to update the longitudinal data on measured factors and collect the new data on exposures to different risk factors. In order to track participants' health-seeking behaviour, outcome events and medication usage, the baseline survey data was linked to the local health information system, which consists of an electronic medical record system, a chronic disease management system, a cancer registry system, an infectious disease report system and a death registry system. The national identification card of each participant will be used to link the different databases.

Patient and public involvement

No patient involved.

Findings to date

From 6 April 2016 through to 31 October 2017, we conducted face-to-face interviews and clinical examinations in 44 887 participants: 35 727 from Songjiang District and 9160 from Jiading District (figure 2). The average age of participants was 56.4±11.2 years old in Songjiang and 56.6±10.5 years old in Jiading. Overall, 41.1% participants were older than 60 years (41.4% in Songjiang and 39.9% in Jiading), 38.2% were educated up to middle school and 59.5% were retired (figure 3, table 3). Table 4 shows the prevalence rates of selected chronic conditions among SSACB participants. The prevalence of hypertension was 34.0%, the prevalence of diabetes was 8.2% and the prevalence of dyslipidaemia was 11.1%.

Strengths and limitations

There are several features of the SSACB sudy that reflect the study's strengths. First, the SSACB cohort study differs from many other studies in its method for population selection. Many other existing cohort studies in China, have mainly enrolled participants from urban or rural areas, whereas the SSACB cohort has enrolled participants from recently urbanised areas, in which there was rapid urbanisation and industrialisation. Our study would help lay a foundation for further investigation on the impact of urbanisation on health. Second, our study uses an

Table 4 Prevalence of selected chronic conditions among Shanghai Suburban Adult Cohort and Biobank participants by age group and gender (N, %)

	Age group, years						Gender					
	<40		40~60		>60		Male		Female		Total	
Chronic conditions	N	%	N	%	N	%	N	%	N	%	N	%
Hypertension	174	4.0	6081	27.6	9015	48.8	6932	38.0	8338	31.3	15270	34.0
Diabetes	41	0.9	1536	7.0	2108	11.4	1631	9.0	2054	7.7	3685	8.2
Dyslipidaemia	162	3.7	2336	10.6	2475	13.4	2163	11.9	2810	10.5	4973	11.1
Cardiovascular disease	13	0.3	568	2.6	1354	7.3	758	4.2	1177	4.4	1935	4.3
Chronic bronchitis	155	3.5	1339	6.1	1779	9.6	1288	7.1	1985	7.4	3273	7.3
Cancer	12	0.3	271	1.2	379	2.1	228	1.3	434	1.6	662	1.5

electronic information system to track all possible outcome events. Both Songjiang and Jiading Disease Control and Prevention centres have effective health information systems which include the following items: population-based disease registry, infectious disease report, chronic disease management, cancer registry and death registry. This ensures that any common or uncommon health events can be investigated in the future. Third, SSACB is a large, population-based prospective cohort study that uses a representative sample of suburban residents. A large sample size allows for the assessment of some small but important differences in subgroups, and it can also accommodate nested case-control studies for further analyses. Moreover, SSACB study is part of the natural population cohort of East China, which is supported by the China MOST, and will be integrated in to the China natural population cohort in the future.

It is also important to highlight the limitations of our SSACB study. First, we only collected a blood sample and urine sample at one time during the baseline survey, thus limiting the ability to assess the effect of exposures to different NCD risk factors. Second, the assessment of chronic disease conditions at baseline was obtained from a self-reported questionnaire, which may lead to information bias. Such limitations associated with the use this kind of data for health research are unavoidable. Moreover, the health outcome events in this study are from the health information system, which may be incomplete (particularly for participants visiting other hospitals outside the study site) or have poor quality of information. Furthermore, the baseline survey did not collect information on 24 hours dietary recall, sexual behaviour, or other sensitive topics that may have an impact on health. Finally, loss to follow-up is a common concern in cohort studies. However, we were able to minimise loss to follow-up through extensive data linkages across multiple data sources.

SUMMARY

In summary, the baseline survey of the SSACB cohort study has completed the collection of information from questionnaires, physical examinations, and blood and urine tests, and also has blood and urine samples stored in a biobank. These data are linked to the health information system for annual tracking. The SSACB cohort study is a large, prospective cohort study that investigates the unique characteristics of suburban residents, and will be a major contribution to research on NCDs in China. This study's importance in NCD research will continue to increase as follow-ups are conducted and continued over time.

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