

# Analysis of the Economic Burden of Noncommunicable Diseases in Dalian City of China, Based on the “System of Health Accounts 2011”

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## Research article

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# Abstract

**Objectives:** Noncommunicable diseases (NCDs) are the leading causes of morbidity and mortality worldwide. Understanding the distribution of diseases can provide a basis for policy formulation and intervention. This study analyses the status of the NCDs spending based on “System of Health Accounts 2011” (SHA 2011), to provide health policy advice to China, and give guidance for other areas in the world.

**Methods:** Data were collected by multi-stage stratified random sampling in 2018. The medical expenses of patients with NCDs were calculated based on SHA 2011, Analyze from funding sources, dimensions of institutional flow, and financing scheme. The factors influencing the cost of hospitalization were analyzed by linear regression. All analyses were conducted by software SPSS 25.0 and STATA 15.0.

**Results:** A total of 392 institutions and 2,478,359 valid items were included for study. The current curative expenditure (CCE) of NCDs was 15.914 billion CNY. 61.78% of NCDs financing came from public financing scheme. The proportion of family health financing (32.56%) was higher. The expenditures were mainly in general hospitals (74.95%). Elderly patients account for the majority (76.35%). Drug expenses, length of stay, and institution level were the major factors affecting hospitalization expenses.

**Conclusions:** NCDs are the main economic burden of diseases in Dalian, and its resources are not allocated reasonably. To reduce the economic burden of NCDs, the government needs to optimize resource allocation, and rationalize institutional flows and functions.

## Introduction

Due to the gradual transition of diseases spectrum, noncommunicable diseases (NCDs) are now the leading causes of morbidity and mortality worldwide [1-2]. According to the World Health Organization (WHO), NCDs currently cause more deaths than all other causes combined. In 2012, 56 million people died worldwide, 38 million (68%) were caused by NCDs, and NCD deaths are projected to reach 52 million by 2030. The situation is worse in low- and middle-income countries (LMICs), Nearly three-quarters of these NCDs deaths occurred in LMICs, and the death rate is about 1.6 times higher than in high-income countries [3-4]. It is also a huge challenge even among the richest countries which are members of the Organization for Economic Co-operation and Development (OECD) [5], NCDs are among the most prevalent and costly health conditions in the United States. Besides, NCDs also have a huge impact on families and poverty [6-7]. Especially for the uninsured and the elderly [8].

NCDs have a long incubation period, and cannot heal after the onset or difficult to heal [9-11], which raised demand for long-term care expenditures. During 2001-2025, cumulative economic losses due to NCDs under a “business as usual” scenario in LMICs have been estimated at US\$ 7 trillion, which is sum far outweighs the annual US\$ 11.2 billion cost of implementing a set of high-impact interventions to reduce the NCDs economic burden [3]. A recent study by the Harvard School of Public Health and World Economic Forum estimates that over the next 20 years, at the global level, NCDs will cost more than US\$ 30 trillion, representing 48% of global GDP in 2010, and will push millions of people below the poverty line[12]. As a result, many countries around the world have made NCDs a priority for Universal Health Coverage (UHC), which is considered a key element of sustainable human development goals [13-16].

China is the largest developing country in the world, it had 6.6 million deaths from chronic diseases in 2015, the highest of any country in the world [17]. In addition to the excessive death toll related to the population base, China's aging population, especially the elderly over the age of 60, is related to the increase. A study showed that 92% of the elderly had at least one NCDs and 77% had two NCDs [18]. China has more than 230 million people over the age of 60, accounting for 16.7% of the total population in 2016[19]. Since 2010, the elderly population has increased by 29.5% [20].

Older adults with good household assets and access to medical services were less likely to experience multimorbidity [21]. Dalian is located in the southern northeast China, its elderly population over 60 more than the national average, which brought difficulties to prevention and management of NCDs [22-23].

Previous work was focused on specific types of NCDs or specific regions of the world [24-26], although this can provide a more accurate intervention scheme for a certain NCDs, it is easy to waste resources if it is not grasped at a higher level because there are more people have more than one type of NCDs [18], and there are more types of NCDs. In this study, we collected expenditure information of NCDs patients in Dalian and used "System of Health Account 2011" (SHA 2011) to count each part of curative expenditure[27-28]. As a result, China began to adopt the new accounting system "SHA 2011" in 2014. SHA 2011 further developed additional analytical possibilities, it provides a breakdown of input factors and associated costs for health care products and services. For example, based on the basic characteristics of patients, we can calculate the medical costs under different ages, gender, and disease categories. And can make more accurate division between expenditure and input. Current research on SHA 2011 is not much, China National Health Development Research Center has analyzed the health costs and financing of chronic non-communicable diseases in 2010, which brings reference to NCDs policy making. With the changes in the disease spectrum and social development, we need new evidence about the economic burden of NCDs [29]. Therefore, this paper chooses Dalian's health data, analyses the status of the NCDs spending by SHA 2011, provides health policy advice in this city, gives guidance to other parts of China, and offers a reference basis in China's medical insurance.

## Material And Methods

### 1. Data sources

The data included total health expenditure and sample health expenditure. Total health expenditure data provided by Dalian Health Development Research Center, including Dalian Statistical Yearbook 2018, Dalian Health Accounting Report 2018, Dalian Health Finance Annual Report 2018, and Dalian Health Statistics Annual Report 2018. Sample health expenditure were obtained by sampling medical institutions.

### 2. Study sample

This study was based on the "Health expense accounting System 2011" in China, adopts multistage stratified cluster random sampling. This method comes from China National Health Development Research Center[30].A total of 392 institutions with valid data were collected. (Appendix file 1)

There are multiple diagnoses of the same patient in the survey data. In this study, only the patients with the first diagnosis of NCDs were selected, without considering other complications. A total of 2,478,359 valid items for NCDs from January 1 to December 31, 2018 were collected.

### 3. Quality control and data management

In order to ensure accuracy, we conducted training for sample institutions in 2017. Data were processed by graduate students trained China National Health Development Research Center. Submit the audited data to the China National Health Development Research Center for further review, and only after the review was approved can the post-calculation be started. Data management were followed the basic accounting guidelines of SHA 2011[31]. All data were processed by Stata 15.0 (TX, USA).

### 4. Analyses of influencing factors of hospitalization curative care expenditure for NCDs

A total of 194,732 items of inpatient data was extracted from the whole valid items of NCDs. Expenditures don't conform to a Gaussian distribution but were log-normally distributed. Multiple stepwise regression was used to analyze the influencing factors. The independent variables were age, gender, length of stay, drug expenses, medical insurance or not, and institution level. Besides, the drug expenses are divided into 3 groups according to the quartiles. The lower group is less than  $Q_{25}$ , the middle group is  $Q_{25}$ - $Q_{75}$ , and the higher group is greater than  $Q_{75}$ . Inclusion criteria were 0.05 and exclusion criteria were 0.10. All statistical analyses were performed using SPSS 25.0 (Inc., Chicago, IL, USA).

## Results

### 1. The basic situation for NCDs.

In 2018, a total of 3,944,902 samples were included in the database, of which 2,478,359 (62.82%) were NCDs. The CCE was 24.163 billion CNY (1 USD  $\approx$  6.617 CNY), of which the CCE of NCDs was 15.915 billion CNY, accounting for 65.87%.

### 2. Allocation of CCE in different medical institutions

In terms of expenditure allocation of medical institutions, NCDs expenditures in 2018 were mainly concentrated in hospitals, accounting for nearly 90% of the total. General hospitals accounted for 74.95%, primary hospitals accounted for 5.52%, and outpatient and public health institutions accounted for less than 5%. The inpatient expenditures of NCDs was 11.007 billion CNY, accounting for 69.16% of all, higher than the outpatient, which was 4.908 billion CNY (30.84%). Compared with the whole disease, the expenditure of NCDs in primary hospitals and public health institutions account for a relatively low proportion, and the total inpatient expenditures ratio was significantly higher. (Table 1)

Table 1  
Institutions for inpatient and outpatient[100 million CNY(%)]

Institutions	CCE for NCDs			CCE for all diseases		
	Total	Outpatient	Inpatient	Total	Outpatient	Inpatient
Hospital	143.07(89.90)	36.16(25.27)	106.91(74.73)	211.29(87.44)	62.5(29.58)	148.79(70.42)
General hospital	119.29(74.95)	25.67(21.52)	93.62(78.48)	172.26(71.29)	45.77(26.57)	126.48(73.42)
Traditional Chinese medicine hospital	6.12(3.85)	1.61(26.31)	4.51(73.69)	9.91(4.10)	3.21(32.39)	6.7(67.61)
Special hospital	17.66(11.10)	8.89(50.34)	8.77(49.66)	29.13(12.06)	13.52(46.41)	15.61(53.59)
Primary medical and health institutions	8.78(5.52)	6.65(75.74)	2.13(24.26)	14.15(5.86)	11.8(83.39)	2.35(16.61)
Outpatient service agencies	5.83(3.66)	5.83(100.00)	0(0.00)	8.95(3.70)	8.95(100.00)	0(0.00)
Public health agency	1.47(0.92)	0.44(29.93)	1.03(70.07)	7.23(2.99)	3.76(52.01)	3.47(47.99)
Total	159.14(100.00)	49.08(30.84)	110.07(69.16)	241.63(100.00)	87.02(36.01)	154.61(63.99)

### 3. Allocation of CCE in different financing scheme

For financing scheme, the proportion of NCDs in family health expenditure is lower than that of whole diseases (32.56% vs. 39.46%). The public financing scheme was the most important source of funds for both NCDs and whole diseases, and the proportion of NCDs was higher (61.78% vs. 55.18%). For all financing scheme, the inpatient expenditures of NCDs was higher than outpatient's, and the inpatient expenditures of NCDs was higher than that of all diseases. (Table 2, Fig. 1)

Table 2  
Financing scheme for inpatient and outpatient[100 million CNY(%)]

Service function	CCE for NCDs			CCE for all diseases		
	Total	Outpatient	Inpatient	Total	Outpatient	Inpatient
Public financing scheme	98.31(61.78)	31.66(32.20)	66.66(67.81)	133.34(55.18)	51.11(38.33)	82.23(61.67)
Social medical insurance	10.75(6.76)	3.55(33.02)	7.2(66.98)	8.75(3.62)	3.24(37.03)	5.52(63.09)
Government financing	87.57(55.03)	28.11(32.10)	59.46(67.90)	124.59(51.56)	47.88(38.43)	76.71(61.57)
Voluntary financing scheme	9.01(5.66)	0.46(5.11)	8.55(94.89)	12.95(5.36)	0.83(6.41)	12.12(93.59)
Family health expenditure	51.82(32.56)	17.15(33.10)	34.67(66.90)	95.34(39.46)	36.86(38.66)	58.48(61.34)

#### 4. Allocation of CCE in different ages

The age distribution of NCDs shows that before the age of 65, with the increase of age, the CCE keeps increasing, reaching the highest level in the 60–64 groups, reaching 2.301 billion CNY. After that, the expenditure of CCE keeps decreasing. The 45–84 age group was the main group of NCDs CCE, accounting for 76.35% of the expenditure. The outpatient expenditure of NCDs was higher than inpatient before aged 35. However, The inpatient expenditure of NCDs was higher than outpatient after that. (Fig. 2)

#### 5. Allocation of CCE in different ICD-10 categories

Among the 22 categories classified by ICD-10, 15 categories include NCDs, among which the circulatory system was the highest with CCE of 4.227 billion CNY, followed by a tumor of 2.573 billion CNY and digestive diseases of 2.495 billion CNY. For these three categories, the hospitalization cost was much higher than the outpatient cost. (Table 3)

Table 3  
ICD-10 for inpatient and outpatient [100 million CNY (%)]

ICD-10	Total	Outpatient	Inpatient
Tumor	25.73(15.9)	4(15.55)	21.72(84.42)
Diseases of the blood and hematopoietic organs	0.83(0.51)	0.41(49.4)	0.42(50.6)
Endocrine, nutritional and metabolic diseases	9.31(5.75)	3.87(41.57)	5.44(58.43)
Mental and behavioral disorders	3.78(2.34)	0.59(15.61)	3.2(84.66)
Nervous system disorders	7.44(4.6)	1.06(14.25)	6.38(85.75)
Eye and appendage disorders	4.77(2.95)	1.73(36.27)	3.04(63.73)
Diseases of the ear and mastoid process	2.9(1.79)	0.63(21.72)	2.27(78.28)
Circulatory disease	42.27(26.12)	9.8(23.18)	32.47(76.82)
Respiratory disease	9.23(5.70)	2.03(21.99)	7.2(78.01)
Digestive diseases	24.95(15.42)	8.7(34.87)	16.25(65.13)
Diseases of the skin and subcutaneous tissue	3.23(2.00)	1.68(52.01)	1.55(47.99)
Diseases of the musculoskeletal system and connective tissue	12.78(7.90)	5.93(46.4)	6.85(53.6)
Urogenital diseases	11.84(7.32)	4.95(41.81)	6.88(58.11)
Congenital malformations, deformations and chromosomal abnormalities	0.52(0.32)	0.03(5.77)	0.48(92.31)
Others	2.24(1.38)	0(0.00)	2.24(100.00)

#### 6. Influencing factors to inpatient expenditure

Multiple linear regression was used to analyze the influencing factors of inpatient expenditures with NCDs. The included independent variables were gender, age, length of stay, drug expenses, whether insurance, and level of medical institution. There was no collinearity between independent variables and dependent variables. Finally, all independent variables except gender can be included in the regression equation ( $P < 0.001$ ). The linear model can explain the 47.8% change in total hospitalization expenses. The first three factors affecting hospitalization expenses were the drug expenses, length of stay, and institution level (Table 4).

Table 4  
Regression analysis of influencing factors of hospitalization expenditure

	Unstandardization Coefficient		Standardization Coefficient	T	Sig
	B	S.E	Beta		
Constant	3.478	0.004		941.066	∅0.001
Length of stay	0.015	∅0.001	0.266	152.430	∅0.001
Drug expenses level	0.245	0.001	0.484	271.038	∅0.001
Age	0.001	∅0.001	0.007	4.209	∅0.001
Insurance	-0.005	0.002	-0.004	-2.614	∅0.001
Institution level	-0.087	0.001	-0.198	-117.047	∅0.001

\*B = unstandardization regression coefficient. SE = Standard Error. Beta = standardization regression coefficient. T = t test value (t-statistic). Sig = significance (p) of coefficients.

## Discussion

The impact of NCDs on the health burden is global, and its economic burden is the heaviest of all types of disease. In LMICs, it is simultaneously a rapid growth in the health and economic burden of NCDs [3]. In Middle-income countries, such as Russia and India, where the OOP burden of NCD payments has been found to be significant; Even in the United States, NCDs are among the most prevalent and costly health conditions[24]. NCDs receives comparatively little attention compared to infectious disease treatment [32]. So far, only four Asian countries, that have published information on NCDs financing [33], and those were years ago. Which presents us with a challenge in formulating health policy. The purpose of this study is to describe the economic expenditure of NCDs in Dalian, and to analyze the similarities and differences between different types of NCDs, different medical institutions, different service function, different ICD-10 categories, and the influencing factors to inpatient expenditure.

Previous studies show a steady global increase in household expenditure on NCDs from 1999 to 2014[34]. In 2018, The CCE of NCDs accounts for 65% of the total CCE, considering the number of included samples, the average health cost of NCDs may be higher than other diseases. Therefore, we should take more forceful measures to deal with the possible impact of NCDs, which is also the call of The United Nations and WHO [35–36].

This study shows that the CCE of NCDs is related to age, before the age of 65, the CCE increases with the increasing of the age, this is similar to previous studies, the people who are over the age of 60 are at high risk of NCDs [37–38]. At present, because of the unhealthy lifestyle, 150 million young people smoking, 84% of teenage girls and 78% of boys who lack physical exercise, 11.7% of teenagers drink alcohol, while 41 million children under the age of five are overweight or obese around the world [3], NCDs is becoming younger. Previous studies have shown that high blood pressure and diabetes, are on the rise among young people[39–40], this study found that CCE of NCDs higher group is 45–84 age group. Although the elderly are still the main focus of NCDs, we should not ignore the young and we should advocate a healthy lifestyle, such as not smoking, drinking less alcohol, and taking more exercise [41–42].

The CCE financing of NCDs mainly comes from public financing scheme, although the proportion of family health expenditure is lower than total disease, it still above 30%. Contrary to other studies [6–7], this may be due to higher health expectations among residents of economically developed regions [3]. In recent years, China has adopted some active health policies, in 2013, China's basic medical insurance coverage has reached more than 95%[43], in 2017, began

to implement Drug zero markup policy[44], in 2018, the national basic Public health benefits have increased from 50 to 55 CNY per person[45]. All this has dramatically reduced household health spending. However, NCDs is easy to cause household poverty [46–47], and we should continue to increase financial support to reduce household spending, especially for hospitalized patients, the proportion of family health expenditure is higher.

In China, high-quality medical resources are mostly concentrated in the 3A (Class Three/Grade A) hospitals, although graded treatment has been carried out for some years, the results are not significant. People tend to go straight to the 3A hospital [48]. The CCE of NCDs in Dalian city accounts for nearly 90% in the hospital, higher than that of all diseases, which shows that the hierarchical diagnosis and treatment advocated in China's medical reform is not carried out smoothly. For NCDs, primary health care, such as primary health care institutions and public health agencies, should be given more responsibility [49]. NCDs have a long course and require frequent medical treatment [9–10]. While 80.00% of basic medical care can be provided in primary medical and health institutions, and more medical resources can be used for NCDs treatment in primary medical and health institutions, which is more cost-effective in resource allocation and use [29]. Besides, primary care programs such as family doctors should be promoted by regional characteristics.

For all ICD-10 categories, the CCE of circulation system is highest, on the one hand, it is related to unhealthy lifestyles, such as smoking, lack of exercise, unbalanced diet and so on, on the other hand, we have to attach importance to the influence of the environment, Although in our knowledge, the environment is often associated with respiratory diseases, studies have shown that the deterioration of environment can increase the incidence of various diseases such as chronic diseases [49]. Therefore, we must pay attention to the environment protection, strengthen the health behaviors throughout the whole life cycle, and establish health programs for key disease populations.

The results of multiple regression analysis showed that drug cost, length of stay, and type of insurance were the main factors affecting CCE. As for drug costs, we should continue to promote the Drug zero markup policy and avoid increasing the medical institution checking cost, medical service cost prices, and the cost of the whole health system [50]. The length of stay can be shortened by improving the efficiency of hospitals [51]. To control health expenses, the hospital should improve the level of diagnosis and treatment levels, and establish common NCDs of the basic norms of evidence-based clinical guidelines [52]. Dalian plans to achieve full medical insurance coverage by 2020. However, this study shows that there is still a gap with this goal. Considering the economic burden and mortality rate of NCDs in all types of diseases, reimbursement rates for NCDs diseases should be increased. For NCDs with high prevalence rate, high treatment frequency, and early control, special compensation schemes should be explored and designed.

## Limitation

Firstly, the bias caused by the samples. Since the information systems of different medical institutions are not unified, we cleaned and sorted the data as much as possible according to the ICD-10 code. But we believe although part of the data was discarded, the quality of the samples was guaranteed, and the quantity was sufficient to conclude this study. Secondly, only the patients with the first diagnosis of NCDs were selected, without considering other complications, which may have a greater reference value for the major diagnosis of NCDs. Thirdly, as an economically developed area, the results of Dalian city have little real-time reference value to the poor areas.

## Conclusion

The SHA 2011 accounting system can help explain CCE. NCDs still face problems of medical coverage and access to medical services in Dalian, and their costs are closely related to drug cost, length of stay, and institution level. The government needs to restructure financing, redistribute the costs of NCDs, and rationalize institutional flows and functions.

## Declarations

### Ethics approval and consent to participate

The study was supported by Health Commission of Dalian city and Ethics Committee of China Medical University. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and national research committee and with the Helsinki declaration and its later amendments or comparable ethical standards. This manuscript adheres to the appropriate reporting guidelines and community standards for data availability.

### Consent for publish

Not applicable.

### Availability of data and materials

The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

### Competing interests

The authors declare that they have no conflict of interest.

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### Authors' contributions

QF designed the whole process and did the pre-research. QF and SLZ were the main drafters of the manuscript. SZ and HZ did some of the expeditionary research. BXL contributed the coordination and manuscript editing. XW was the director for the fund and designed ideas of research. All participated in the analysis and discussion of the topic, under the leadership and instruction of XW. All authors read and approved the final manuscript.

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## Figures

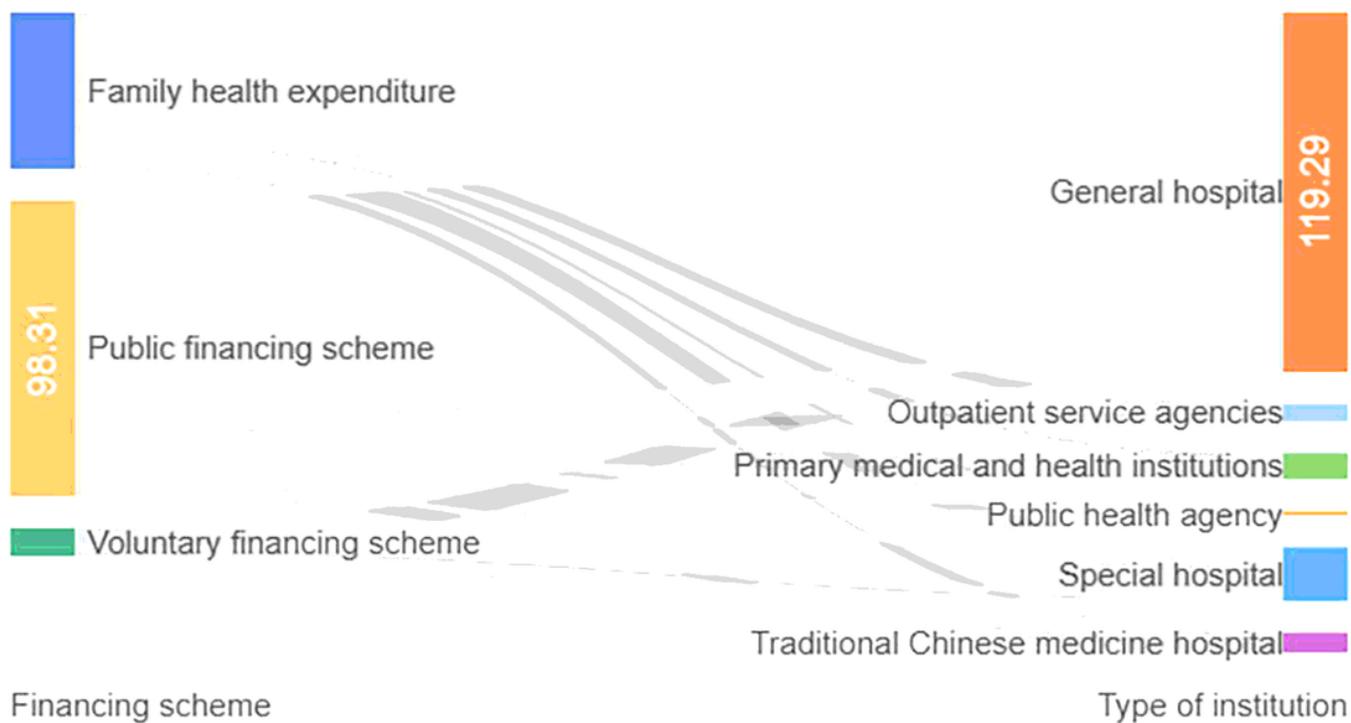
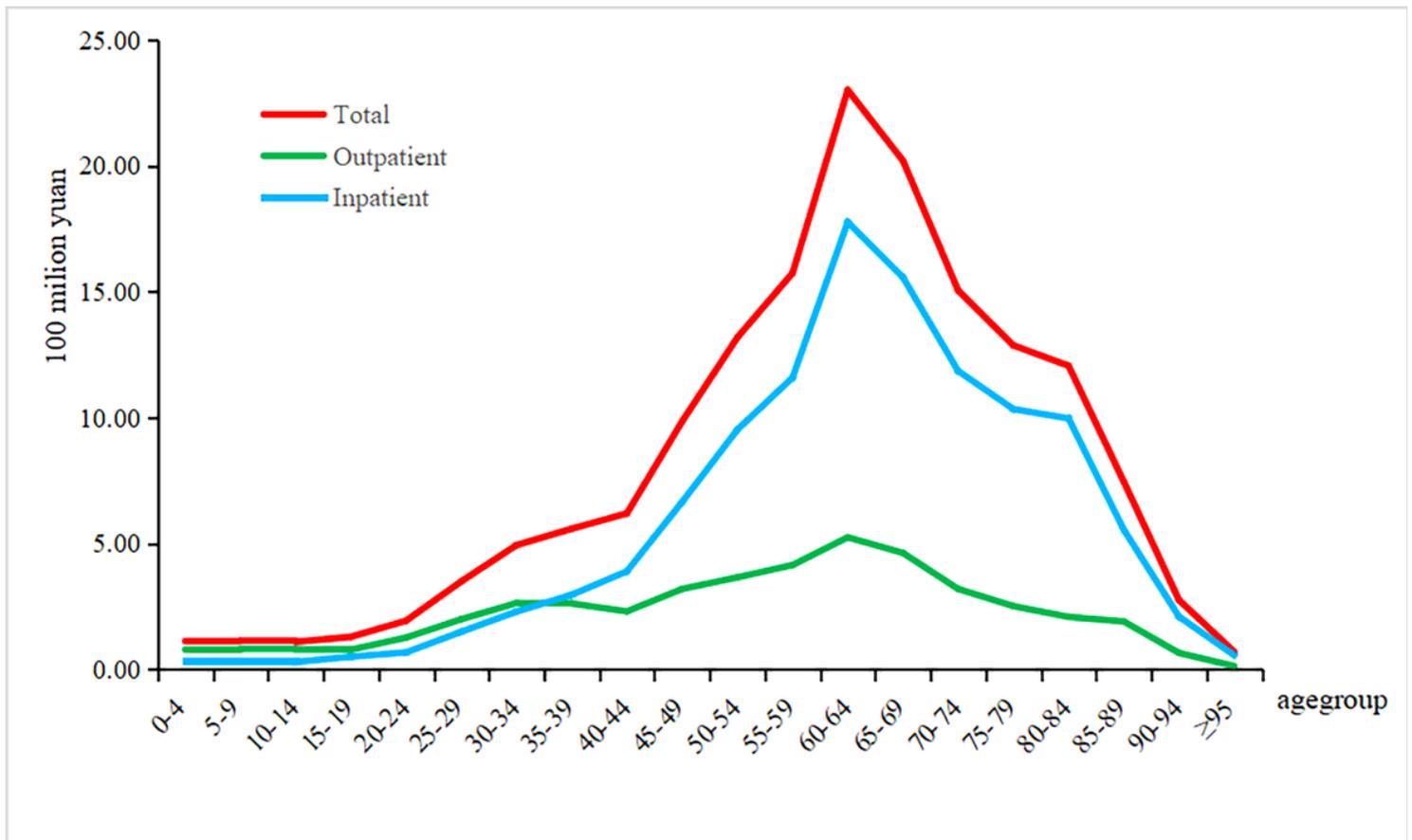


Figure 1

Flow of financing in different institutions



**Figure 2**

Age group for inpatient and outpatient

## Supplementary Files

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