

Does Family Doctor Contracting Improve the Health of the Elderly: An Empirical Study from Beijing, China

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Background: Amid rapid population aging and the rising prevalence of chronic diseases in China, family doctor contract services have become a key healthcare reform aimed at strengthening primary care. The elderly are a priority group for these services. This study examines their specific relationship on the health of older adults, providing a scientific basis for expanding the services and improving health outcomes in this population.

Methods: This study employed a cross-sectional research design. A cluster sampling method was used to select 2052 elderly individuals aged 60 years and above from a community in District F, Beijing. A total of 1814 valid questionnaires were collected, yielding an effective response rate of 88.40%. To analyze the relationship between family doctor contracting and the health status of the elderly, the PSM model was applied to construct a control group with similar observable characteristics, thereby addressing self-selection bias. Additionally, the 2SLS model was adopted, incorporating instrumental variables to control for potential endogeneity issues.

Results: The proportion of elderly individuals who signed contracts with family doctors was relatively low, at 21.72%. The average self-rated physical health score was 10.18. In the PSM analysis, the effect sizes for kernel matching, k-nearest neighbor matching, and radius matching were -0.17 , -0.09 , and -0.12 , respectively. The preference for primary medical and health institutions as the first point of care passed the weak instrumental variable test ($F=36.25$). The regression coefficient derived from the 2SLS method was -0.02 .

Conclusion: The willingness to sign up for family doctor services among the elderly in Beijing remains generally low. Health status is influenced by chronic disease, activity, education, and occupation, yet enrollment alone yields no significant improvement. This points to ineffective service engagement. Stronger policy authority, better mechanisms, aligned services, and enhanced execution and trust are urgently needed to realize family doctors' role.

Keywords: elderly, family doctor contract, health, propensity score matching, two-stage least squares

Background

Population aging has had a significant impact on global public health, with an estimated 1.5 billion people aged 60 years and older globally by 2030.¹ As a populous country, China's aging process is much faster than that of many other countries in the world.² By 2020, individuals aged 60 and older in China will reach 260 million, accounting for 18.7% of the total population.³ By 2035, the number of people over the age of 60 in China is expected to increase to 420 million, indicating that the aging situation in China is becoming increasingly serious and placing increasing pressure on healthcare service providers.⁴ Due to the changes in environment and lifestyle, the prevalence of chronic diseases in the elderly has increased, and the number of elderly people suffering from one or more chronic diseases has reached 75.80%.⁵ For example, changes in living environment such as increased social pressure brought by urbanization, and

lifestyle changes such as decreased exercise of the elderly due to increasing age will increase the prevalence of cardiovascular diseases in the elderly.⁶ At the same time, the elderly receive less social support and face the risk of social isolation, which seriously affects the health level of the elderly.⁷ Improving the health of the elderly promotes the sustainable development of the social-demographic structure of society and reduces the burden of medical care for the elderly on families and society, so it is of great significance to improve the health level of the elderly.⁸

Contracting family physician services is a key strategy for achieving primary care goals and has been implemented in more than 50 countries. This model originated in the United States and developed rapidly in countries such as the United Kingdom, Germany, Cuba, and Denmark, each forming its own unique service model.⁹ China introduced the concept of “family doctors” in the 1980s and began promoting contracted services nationwide in 2016. These services aim to provide continuous, safe, effective, and appropriate primary medical care, public health services, and health management through a team-based total health management approach.¹⁰ In terms of policy implementation, the state has issued a series of policy documents for regulation and guidance. For example, guiding policies such as the Guiding Opinions on Promoting Contracted Services of Family Doctors have been released, clarifying the objectives, content, methods, and safeguard measures. Implementation emphasizes multi-sector collaboration, integration of grassroots health resources, and the formation of teams consisting of general practitioners, nurses, and public health professionals.¹¹ Goals include improving access to primary care, reducing costs, fostering long-term trust between physicians and patients, and enabling chronic disease management and health planning for older adults. However, challenges remain—most policies are non-binding guidelines, leading to inconsistent implementation and varying service quality across regions, which may affect outcomes and inform future research.

Globally, family doctor contract service has drawn widespread attention as an important strategy for improving the quality of primary healthcare and promoting population health. Although this service model has been adopted in many countries as a key means to enhance primary care and has been actively promoted in China since 2016, existing research still has notable limitations. First, most studies focus on factors influencing the uptake of family doctor services among older adults, such as income and education level.^{12,13} Some research has further examined determinants of continued use, including service accessibility and perceived quality.¹⁴ However, systematic evaluations of post-signing health outcomes remain scarce. Second, while a few studies have explored the effects of family doctor contracts on medical expenses, patient satisfaction, and quality of life,^{15–18} there is still a lack of large-sample empirical evidence regarding health improvements among older adults—a key contracting group. Moreover, existing studies predominantly rely on descriptive statistics or simple regression analyses,^{19,20} which are insufficient for addressing self-selection bias and endogeneity, thereby compromising the reliability of their conclusions. Against the backdrop of rapid population aging and a high prevalence of chronic diseases in China, clear evidence is still lacking on whether family doctor contract services can effectively enhance the health status of older adults. This population is exposed to multiple health risk factors and generally experiences poor overall health. In China, family doctor contract services specifically prioritize older adults.²¹ Therefore, it is essential to investigate the association of these services on the health of the elderly. To address this gap, using empirical data from the older adult population in Beijing, this study employs propensity score matching (PSM) and two-stage least squares (2SLS) to systematically evaluate the health effects of family doctor contracted services. This approach addresses key deficiencies in current service effect evaluations, methodological rigor, and research focusing on the elderly group.

This study focused on contracted family doctor services for the elderly in Beijing, China. Through empirical analysis, this study reveals the relationship of contracted services and other factors on the health level of the elderly. This study not only provides key evidence for the optimization of China’s primary medical and health service system and the formulation of family doctor contracts and service policies but also improves the accessibility and effectiveness of contract service. At the same time, the results of this study can provide a reference for countries with similar national conditions and global aging societies to deal with the health challenges brought by aging. It will help improve the global health governance system and jointly promote the improvement of the health level of the elderly and the realization of health equity.

Object and Method

Survey Object

This study conducted a cross-sectional survey in Beijing, China, from July to August 2021. A cluster sampling method was used to conduct a questionnaire survey among the elderly aged ≥ 60 years in a community. First, Area F is situated at the urban-rural fringe, and its socioeconomic conditions, healthcare resources, and population structure exhibit characteristics of “urban-suburban-rural” integration, offering strong regional representativeness. Second, Community A has a concentrated elderly population with a reasonable age distribution, aligning with the age structure of the elderly population in Beijing. Third, cluster sampling is easy to organize, cost-effective, and yields a high response rate, making it suitable for a comprehensive survey of all elderly residents in the community while avoiding the sampling bias associated with individual sampling. In summary, this study selects all elderly individuals in Community A, Area F, Beijing as the sample. Inclusion criteria: (1) The subjects were older than or equal to 60 years old. (2) The respondents are willing and able to clearly answer the questionnaire questions; Exclusion criteria: (1) Elderly people who are not willing to participate in this survey. (2) Questionnaires with more missing values and logic errors included a total of 2052 people as research objects. According to the sample size calculation formula,

$$n = \frac{\mu^2 \alpha \rho (1 - \rho)}{\delta^2}$$

$\rho=28.20\%$ (according to a study in the same region, 28.20% of the elderly in all the survey subjects signed a contract with a family doctor¹¹) allows an error of $\delta=0.025$, making $\alpha=0.05$ and $\mu\alpha=1.96$. The minimum sample size required, calculated using the sample size formula, was 1245 individuals. This study actually enrolled 2052 older adults in Community A who met the inclusion criteria. The actual number of participants far exceeds the minimum requirement, indicating that the study has sufficient statistical power in terms of sample size.

Questionnaire Survey Method

The questionnaire was designed on the basis of a previous literature review. The questionnaire mainly included four parts: the first part was sociodemographic information (including age, gender, place of residence, marital status, and educational level), the second part was personal disease history, the third part was physical activity, and the fourth part was lifestyle and health status. Cronbach's α coefficient and KMO value of the tested questionnaire were 0.792 and 0.891 ($P<0.05$), indicating that the questionnaire had good reliability and validity. The paper questionnaire was used to conduct a questionnaire survey on the elderly people through uniformly trained investigators. A total of 2052 questionnaires were sent out in this study, and 1814 valid questionnaires were finally collected, with an effective recovery rate of 88.40%. Invalid questionnaires are mainly due to substandard filling quality and missing key indicators, such as regular answers, significantly abnormal data that cannot be verified.

Propensity Score Matching (PSM Model)

Signing up with family doctors is a choice made by the elderly according to their own needs, not the result of random selection, which may produce self-selection bias and affect the research results. Therefore, this study uses the propensity score matching method to explore the relationship of signing up with family doctors on the health of the elderly. The physical health of the elderly is taken as the explained variable, and whether to sign a contract with a family doctor is taken as the core explanatory variable (treatment factor). By matching the treatment group (contracted family doctor service) with the appropriate control group (not contracted family doctor service), the treatment effect of the health outcomes of the two groups of the elderly was obtained, and the relationship of the family doctor contract on the health of the elderly was evaluated. Firstly, the logit model was used to calculate propensity score $P(X_i)$ to match the signed and unsigned elderly people. The co-supporting hypothesis test requires that there be no significant difference between the variable characteristics of the control group and the treatment group, and the standard deviation should be less than 20%. The co-supporting hypothesis test requires that most samples of the control group and the treatment group can be successfully matched. Finally, the Average Treatment Effects on the Treated (ATT) on the health of the elderly family doctor contract was calculated.²² In order to ensure the robustness of the matching results, kernel matching, K-nearest neighbor matching, and radius matching were used to calculate the ATT. By comprehensively applying these three

matching methods, we can estimate the treatment effect from different perspectives and mutually verify the robustness of the results. If the results obtained by the three methods have the same trend, it will enhance our confidence in the research conclusion. By default, the secondary kernel is used for kernel matching, bandwidth is set to 0.06, k-nearest neighbor matching n is set to 4, and the radius matching caliper range is set to 0.02.²³

Two-Stage Least Squares (2SLS Model)

There may be a mutual causal relationship between whether an elderly person contracts with a family doctor and their health. That is, the poor health of the elderly may prompt them to sign up and seek the help of a family doctor. Rather than improving their health by signing up with a family doctor. Thus, endogeneity problems may arise and affect the research results. The two-stage least squares method is a commonly used method to solve endogenous problems. The regression model is built by using instrumental variables, which should meet the requirements of correlation and externality. That is, it is highly correlated with the endogenous variables but uncorrelated with the random error term.

Willingness can be understood as a preference or inclination toward a particular activity, choice, or decision. Many scholars at home and abroad have used willingness as an instrumental variable to address endogeneity problems.²⁴ In this study, elderly respondents were asked whether, when feeling unwell, they would be willing to first seek care at primary medical institutions (such as community health service centers, their stations, or township health centers). This question serves to measure the elderly's willingness to use primary medical and health institutions as their first point of care. This willingness reflects the degree to which older adults prioritize primary care facilities when facing illness. The concept emphasizes recognition of and compliance with the hierarchical medical system, rather than a general inclination to seek medical care. Consequently, it has no direct relationship with physical health status, satisfying the exogeneity requirement for an instrumental variable. A strong willingness to first visit primary medical and health institutions indicates that the elderly have a high level of recognition of the hierarchical system and strong confidence in the service capacity of these institutions. Therefore, such willingness increases the likelihood of contracting with family doctors, meeting the correlation requirement between the instrumental variable and the endogenous variable.²⁵ Based on data availability, this study uses the elderly's willingness to first seek care at primary health care institutions as an instrumental variable.

Propensity score matching plays a different role than the two-stage least squares method.²⁶ The propensity score matching method mainly focuses on the source of the problem, and it focuses on solving the possible self-selection bias problem by selecting the appropriate matching reference object. From the point of view of process, the two-stage least squares rule mainly solves the endogeneity problem caused by mutual causality by selecting effective instrumental variables. The combination of these two methods can achieve a more accurate estimation of the influence effect, thus ensuring the accurate identification of the causal effect and making the research results more robust and reliable.²⁷

Variable Measurement: Explained Variable

Health level refers to the comprehensive state achieved by an individual in multi-dimensional physical, psychological and social adaptability, not only the absence of disease. Self-evaluation of health status is a subjective evaluation of health status made by individuals, which is consistent with objective health status. The studies of Manderbacka showed that the self-rated health index could scientifically and effectively evaluate the health level of residents.²⁸ Yang H further proved that the self-rated health index could effectively measure the health level of Chinese elderly people.²⁹ M. Vaez found through research that self-rated quality of life is significantly related to health status.³⁰ E. Huebner also pointed out that self-perceived quality of life is one of the criteria to evaluate the overall health level.³¹ Self-rated health focuses on two key dimensions: physical and mental. It can directly and effectively map the running state of the elderly's physical functions and the subjective feelings and experiences at the psychological level. The self-rated quality of life focuses on the actual situation of the elderly in terms of the degree of integration into the social network and the ability to adapt to social roles. The integration of self-rated health and self-rated quality of life can achieve a comprehensive, accurate, and systematic assessment of the health status of the elderly. Therefore, this study evaluates the health status of the elderly through the self-rated health status and the self-rated quality of life score, and the two questions are measured by the 7-point Likert scale, with a total score of 14.

Variable Measurement: Explanatory Variable

The core explanatory variable of this study is the signing status of family doctors of the elderly, which is measured by the question “Do you currently have a contract with a family doctor?” with two options, namely “signed (1)” and “not signed (0)”.

Variable Measurement: Control Variable

In this study, control variables were included according to the factors that affect the physical health status of the elderly pointed out in relevant studies.^{32,33} A total of 10 control variables were selected in this study, which were gender, age, marital status, pre-retirement occupation, education level, monthly income, smoking status, drinking status, physical activity intensity, and chronic disease comorbidity. The variables are shown in Table 1. The degree of physical activity was measured by the International Physical Activity Scale (IPAQ-SF). The scale measures the time and frequency of walking and moderate and vigorous physical activity per week. Intensity of physical activity = duration of activity × days of activity × MET value of this physical activity. The scale has good reliability and validity in the Chinese population.³⁴ Physical activity intensity refers to the rate of energy expenditure or physiological load incurred during physical activity. In this study, it was assessed using the International Physical Activity Questionnaire–Short Form (IPAQ-SF), which measures the

Table 1 Research Variable Assignment Table

| Variable | Assignment |
|---|--|
| Explained variable | |
| Family doctor contract status | 0= not signed; 1= Contract |
| Explanatory variable | |
| Self-assessment of health status | Very poor=1; poor=2; poorer =3; General=4; Better=5; Good=6; Very good=7 |
| Self-rated quality of life | Very poor=1; poor=2; poorer =3; General=4; Better=5; Good=6; Very good=7 |
| Control variable | |
| Sex (male as reference) | |
| Female | 0= no; 1= yes |
| Age (age 60 to 69 as reference) | |
| Age 70 to 79 | 0= no; 1= yes |
| Age ≥ 80 | 0= no; 1= yes |
| Educational attainment (with reference to illiteracy) | |
| Primary school | 0= no; 1= yes |
| Junior high school | 0= no; 1= yes |
| Senior high school | 0= no; 1= yes |
| Associate’s degree and bachelor’s degree | 0= no; 1= yes |
| Graduate and above | 0= no; 1= yes |
| Marital status (Use married as a reference) | |
| Unmarried | 0= no; 1= yes |
| Divorced | 0= no; 1= yes |

(Continued)

Table 1 (Continued).

| Variable | Assignment |
|--|---|
| Widowed | 0= no; 1= yes |
| Pre-retirement employment (by reference to workers) | |
| Government staff | 0= no; 1= yes |
| Professional technical personnel | 0= no; 1= yes |
| Others | 0= no; 1= yes |
| Average monthly income (RMB) | 0–1999=1; 2000–3999=2; 4000–5999=3; 6000–7999=4; ≥8000=5 |
| Smoking status (non-smoking as reference) | |
| Used to smoke | 0= no; 1= yes |
| Smoke now | 0= no; 1= yes |
| Drinking status (non-drinking as reference) | |
| Used to drink | 0= no; 1= yes |
| Drink now | 0= no; 1= yes |
| Physical activity level | Low physical activity =1; Moderate physical activity level =2; High level of physical activity =3 |
| Degree of chronic disease comorbidity | Continuous type variable |
| Instrumental variable | |
| Willingness of elderly people to first visit primary medical and health institutions | Very willing=5; fairly willing=4; fair=3; fairly unwilling=2; very unwilling=1 |

weekly duration and frequency of walking, as well as moderate- and high-intensity physical activity. Based on the established criteria for physical activity intensity, the physical activity level of the elderly participants was classified into three categories: high, moderate, and low. The questionnaire questions on smoking were set as three options: never smoking, ever smoking, and current smoking. The questionnaire questions about drinking were set as three options: never drinking, ever drinking, and current drinking. Chronic disease severity refers to the extent of the burden that confirmed chronic conditions impose on an individual's physical function, organ systems, and daily activities. The degree of chronic disease comorbidity is measured by the Charlson Comorbidity Index. The Charlson comorbidity index is a comprehensive index widely used in clinical research to measure the severity of patient comorbidities. It is based on the different chronic diseases of patients, combined with the weight of the relationship of each disease on the prognosis, and a weighted calculation of the total score. The higher the total score of the index is, the more serious the comorbidity is and the worse the health status is, which can more accurately reflect the overall health burden and nursing needs of patients.

Results

Demographic Characteristics of the Survey Participants

The proportion of respondents was equal between men and women, with the largest number of people aged 60–69 (38.42%). The average monthly income of the elderly is 4000–7999 yuan, 56.45% of the elderly were workers before retirement, the mean Charlson Comorbidity Index for the elderly was 1.99 ± 2.01 , and 52.70% of the elderly were willing or very willing to seek medical treatment in primary medical and health institutions. 21.72% of the elderly had signed a contract with a family doctor, and the average health self-rating score of the survey subjects was 10.18 ± 1.95 points. The demographic characteristics of the research subjects are shown in [Table 2](#).

Table 2 Demographic Characteristics of the Survey Participants

| Demographic Characteristics | Number of Persons (Persons) | Composition Ratio (%) |
|---------------------------------------|----------------------------------|-----------------------|
| Sex | | |
| Male | 979 | 53.97 |
| Female | 835 | 46.03 |
| Age | | |
| 60–69 | 697 | 38.42 |
| 70–79 | 567 | 31.26 |
| ≥80 | 550 | 30.32 |
| Marital status | | |
| Unmarried | 11 | 0.61 |
| Married | 1450 | 79.93 |
| Divorced | 32 | 1.76 |
| Widowed | 321 | 17.70 |
| Educational attainment | | |
| Illiteracy | 6 | 0.33 |
| Primary school | 93 | 5.13 |
| Junior high school | 689 | 37.98 |
| Senior high school | 637 | 35.12 |
| Junior college and undergraduate | 387 | 21.33 |
| Graduate and above | 2 | 0.11 |
| Average monthly income | | |
| 0–1999 | 2 | 0.11 |
| 2000–3999 | 16 | 0.88 |
| 4000–5999 | 815 | 44.93 |
| 6000–7999 | 733 | 40.41 |
| ≥8000 | 248 | 13.67 |
| Pre-retirement employment | | |
| Workers | 1024 | 56.45 |
| Government staff | 114 | 6.28 |
| Professional technical personnel | 357 | 19.68 |
| Others | 319 | 17.59 |
| Smoking status | | |
| Non-smoking | 1326 | 73.10 |
| Used to smoke | 229 | 12.62 |
| Smoke now | 259 | 14.28 |
| Drinking status | | |
| Non-drinking | 1308 | 72.11 |
| Used to drink | 104 | 5.73 |
| Drink now | 402 | 22.16 |
| Physical activity level | | |
| Low physical activity | 130 | 7.17 |
| Moderate physical activity level | 552 | 30.43 |
| High level of physical activity | 1132 | 62.40 |
| Degree of chronic disease comorbidity | 1.99±2.01 ($\bar{X} \pm \mu$) | |
| Family doctor contract status | | |
| Yes | 391 | 21.55 |
| No | 1423 | 78.45 |
| Average self-rated health score | 10.18±1.95 ($\bar{X} \pm \mu$) | |

Table 3 The Balance Test Results of Propensity Score Matching

| Nuclear Matching | Pseudo-R ² | LR χ^2 | Mean Bia | β |
|------------------|-----------------------|-------------|----------|---------|
| Before matching | 0.041 | 76.94 | 9.60 | 50.80 |
| After matching | 0.001 | 1.50 | 1.10 | 8.70 |

A Study on the Relationship Between Family Doctor Contract and Health Level in Elderly People Based on PSM

Parallel Hypothesis and Co-Supporting Hypothesis

This study explored the relationship between family doctor contracts and physical health (mental health) of the elderly by using three matching methods: nuclear matching, K-nearest neighbor matching, and radius matching. Since the hypothesis test and parallel hypothesis test results supported by the K-nearest neighbor matching method, radius matching method, and kernel matching method are basically the same, this study only shows the hypothesis test results of the kernel matching method.

The variables do not differ statistically after matching. After matching, the standard deviation of almost all variables was less than 5%, and the average standard deviation was only 1.10%, which was better than the absolute limit of 20% standard deviation. Pseudo-R² was close to zero, indicating that the dominant deviation between the variables of the treatment group and the control group was basically eliminated. The balance test results of propensity score matching are shown in Table 3. The kernel density before and after matching are shown in Figures 1 and 2 respectively.

The matching results of the treatment group and the control group are shown in Table 4. The results of the co-supporting hypothesis test show that the nuclear density curves of the matched and unsigned groups have the same trend, and the fitting degree is better. Among all the 1814 samples, 19 samples were excluded because they did not meet the matching conditions and met the common supporting hypothesis.

Average Treatment Effect of Family Physician Contract on Health Level of the Elderly (ATT)

The average treatment effect of family doctor contracts on the health of the elderly after matching is shown in Table 5. After satisfying the parallel and co-supporting hypothesis tests, propensity score matching was used to analyze the relationship of family doctor contracts on elderly health (self-rated health and quality of life). Kernel matching showed that the average treatment effect on health was below the critical value of 1.96 ($P > 0.05$). Robustness checks using K-nearest neighbor and

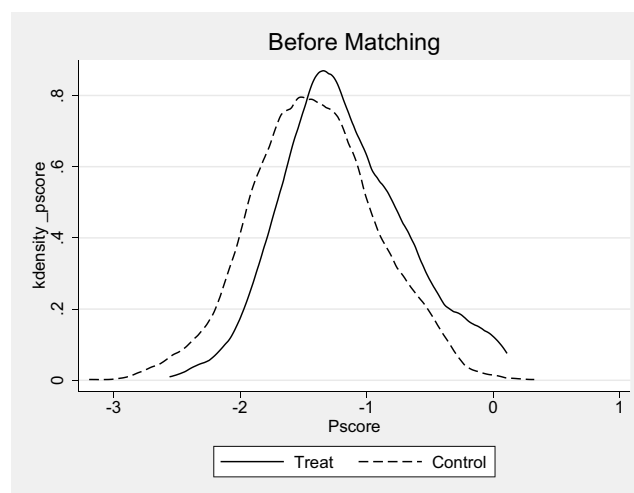


Figure 1 Kernel density before matching.

Notes: The solid line represents the probability density distribution of the propensity value of the treatment group, and the dashed line represents the probability density distribution of the propensity value of the control group.

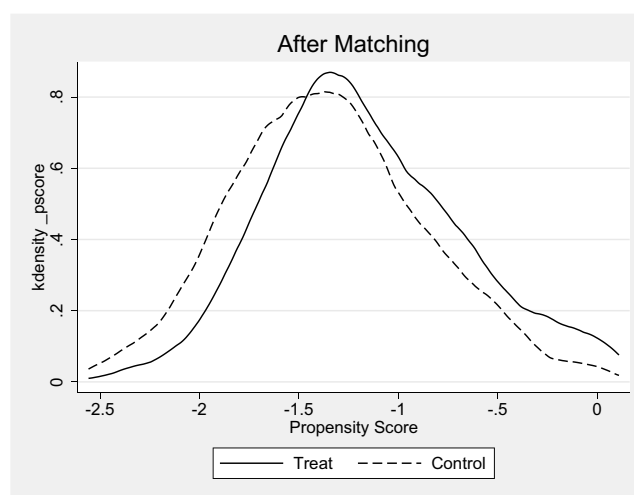


Figure 2 Kernel density after matching.

Notes: The solid line represents the probability density distribution of the propensity value of the treatment group, and the dashed line represents the probability density distribution of the propensity value of the control group.

radius matching yielded consistent results ($P>0.05$). Overall, no statistically significant difference in health was found between contracted and non-contracted elderly, suggesting that the current family doctor contract model may not yet produce the expected positive health effects. Further analysis of underlying reasons is warranted.

Table 4 Matching Covariates Difference Between Treatment Group and Control Group

| variable | Standard Deviation (%) | | Standard Deviation Elimination (%) | P | |
|---|------------------------|-------------------|------------------------------------|--------------------|-------------------|
| | Before Matchmaking | After Matchmaking | | Before Matchmaking | After Matchmaking |
| Sex (male as reference) | | | | | |
| Female | 8.50 | 0.70 | 71.90 | 0.03 | 0.62 |
| Age (age 60 to 69 as reference) | | | | | |
| Age 70 to 79 | 11.00 | 1.30 | 88.30 | 0.05 | 0.86 |
| Age \geq 80 | -16.80 | <0.10 | 99.80 | 0.004 | 0.99 |
| Marital status (Use married as a reference) | | | | | |
| Unmarried | 4.50 | 1.00 | 76.80 | 0.44 | 0.88 |
| Divorced | -2.30 | -0.40 | 84.00 | 0.70 | 0.96 |
| Widowed | -4.50 | -1.30 | 71.60 | 0.44 | 0.86 |
| Educational attainment | 11.00 | 2.80 | 74.70 | 0.06 | 0.69 |
| Pre-retirement employment (by reference to workers) | | | | | |
| Government staff | -6.30 | 0.20 | 96.30 | 0.28 | 0.97 |
| Professional technical personnel | 10.50 | 4.20 | 60.00 | 0.06 | 0.57 |
| Others | -2.40 | -1.40 | 39.70 | 0.68 | 0.84 |
| Average monthly income (RMB) | -15.00 | -2.60 | 82.30 | 0.01 | 0.71 |
| Smoking status (non-smoking as reference) | | | | | |
| Used to smoke | 4.50 | 1.30 | 72.00 | 0.43 | 0.86 |
| Smoke now | -13.40 | 0.80 | 93.90 | 0.02 | 0.90 |

(Continued)

Table 4 (Continued).

| variable | Standard Deviation (%) | | Standard Deviation Elimination (%) | P | |
|---|------------------------|-------------------|------------------------------------|--------------------|-------------------|
| | Before Matchmaking | After Matchmaking | | Before Matchmaking | After Matchmaking |
| Drinking status (non-drinking as reference) | | | | | |
| Used to drink | -4.90 | 0.30 | 94.00 | 0.40 | 0.97 |
| Drink now | 3.40 | 1.70 | 48.60 | 0.55 | 0.81 |
| Physical activity level | 16.80 | 0.50 | 97.30 | 0.01 | 0.95 |
| Degree of chronic disease comorbidity(CCI) | -0.10 | 0.10 | 30.40 | 0.98 | 0.99 |

Notes: The results of the common support hypothesis test and the parallelism hypothesis test of the K-nearest neighbor matching method and the radius matching method are basically consistent with those of the kernel matching method, so this study only shows the hypothesis test results of the kernel matching method.

Table 5 Average Treatment Effect of Family Doctor Contract on the Health of the Elderly After Matching

| Matching Method | Control Group | Treatment Group | ATT | SE | T | P |
|-----------------------------|---------------|-----------------|-------|------|-------|-------|
| Nuclear matching | 10.30 | 10.14 | -0.17 | 0.12 | -1.37 | >0.05 |
| K-nearest neighbor matching | 10.22 | 10.14 | -0.09 | 0.11 | -0.79 | >0.05 |
| Radius matching | 10.26 | 10.14 | -0.12 | 0.11 | -1.11 | >0.05 |

A 2SLS-Based Study on the Health Effects of Family Physician Contracting in the Elderly

A two-stage least-squares regression analysis was conducted on the “willingness to first visit in primary health care institutions” of the elderly as an instrumental variable. The minimum eigenvalue measurement method was used to test whether the instrumental variables were valid. The F-value of the test result was 36.25, which was greater than the critical 10. The weak instrumental variable test showed that the instrumental variables selected in this study were valid. The results showed that the regression coefficient of the effect of family doctor contracts on the health of the elderly was -0.02 ($P>0.05$). The results of 2SLS analysis of the relationship of family doctor contracts on the health of the elderly are shown in Table 6.

Table 6 Results of 2SLS Analysis of the Relationship of Family Doctor Contracts on the Health of the Elderly

| Variable | β | SE | P | 95% CI |
|----------------------------------|---------|------|--------|----------------|
| Contracted family doctor | -0.02 | 0.80 | 0.98 | (-1.59, 1.55) |
| Female | 0.16 | 0.13 | 0.22 | (-0.10, 0.43) |
| Age 70 to 79 | 0.22 | 0.07 | 0.002 | (0.08, 0.36) |
| Age \geq 80 | 0.14 | 0.14 | 0.31 | (-0.13, 0.42) |
| Unmarried | 0.22 | 0.59 | 0.71 | (-0.93, 1.37) |
| Divorced | 0.27 | 0.69 | 0.69 | (-1.08, 1.63) |
| Widowed | 0.10 | 0.60 | 0.87 | (-1.08, 1.27) |
| Educational attainment | 0.16 | 0.07 | 0.02 | (0.02, 0.29) |
| Government staff | 0.16 | 0.20 | 0.41 | (-0.22, 0.55) |
| Professional technical personnel | -0.50 | 0.14 | <0.001 | (-0.79, -0.22) |

(Continued)

Table 6 (Continued).

| Variable | β | SE | P | 95% CI |
|--|---------|------|--------|----------------|
| Others | -0.40 | 0.13 | 0.02 | (-0.47, -0.15) |
| Average monthly income (RMB) | 0.06 | 0.09 | 0.69 | (-0.11, 0.23) |
| Used to smoke | -0.16 | 0.16 | 0.31 | (-0.47, 0.15) |
| Smoke now | -0.23 | 0.16 | 0.14 | (-0.54, 0.07) |
| Used to drink | -0.20 | 0.22 | 0.36 | (-0.63, 0.23) |
| Drink now | 0.20 | 0.13 | 0.12 | (-0.05, 0.45) |
| Physical activity level | 0.32 | 0.09 | <0.001 | (0.15, 0.49) |
| Degree of chronic disease comorbidity(CCI) | -0.37 | 0.09 | 0.001 | (-0.51, -0.23) |

Discussion

The results indicate that chronic disease prevalence, physical activity intensity, education level, and pre-retirement occupation significantly affect elderly health, and these individual-level factors are closely linked to the policy implications of low family doctor contract rates. While most studies confirm that chronic diseases impair physical health, few have examined the relationship of the number of chronic diseases. This study finds that as the number of chronic diseases increases, health outcomes worsen, consistent with Zheng DD et al³⁵ More chronic diseases lead to compounded functional decline and increased complications,³⁶ reducing daily living ability and potentially causing disability and negative emotions, which lower self-rated health. Given the low contract rate, elderly with common diseases urgently need professional health management, yet current policies lack sufficient incentives. To boost contract rates, policies should enhance incentives. Sedentary behavior is a lifestyle risk factor for chronic diseases. Appropriate physical activity can improve fitness, immunity, and chronic disease symptoms.³⁷ The low contract rate reflects weak policy support for family doctors to guide elderly physical activity. Policies could require doctors to develop personalized activity plans for contracted elderly and include this in performance assessments, while providing training and financial support (eg., specialized sports guidance courses and rewards) to increase elderly participation and willingness to use contract services. Higher-educated elderly have better health literacy, healthier lifestyles, higher income, and greater healthcare use, mitigating chronic disease association. Low-educated elderly may have limited understanding, poor health program acceptance, insufficient disease prevention knowledge, and weak self-management skills.³⁸ Low contract rates may indicate policy advocacy fails to adequately reach this group. Policies should adopt accessible, diversified strategies, such as illustrated brochures with simple language. Elderly who were workers before retirement have better physical health than those who were professional and technical personnel, likely due to higher occupational physical activity. Technicians may exercise less, with long-term sedentary effects. For this group, policies can guide family doctors to address health issues related to prolonged sitting and low activity.

Additionally, the study found that the current signing rate of family doctor services for the elderly in Beijing is only 21.55%. This may be attributed to several factors: low awareness among the elderly regarding the importance and advantages of such services; inadequate publicity and outreach; resource shortages in some areas that fail to meet diverse health needs; and cumbersome signing procedures that reduce willingness. Based on these findings, the study recommends: first, strengthening health education and awareness through traditional methods such as community lectures and brochures, focusing on chronic disease prevention and preferential policies; second, optimizing resource allocation by increasing investment in family doctor teams—for example, establishing a dynamic “heat map” mechanism based on elderly population density and chronic disease prevalence. In high-demand “red zones” (eg., elderly-dense communities), more family doctor teams should be deployed, along with door-to-door signing and examination services.

Through three propensity score matching methods, namely nuclear matching, K-nearest neighbor matching, and radius matching, the two groups of elderly people who signed and did not sign family doctor services were repeated to exclude self-selection bias, and it was found that the contract of family doctor had no significant association on the health level of elderly people ($P>0.05$). Through the two-stage least squares regression analysis, the “intention of first

consultation in primary medical and health institutions” of the elderly was used as an instrumental variable to exclude endogenous problems, and the conclusion was also obtained that “the contract of family doctors of the elderly has no significant relationship on the health level ($P>0.05$)”. At the same time, this study also found that the degree of chronic disease, physical activity intensity, education level, and pre-retirement occupation will affect the health level of the elderly. The reasons for the ineffectiveness of family doctor contracting services, as reflected in the above unfavorable outcomes, were analyzed and discussed in this study.

First, this conclusion may reflect the complex challenges that family doctor contracting services face in the actual implementation process. Although the purpose of the contracted services of family doctors is to provide comprehensive and personalized health management for the elderly. However, in practice, the effect of the service is not significantly reflected due to the inadequate implementation of the service or the low utilization rate of the service by the elderly. According to a large-scale survey covering 31 provinces in China, only 6.9% of residents can effectively use family doctor contract services.³⁹ Further focus on the elderly, An independent survey of the elderly who have signed contracts in N City and B City in China shows that although 61.8% of the elderly in N City know that they have signed contracts with family doctors,⁴⁰ understanding is not the same as effective participation and utilization. The proportion of contracted elderly people in City B actually using family doctor services is only about 50%.⁴¹ Thus, it can be seen that some elderly people may only regard signing a contract as a formal procedure and have not really integrated into the systematic health management services provided by family doctors.⁴² Although some scholars in other cities have found that family doctors’ contract services may promote the health of the elderly,⁴³ the phenomenon of “signing without contract” leads to the low service utilization rate and affects the effect of promoting the health status of the population. First, service supply capacity is insufficient. Family doctor teams are understaffed and overburdened, making it difficult to deliver differentiated, proactive health management services to contracted elderly individuals. Second, there is a gap in residents’ perception and trust. Some older adults place greater trust in specialist physicians at public hospitals than in general practitioners at primary care institutions. To address these issues, this study proposes closing the gap through the following two approaches: first, optimize the organizational mechanism by incorporating the quality of chronic disease management into performance evaluations. This will guide primary care institutions to shift their focus from “contract quantity” to “service quality,” while alleviating workforce shortages through optimized team allocation and coordination within medical alliances. Second, leverage high-frequency interactions during chronic disease interventions to strengthen elderly patients’ understanding of and trust in family doctors, encouraging a transition from passive enrollment to active engagement. Through these measures, formal “contract signing” can be transformed into substantive, continuous chronic disease management services, effectively bridging the gap between mere enrollment and actual health improvement.

Second, some studies have pointed out that the policy documents of family doctors in China are mainly guidance, and the authority of the policy is insufficient. In the process of supervising and evaluating the contracted services of family doctors, primary medical and health institutions have the dual status of “referee” and “athlete”, and the supervision process is “careless” and fails to achieve the ideal effect.⁴⁴ At the same time, the contracted service of family doctors is dominated by the government, and multiple departments cooperate with each other. However, the responsibility boundaries of each department may be unclear, and problems encountered in the process of policy implementation may be blamed on each other.⁴⁵ As for the problem of insufficient policy authority, it is suggested to further improve the incentive policy of family doctors’ contracted services and establish and improve the performance evaluation mechanism of family doctors’ contracted services. For example, the weight of performance indicators such as signing rate and service satisfaction of the elderly should be increased. Extra allowance will be given to teams whose signing rate exceeds the standard. Thus, family doctors are encouraged to sign up and provide services to the elderly.

Third, the health level of the elderly is affected by many complex factors. Some studies have pointed out that although family doctor contract service can improve the health management status of the elderly to a certain extent, its effect on health may be relatively limited in the face of the comprehensive relationship of multiple factors. Especially for the elderly who already suffer from multiple chronic diseases, it may be difficult to significantly improve their health in a short period of time by relying solely on the contracted services of family doctors.⁴⁶ At the same time, due to limited exposure to or less familiarity with new healthcare-related information and service models, some elderly individuals may have insufficient awareness of the contracted services of family doctors and may be slower to accept these services.

Moreover, the traditional concept of medical treatment often leads them to prefer seeking medical care in secondary and tertiary hospitals.⁴⁷ Therefore, it is suggested to strengthen the publicity of the family doctor contract service policy through various channels, enhance the influence of the policy and the elderly's understanding of the policy, and build a pattern of joint participation of the government, media, volunteers, and other subjects. For example, when promoting family doctor contract service, Shanghai, China, makes full use of offline channels such as community publicity boards and community activity centers to regularly hold health lectures and consultation activities, and family doctors explain the content, advantages, and process of contract service to residents on-site.⁴⁸

Finally, the quality and continuity of service is also an important factor affecting the effect of family doctor contract service. High-quality family doctor services should include comprehensive health assessment, personalized health management plan formulation, timely and effective disease intervention and other links. If the professional level of the family doctor is not high, the service attitude is not good, or the service lacks continuity and system, then the elderly may not be able to obtain high-quality health management services, resulting in contracted services to improve the health level not being obvious. At present, China's family doctors are staffed by medical staff from primary medical and health institutions, and they have a busy schedule. At present, the assessment of family doctors' contract services is mainly carried out from the two aspects of service quantity and service quality. In order to obtain better assessment results, family doctors may give priority to the target of contract quantity that is easier to complete and have a positive attitude towards improving the signing rate but ignore the guarantee of contract service quality and fail to perform the contract well.⁴⁹ First of all, it is suggested to strengthen the cooperation with local and surrounding medical colleges, jointly develop a family doctor talent training program, and increase the enrollment scale of family doctor-related majors. Through setting up special courses and practical teaching bases for family doctors in medical colleges, students can understand the work content and responsibilities of family doctors in advance and improve their sense of identity and interest in the profession of family doctors. To enhance the sense of identity and interest in the profession of family doctors. For example, according to the job requirements of family doctors, medical colleges and universities in Zhejiang Province, China, have set up relevant professional courses and practical teaching links to cultivate family doctors with solid professional knowledge and practical skills.⁵⁰ At the same time, the salary and professional title promotion opportunities of family doctors will be improved, and high-level medical talents will be attracted to engage in family doctor contract services in grass-roots medical and health institutions. On the basis of ensuring that human resources meet the needs of family doctors' contracted services, the service quality and continuity should be improved. For example, the "1+1+N" responsible physician system is implemented; that is, a family doctor, a community nurse, and N specialist doctors form a team to establish electronic health records for the elderly under contract and update them dynamically. Another example is online consultation, which enables primary-level doctors to connect with experts from third-class A hospitals for joint diagnosis and treatment, reducing patients' travel and so on.

To gain a deep understanding of the challenges associated with implementing family doctor contract services in China, it is of great theoretical significance and practical value to analyze this issue from the comparative perspective of transitional economies. Similar to China's healthcare reform process, Kazakhstan and other post-Soviet countries have faced challenges such as insufficient patient trust, low service utilization, and low willingness to sign contracts during their transition from centralized medical systems to primary healthcare. Recent studies indicate that in the process of promoting the family medicine model and compulsory social health insurance system in regions such as Almaty in Kazakhstan, patient satisfaction with primary healthcare services is significantly influenced by factors including medical insurance participation rates, the quality of doctor-patient communication, and the level of medical technology and facilities.^{51,52} These factors may also be key determinants of the contract-signing behavior among the elderly in China.

Limitations

First of all, physical health is the result of subjective evaluation by the elderly. However, some chronic diseases present no obvious symptoms in their early stages, making them difficult for older adults to perceive. To address this limitation, future research will consider collaborating with hospitals and integrating multidimensional objective measurement methods—such as physical examinations, physical function tests, mental health assessment tools, and medical records—to establish a comprehensive health assessment system that combines subjective evaluation.

Secondly, there is no direct relationship between the family doctor contract and the health of the elderly, which may be because the short-term effect of the family doctor contract service has not been fully reflected. After the elderly sign a contract with a family doctor, the medical and health service behavior may change, and the family doctor will also take the initiative to provide services for the elderly, which will ultimately have an impact on the health of the elderly. However, due to the limitations of research resources, time, and investigation methods, it is difficult for this study to obtain the dynamic information of these behavioral changes comprehensively and deeply. So it is difficult to completely overcome this limitation in this study. Future research could overcome this limitation in a number of ways. For example, a longitudinal study design can be adopted to collect long-term follow-up data on the behavior of family doctors, the health service utilization behavior of the elderly, and health-related data after signing the contract. Through these methods, the mechanism of the change of service behavior after signing the contract on the health of the elderly was deeply analyzed so as to provide a more scientific basis for optimizing the contracted service of family doctors.

In addition, the use of family physician services by the elderly is an evolving process, and the length of use may have an impact on health outcomes. Long-term use of family physician services may lead to more comprehensive health management, better control of chronic diseases, and ultimately greater health improvements than short-term use. Because this study did not collect data on the specific timing of use of family physician services by older participants, we were unable to analyze how this factor interacted with the health effects of family physician contracting. As a result, our results may not be precise enough to fully capture the long-term health benefits of family physician services for older adults. Therefore, we plan to include information on the length of service of family doctors in future studies to provide more insight into the relationship between family doctor contracts and the health of the elderly.

In this study, we divided the pre-retirement occupation variable into four subgroups: workers, civil servants, professional and technical personnel, and other occupations, such as agriculture, forestry, animal husbandry, and fishery, into the “other” category. This division is mainly based on the fact that people engaged in agriculture, forestry, animal husbandry, and fishery account for a relatively small proportion of the overall survey respondents in the early stage of urbanization in Beijing. However, this classification method may make it difficult for readers to intuitively understand the differences between different occupational groups, especially because the “other” category covers a wide range of occupational types and cannot accurately reflect the impact of each specific occupation on the health of the elderly. In the following similar studies, we will further optimize the classification of occupational categories and clearly list agriculture, forestry, animal husbandry, and fishery separately so as to improve the representativeness and scientific nature of the research and more comprehensively and deeply explore the impact of pre-retirement occupations on the health of the elderly.

The evaluation of health status in this study was constructed by summing the scores of two Likert-type questions —“self-rated health status” and “self-rated quality of life score”—resulting in an ad hoc index. This measure does not represent a standardized scale commonly used in epidemiological studies. When conditions permit, future research should prioritize the use of validated, standardized health scales to enhance the reliability and sensitivity of health outcome measurement.

Finally, in terms of sample selection, this study focuses on all the elderly aged 60 and above in Community A, District F, Beijing. As a mixed area of urban old community and new affordable housing, the elderly in this community have typical characteristics in terms of age structure, education level, health status, and cognition of family doctor contract service, such as a high comorbidity rate of chronic diseases and a low awareness rate of contract. These characteristics are consistent with the trend of the overall elderly population structure in Beijing and provide effective samples for studying the matching degree of the demand and supply of family doctors’ contracted services. However, limited by the geographical boundary of a single community, the research conclusion should be cautious when being extended. On the other hand, as the pilot city of the national family doctor contract service, Beijing leads the country in terms of policy implementation and medical insurance support, which may cover up the service dilemma of resource-poor communities. Therefore, we plan to use the multi-stage stratified sampling method in future research to cover communities with different levels of economic development, urban-rural differences, and policy implementation stages so as to enhance the extrapolation of conclusions. At the same time, combined with the policy orientation of “strengthening the grassroots and ensuring the basic” of family doctor contract service in China, we will also focus on the weak links in the policy, such as

remote rural areas and migrant population settlement areas, in the subsequent research so as to provide a more comprehensive empirical basis for optimizing the allocation of service resources.

Conclusion

Through questionnaire and descriptive analysis, this study found that elderly people in Beijing do not have a high willingness to take the initiative to contract with family doctors. In order to exclude self-selection bias, this study uses the propensity score matching method. In order to exclude possible endogeneity problems between family doctor contracting and health, this study adopts the two-stage least squares method. Finally, under the present identification assumptions and data limitations, no significant health effects of elderly family doctor contracts are observed. Combined with the implementation of family doctor contract service in China and the results of literature research, it was analyzed that the lack of direct relationship between family doctor contract and health of the elderly may be caused by the existence of the phenomenon of “signing but not signing”, the lack of authority of relevant policies, the poor service quality and continuity, and the low utilization of services by the elderly. This shows that the policy of family doctor contracted service in China needs to be further improved, the medical service ability of family doctors needs to be further strengthened, and the elderly need to improve their cognition of family doctor contracted service, take the initiative to use family doctor contracted service, and give full play to the role of family doctor contracted service.

This conclusion has important reference value for other countries. On the one hand, when implementing the family doctor contract service policy, we should not only focus on the formulation and initial implementation of the policy but also pay attention to the implementation effect of the policy and the improvement of service quality. The formulation of policies needs to fully consider the local medical resources, the characteristics of the health needs of the elderly, and the characteristics of the medical service system to ensure that the policies are targeted and operable. On the other hand, it can encourage countries to re-examine the mode and mechanism of family doctors’ contracted services, explore how to optimize the service process, improve the professional quality and service ability of family doctors, and enhance the trust and acceptance of the elderly in contracted services.

Data Sharing Statement

The datasets generated and analyzed during the current study are available from the corresponding author on reasonable request. E-mail: mengkai@ccmu.edu.cn.

Ethics Approval and Consent to Participate

This study was approved by the Ethics Committee of Capital Medical University (2018SY81). The study was performed in accordance with the Declaration of Helsinki. Informed written consent was obtained from all the participants before the start of this study. By completing a consent form, the participants were informed about the purpose and method of the study. The participants were also informed that the researchers were committed to answering their questions and that their information would be kept confidential.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors declare no competing interests in this work.

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