Evaluation of the effects of a new integrated health management service model on p eople with risk factors for dyslipidemia

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Research article

Keywords: Dyslipidemia, Blood lipid, General medicine, Integrated medicine

Posted Date: November 9th, 2020

DOI: https://doi.org/10.21203/rs.3.rs-48897/v2

Abstract

Background: Dyslipidemia is a factor that affects the occurrence and development of many chronic diseases. With its prevalence increasing each year, dyslipidemia has caused substantial disease and economic burdens in China and around the world. Appropriate health management is imperative for people with risk factors for dyslipidemia. We established a new model of health management services (integration of general practice and personalized disease prevention in health management, IGPDP) to more appropriately manage people with risk factors for dyslipidemia.

Methods: The experiment was conducted in Shenyang, Liaoning Province, China. We selected 5 administrative districts with populations of more than 100,000. Twenty-three community health service centers with a daily average of more than 50 outpatients were selected. A total of 5,032 subjects with risk factors for dyslipidemia who met the inclusion criteria were included in this study. Using prospective cohort study methods, the subjects were followed up for 24 months. The subjects were randomly divided into the control and test groups, and they received traditional health management services or IGPDP. We analyzed and compared changes in disease prevention, health protection, and health promotion between the two groups.

Results: In terms of disease prevention, we found that after the intervention, subjects' behavioral risk factors (smoking habits, diets, sedentary lifestyles) and health literacy improved. In terms of health protection, we observed a decrease in Body mass index (BMI), a gradual improvement in blood lipid levels, and an overall increase in quality of life scores. In terms of health promotion, after the intervention, the proportion of the subjects who were willing to accept the contracted services of general practitioners increased.

Conclusion: IGPDP can effectively cultivate healthy lifestyles, improve health literacy, reduce biological risk factors, decrease risk of dyslipidemia, and improve quality of life of subjects. IGPDP is conducive to improving the quality of the service of general practitioners, increasing the trust of the general public, and facilitating the establishment of a hierarchical medical system.

Background

Dyslipidemia usually refers to abnormal blood lipid metabolism in the human body. According to the diagnostic criteria of the revised guidelines for the prevention and treatment of dyslipidemia in Chinese adults, which were newly formulated in 2016, abnormalities in serum triglyceride (TG), total cholesterol (TC), serum low-density lipoprotein cholesterol (LDL-C) and serum high-density lipoprotein cholesterol (HDL-C) can be diagnosed as dyslipidemia [1]. In the past 30 years, the prevalence of dyslipidemia has been increasing each year, and dyslipidemia has become a public health concern [2]. To fundamentally solve this problem, it is necessary to implement sensible health management for people with risk factors for dyslipidemia.

The health management service model is a relatively new health management model that has been proposed in recent years. Different from the general specialized medical service model, this new model mainly targets chronic diseases (including hypertension, diabetes, etc.) whose prevalence rates are increasing annually [3-5]. In the past 30 years, to solve the burden of chronic diseases, health management has rapidly been established in developed countries. However, health management has only started in China, mainly in the form of physical examinations, and health management is gradually attracting the attention of all parties [6-10]. Although some achievements have been made in the application of the traditional health management model in China, there are still many problems to be solved; for example, the complete medical service model has not been formed, and the personalization is not good. In the past, the traditional health management service model only included a physical examination by an examiner to obtain a simple result, nothing more. Participants did not completely understand their health status after the physical examination, and there was no doctor to explain and guide the physical examination. In addition, research on the traditional health management service model mainly focuses on populations with chronic diseases, such as hypertension and diabetes, and pays little attention to populations with risk factors for chronic disease. To solve the drawbacks described above, this study applied a model (integration of general practice and personalized disease prevention in health management, IGPDP) that combines general practice with personalized disease prevention. IGPDP is an evidence-based health management service model that was established based on the Chinese traditional health management service model and includes the experience of general practitioners around the world. IGPDP incorporates general practice and personalized disease prevention in the health management service framework and provides early screening, early warning, risk factor intervention, and long-term follow-up services for people with major chronic diseases and relatively healthy people who are at risk of these diseases (i.e., people with risk factors for dyslipidemia in this study). IGPDP emphasizes that general practitioners and their teams provide subjects with people-oriented, personalized, continuous, comprehensive, and active health management services. The aim is to provide a systematic service program for health managers to help subjects improve self-efficacy, promote behavioral change, and improve health outcomes.

To explore the difference in the application values and effects of IGPDP and traditional health management models in people with risk factors for dyslipidemia, we studied the differences in disease prevention, health protection, and health promotion at different times.

Methods

General Information

We established the IGPDP prospective study cohort and conducted the study for 24 months. Random sampling was used for sampling. Patients who visited each community health service center within one month and met the inclusion criteria were included in this study, until the number reached the required number.

The sampling steps were as follows: First, the experiment was conducted in Shenyang, Liaoning Province, China. The sampling frame of this study were the lists of districts and community health service centers in Shenyang. We selected 5 administrative districts with populations of more than 100,000, and

we selected community health service centers in these administrative areas with an average daily outpatient volume of more than 50 people. Then, according to the population distribution of Shenyang, a certain number of community health service centers were randomly selected in each administrative region to be included in this study (Table 1) [11, 12]. Finally, the subjects were randomly divided into a control or test group. In Dadong District, Heping district, and Shenhe District, half of the community health centers were randomly selected as the control group, and the other half were selected as the test group. At the community health centers in Huanggu District and Tiexi district, half of the study subjects were randomly selected as the control group, and the other subjects were selected as the test group (Table 1). The Medical Ethical Commission of the China Medical University approved this study. We obtained written consent from the study participants.

Table 1 Source and grouping of research samples

Inclusion and exclusion criteria

A prospective cohort study was carried out, and the inclusion and exclusion criteria are shown in the table below (Table 2). The population with risk factors for dyslipidemia was selected as the research population. Overweight or obesity, current smoking habits, unhealthy diets, and sedentary lifestyles were inclusion criteria. People who were older than or equal to 80 years old or younger than 18 years old, who had been clearly diagnosed with cardio-cerebrovascular diseases (myocardial infarction, stroke), lung cancer, and chronic obstructive pulmonary disease, who are unable to adhere to treatment or use other treatment methods that affected the data collection and efficacy assessment, who were pregnant or lactating, or who had with a genetic dyslipidemia disorder were excluded.

Table 2 Inclusion and exclusion criteria

Intervention methods

IGPDP was used in the test group, and the traditional health management service model was used in the control group. In the control group, an annual physical examination was carried out according to the medical examination package for the subjects, group health consultation was provided for the subjects, and coordinate specialist referral was required. In the test group, the one-year intervention cycle was divided into a two-month strengthening phase, a one-month consolidation phase, and a nine-month stable phase (Fig. 1). According to the individual condition of the subjects, we designed a health plan for them and provided personalized diet and exercise guidelines according to the plan. After a period of intervention, the health plan was modified or reformulated according to changes in the subjects' health status. The effect of implementation was evaluated by analyzing the subjects' questionnaire results and clinical indicator results at baseline, 12 months, and 24 months (Fig. 2).

Fig. 1 Health management cycle

Fig. 2 Technology roadmap

Evaluation index system

We evaluated the effect of IGPDP from three perspectives: "disease prevention", "health protection", and "health promotion”. The results at baseline, 12 months after intervention, and 24 months after intervention were collected by measuring clinical indicators and questionnaires. The data were collected by trained investigators (Table 3).

Table 3 Evaluation index system

Specific information of questionnaires

When formulating an index system for evaluating the effectiveness of health management services, we used evidence-based methods to study a large amount of literature, learn from advanced health management experiences around the world, and hire multidisciplinary senior experts. From multiple angles and multiple dimensions, the main measurable and quantifiable indicators that could reflect the difference between the two health management models were selected within the research time limit.

Health risk assessment questionnaire

This questionnaire was used to collect the subjects' basic information, behavioral risk factors, biological risk factors, and other related indicators. The questionnaire included the subjects' basic information, disease history, family history, tobacco use, alcohol consumption, daily diet and exercise, sleep quality, psychological status, living environment, and basic physical indicators (waist circumference, BMI, blood pressure, blood lipid, fasting blood glucose, etc.).

National Residents' Health Literacy Monitoring Questionnaire

This questionnaire was used to measure participants' health literacy. The questionnaire covers three dimensions: basic knowledge and concept, healthy lifestyle and behavior, and basic skills. This questionnaire is specifically divided into six categories: health science concept, prevention and treatment of infectious diseases, prevention and treatment of chronic diseases, basic medical treatment, safety and first aid, and access to health information. The scoring standard of the questionnaire is 1 point for each question of judgment and single-choice questions, and two points are given for each multiple-choice question. Patients scoring greater than 80% accuracy are considered to have health literacy [13].

Health status SF-36 Questionnaire

This questionnaire was used to measure the quality of life of the subjects. This questionnaire comprehensively measured the quality of life of the subjects from 8 perspectives: physical enginery, physiological function, physical pain, general health, energy, social function, emotional function, and mental health. In addition, this questionnaire also included health change indicators to evaluate the overall changes in the subjects' health status over the past year. According to the choice weight or score of the SF-36 questionnaire, the total score of SF-36 was 145.

Basic Health Service Demand Questionnaire

This questionnaire was used to investigate the needs of community residents for basic medical and health services. The questionnaire included three aspects: basic medical and health service, general practitioner, and community health service center. This questionnaire provided a reference for improving the services of general practitioners and allowing them to better meet the needs of the public.

We verified the reliability and validity of the questionnaire items. We also carefully designed each indicator item, the total evaluation item, and subindicator item for the research question to confirm each other. We analyzed the reliability of this questionnaire based on a small sample of survey data and tested the comprehensibility of each survey index. We sent the questionnaire to the relevant industry experts, and we asked the industry experts to check and correct it to ensure the scientific and structural rationality of the index system. We standardized the research process and avoided random filling-in. We chose the subjects carefully and emphasized the importance of the research data. We prevented the subjects filling in the data at will, trying to maintain the rigor and objectivity of the survey data.

Statistical analysis

Each monitoring and investigation in this study underwent the process of data cleaning, data verification, and standard database establishment. Epidata 3.1 software was used to establish a database. Logical error checking was conducted after data entry, and the outliers, such as missing values, singular values and extreme values, were returned to the original research institution for verification against the original questionnaire. Then, we randomly selected data at a rate of 20% and verified these data with the original data. Each research subject had finished the observation and follow-up, and the data had been retrieved, entered, and verified. After ensuring that that the database was correct, we locked the database for statistical analysis. Under normal circumstances, the data cannot be modified again. SPSS 22.0 software was used for statistical analysis of the data. The measurement data are described as the mean ± standard deviation, and the rate was used to describe the counting data. We used the rate to calculate the proportion of a certain type of patient in the total population. The numerator is the number of patients of a certain type, and the denominator is the total number in the population. The chi-squared test was used to compare the rates. The changes in behavioral risk factors of current smoking habits, unhealthy diets, sedentary lifestyles, changes in health literacy levels, and proportion of people who were willing to accept general practitioners in different study groups were compared by the chi-squared test. The t-test of two independent samples was used to compare the measurement data between the two groups. The comparison of the BMI levels in obese people, comparison of the blood lipid levels in people with dyslipidemia, and changes in the total score of the quality of life assessment in the different study groups were compared by T test. Test level $\alpha = 0.05$.

Results

General Characteristics of subjects

The general characteristics of the subjects in the test and control groups at baseline are shown in Table 4. There was no statistically significant difference between the two groups in terms of general conditions and health indicators, indicating that the two groups were balanced and comparable at baseline.

The average age of the control group was 50.2 ± 14.0 years old, and in this group, 56.8% were female, 71.3% were married, 36.1% had a junior college degree, 42.7% were retired, 83.4% were nonsmokers, and 85.2% had never consumed alcohol. The average age of the test group was 53.8 ± 14.9 years old, and in this group 56.8% were female, 67.9% were married, 33.9% had received a junior college education, 33.9% were retired, 76.1% had never smoked, and 78.8% had never consumed alcohol.

Table 4 General Characteristics of the management and control groups at baseline

Changes in behavioral risk factors before and after intervention in different groups

In both the control and test groups, the proportion of subjects who smoked, ate unhealthy diets, and sat for long periods after the intervention decreased compared with that before the intervention, and the differences were statistically significant. The changes in behavioral risk factors before and after intervention in the different groups are shown in Table 5.

Table 5 Changes in behavioral risk factors after intervention in different study groups

Changes in health literacy levels after intervention

In the test group, the baseline health literacy level of the subjects of different genders and ages was higher than that in the control group, except for the group aged 60-79 years, and the differences were statistically significant. After 12 months of intervention, except for the test group aged 60-79 years, the health literacy level of the subjects of different genders and age groups all showed a downward trend, the reasons for which need further analysis. After 24 months of intervention, the level of health literacy was generally improved compared with that before the intervention, and the difference was statistically

significant. The health literacy level of the test group was still higher than that of the control group, and the difference between the two groups of subjects of different genders and ages was statistically significant. The changes in the health literacy levels in the different groups after intervention are shown in Table 6.

Table 6 Changes in health literacy levels after intervention in different study groups

BMI changes in obese people before and after intervention in different groups

After the intervention, the BMI of obese people in both the control and test groups showed a decreasing trend, and the difference was statistically significant. BMI changes in the obese people before and after intervention in the different study groups are shown in Table 7.

Table 7 Comparison of BMI levels in obese people in different study groups

Changes in blood lipid levels in subjects with dyslipidemia before and after intervention in different groups

After the intervention, the TC, TG, and LDL-C levels of the subjects showed a decreasing trend in both the control and test groups. Except for the difference in the LDL-C levels, the other differences were statistically significant. After intervention, the HDL-C levels increased slightly, with no statistically significant difference. Compared with the control group, the test group showed no obvious improvement in this decrease. The changes in the lipid levels in the dyslipidemia subjects in the different groups before and after intervention are shown in Table 8.

Table 8 Comparison of blood lipid levels in people with dyslipidemia in different study groups

Changes in total score of quality of life assessment after intervention

There was no statistically significant difference in the total quality of life score at baseline between the test and control groups when subjects aged 18-44 years and 60-79 years were assessed. The total score of the quality of life in the test group was higher than that in the control group, and the difference was statistically significant. After 12 months of intervention, the total the quality of life scores in the different groups, genders, and age groups showed a general decreasing trend compared with that before the intervention, and the difference was statistically significant. The reasons need to be further analyzed. After 24 months of intervention, the total quality of life scores in the different groups, genders, and age groups showed an overall increasing trend compared with those before the intervention, and the differences were statistically significant. Compared with that of the control group, the total extent of the increased quality of life was lower in the test group. The changes in the total score of the quality of life assessment in the different intervention groups are shown in Table 9.

Table 9 Changes in total scores of quality of life assessment in different study group populations

The proportion of subjects who were willing to accept general practitioners contract services after the intervention

After 24 months, the proportion of people in the different study groups, gender group, and age groups who were willing to receive general practitioners contract services was higher than that before the intervention. There were statistically significant differences before and after intervention in the male, female, 18-44 and 45-59 years old test groups, and 60-79 years old control group. The proportion of people willing to accept general practitioners contract services was slightly higher in the experimental group than in the control group. The comparison of the proportion of people who were willing to receive general practitioners contract services after the intervention in the different groups is shown in Table 10.

Table 10 Comparison of the proportion of people who were willing to accept general practitioners

Discussion

This research used the IGPDP model, combined routine practice with personalized disease prevention, and solved the problems of simplification and popularization of traditional health management service models.

The baseline survey results showed that there is no significant difference between the control and test groups in terms of general conditions and health indicators, and they are balanced and comparable. The prevalence of dyslipidemia in the test and control groups were 70.7% and 76.6%, respectively, which were both higher than the national average, suggesting that the study population had a heavy burden of dyslipidemia.

IGPDP was used in the test group and a traditional health management service model was used in the control group. We evaluated the effect of IGPDP from three perspectives: "disease prevention", "health protection", and "health promotion". The results at baseline, 12 months after intervention, and 24 months after intervention were collected by measuring clinical indicators and by questionnaires. After the intervention, the proportion of subjects with behavioral risk factors, such as smoking, unhealthy eating, and sitting for a long time, decreased, the subjects' health literacy levels increased, and the BMI of obese people showed a decreasing trend. This result shows that IGPDP can effectively cultivate healthy lifestyles, improve health literacy, and reduce biological risk factors of subjects. After the intervention, the TC, TG, and LDL-C levels of the subjects with dyslipidemia decreased, and the total score of quality of life assessment increased. These findings show that IGPDP can reduce the risk of dyslipidemia and improve the quality of life of subjects. In addition, we used the proportion of subjects who were willing to receive contract services from a general practitioner to evaluate the utilization of primary care facilities. The results showed that compared with that before the intervention, the number of people who were willing to accept contracted services by general practitioners in the experimental group after the intervention showed an increasing trend, and the increase was significantly higher than that in the

control group. In short, IGPDP is scientific in design and feasible in operation. based on the current effect of implementation, IGPDP is more effective and better than the traditional health management model.

The traditional health management service model does not implement the new "health management path and implementation process of grassroots high-risk groups of chronic diseases" and does not establish a vertical collaboration platform between comprehensive departments of general hospitals and grassroots medical institutions. The subjects received follow up and nonindividualized health education at the community health service center. However, this service model is too simple to meet the needs of people with risk factors for dyslipidemia. The IGPDP provides health management services to selected high-risk groups with the aim of achieving effective interactions between general practitioners, clients, patients, families, and the community in health status assessment, self-management support, health management program optimization, and follow-up management. IGPDP adopts the contract service model of general practitioners, establishes a vertical cooperation platform among general hospitals, primary medical institutions, and some pilot institutions to establish a remote "Internet +" cooperation platform to develop a reasonable division of labor and management model between primary medical institutions and 3A hospitals and between general practitioners and experts. IGPDP trains primary-level general practitioners and their teams, provides convenient "two-way referral" channels for patients, and gradually forms a progressive diagnosis and treatment model of "initial diagnosis, two-way referral, rapid division and treatment, and linkage up and down". IGPDP can improve the service quality and utilization of health management, improve service target satisfaction and compliance, and help control the lipid level of high-risk populations.

The IGPDP emphasizes that general practitioners and their teams provide subjects with people-oriented, personalized, continuous, comprehensive, and active health management services. Specifically, personalization is reflected in the fact that researchers carry out personalized health counseling and health education services according to the differences in the subjects' own conditions, formulate corresponding and specific health management plans for these subjects and supervise the implementation of these plans. This model overcomes the shortcomings of the traditional health management model which ignores individual differences.

The continuity of IGPDP is reflected in the fact that its intervention process is a continuous dynamic process. We divided the entire intervention cycle into the strengthening, consolidation, and stable phases. During each phase of the intervention cycle, the subjects were steadily and continuously followed, and their health plans were monitored throughout. In addition, we measured the health status of the subjects in stages, monitored the changes in their health status, adjusted the intervention intensity in a timely manner, and improved the intervention plan according to the changing health status to finally achieve the goal of improving the health status of the subjects.

The comprehensiveness of IGPDP is reflected in its diversified management methods. Different forms of health counseling and health education were given to the subjects, and health knowledge was popularized to the subjects to help them master the prevention and treatment methods of dyslipidemia and other chronic diseases and improve their health literacy.

Limitations

Although IGPDP is scientific and effective, this model still has some limitation. First, general practitioners play an irreplaceable role in IGPDP. However, the number of general practitioners in China is not enough to meet the requirements of implementing IGPDP on a large scale. Second, the development of a healthy lifestyle requires a long-term process. Although the IGPDP intervention improved the participants' lifestyle in the short term, there may be relapses after the intervention. Finally, this study only selected some of the indicators that should be included in the evaluation system described this study, and thus, this system could not be analyzed more comprehensively. More evaluation indicators can be included in future research to achieve a more comprehensive evaluation effect.

Conclusion

The purpose of constructing, implementing, and evaluating the new health management model is to innovate the health management model, improve the ability, quality, and effect of general practitioners in managing the population with risk factors for dyslipidemia, improve the health status of service subjects, and delay the occurrence of dyslipidemia. This is a beneficial exploration of health management for dyslipidemia, which provides a basis for reducing the occurrence and development of chronic diseases such as dyslipidemia and decreasing the cost of human resources. By transforming the model of grassroots medical and health services, realizing the contract service of general practitioners, and strengthening the network function of grassroots medical and health service, these measures can not only deepen the reform of the medical and health system but also better safeguard people's health in the new situation. The promotion of contract services for general practitioners will gradually form a hierarchical diagnosis and treatment model of "primary-level diagnosis, two-way referral, rapid diagnosis and treatment, and linkage between upper and lower levels". With the aid of modern information technology, we can establish and improve the long-term working mechanism of general hospitals and general practitioners , provide support for the development of general practitioners in grassroots medical institutions and construction of their teams, improve the medical and health service capabilities and primary health management capabilities of grassroots general practitioners, and sign the service contract of grassroots general practitioners. The above measures are of great significance for the establishment of the hierarchical diagnostic system.

List Of Abbreviations

BMI: Body mass index; HDL-C: High-density lipoprotein cholesterol; IGPDP: Integration of general practice and personalized disease prevention in health management; LDL-C: Low-density lipoprotein cholesterol; TC: Total cholesterol; TG: Triglyceride

Declarations

Ethics approval and consent to participate

The Medical Ethical Commission of the China Medical University approved this study. The consent we obtained from study participants was written.

Consent for publish

Written informed consent for publication was obtained from all participants.

Availability of data and materials

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

Competing interests

All authors declare that they have no competing interests.

Funding

We gratefully acknowledge funding from the National Natural Science Foundation of China (Grant Number 71273279). Funds provided by funders help us complete data collection and analysis.

Authors' Contributions

The research was designed by XSY and RZ. It was executed by RZ, SW, YNH, BW, YW, KY, and DJQ. The first draft was prepared by RZ. XSY reviewed and helped to revise the manuscript. All authors read and approved the final manuscript.

Acknowledgments

We would like to acknowledge the collaboration and commitment of all local investigators and their staff, without whom the present study would not have been possible.

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Tables

Table 1 Source and grouping of research samples

District	Group	Community Health Center	Baseline Population
Dadong	Control	Dabei	115
		Guancheng	104
		Dongzhan	118
		Wanquan	92
	Test	Xiaobei	144
		Ertaizi	136
		Xiaodong	147
		Liaoshen	120
Heping	Control	Taiyuan	101
		Maluwan	277
		Hunhewan	244
	Test	Beishi	107
		Xita	184
		Nanzhan	275
Huanggu	Control/Test	Santongqiao	44/41
		Huaihe	100/98
		Beita	89/94
		Shouquan	45/51
Shenhe	Control	Daxi	284
		Nanta	284
	Test	Danan	286
		Binhe	281
Tiexi	Control/Test	Qigong beiyixin Village	583/588
Subtotal	Control		2480
	Test		2552
Total			5032

Table 2 Inclusion and exclusion criteria

Criteria	Evaluation index	
Inclusion criteria	Biological risk factors	Overweight or obesity According to the Chinese standard, a BMI greater than 24 is considered overweight, while a BMI greater than 30 is considered obese
	Behavioral risk factors	Current smokers (Those who have smoked continuously or cumulatively for 6 months or more in their lifetime, or those who have smoked within 30 days before the visit)
	Unhealthy diet	The daily intake of cooking oil for each person is greater than 30 grams as the judgment standard of unhealthy diet
	Sedentary	Sit with sitting time accumulates 8 hours everyday as the judgment standard of sedentary
Exclusion criteria	Age ≥80 years or 18 years	
	People who have been clearly diagnosed with cardio-cerebrovascular diseases (myocardial infarction, stroke), lung cancer, and chronic obstructive pulmonary disease	
	People who are unable to adhere to treatment or use other treatment methods, affecting data collection and efficacy assessment	
	Pregnant or lactating women	
	People with a genetic dyslipidemia disorder	

Table 3 Evaluation index system

Aspect	Evaluation index	
Disease prevention	Behavioral risk factors	Smoking; Diet; Sedentary.
	Health literacy	A survey was conducted using the National Residents' Health Literacy Monitoring Questionnaire.
Health protection	Biological risk factors	BMI
	Risk	Dyslipidemia
	Quality of life	A survey was conducted using the Health status SF-36 Questionnaire.
Health promotion	Utilization of primary medical institutions	A survey was conducted using the Basic Health Service Needs Questionnaire.
Clinical index measurement methods	Physical condition and routine examination	Height, weight, waist circumference (weight and waist circumference should be measured on an empty stomach in the morning), blood pressure (measured with an electronic sphygmomanometer), fasting blood glucose (blood glucose measured by fasting venous blood), etc.
	Serum lipid levels	TG,TC, LDL-C and HDL-C levels were detected in fasting venous blood.TG≥1.7mmol/L, HDL-C < 0.9mmol/L (male) or < 1.0mmol/L (female), TC≥5.2mmol/L, LDL-C >3.4mmol/L, meeting one of the above conditions was diagnosed as dyslipidemia.
Specific information of questionnaires	Health risk assessment questionnaire	
	National Residents' Health Literacy Monitoring Questionnaire	
	Health status SF-36 Questionnaire	
	Basic Health Service Demand Questionnaire	

Table 4 General Characteristics of the management and control groups at baseline

Variables	Control group (n=2480)	Test group (n=2552)
Age		
Mean±SD	50.2±14.0	53.8±14.9
Range	18-79	18-79
Gender		
Male	1072(43.2)	1103(43.2)
Female	1408(56.8)	1449(56.8)
Resident Status		
Unmarried	179(7.2)	156(6.1)
Married	1768(71.3)	1734(67.9)
Divoiced or widowed	196(7.9)	179(7.0)
Others	337(13.6)	483(18.9)
Educational Level		
Elementary school and below	29(1.2)	35(1.4)
Junior high school	229(9.2)	425(16.7)
Senior high school	403(16.3)	545(21.4)
Secondary school	625(25.2)	562(22.0)
Junior college	895(36.1)	865(33.9)
University and above	299(12.1)	120(4.7)
Nationality		
Han nationality	2383(96.1)	2387(93.5)
Other	97(3.9)	165(6.5)
Occupation		
Institutional enterprise management	184(7.4)	219(8.6)
Professional skill worker	392(15.8)	607(23.8)
General staff	258(10.4)	260(10.2)
Business/service staff	103(4.2)	158(6.2)
Individual industrial and commercial households	91(3.7)	103(4.0)
Non-agricultural industrial workers	162(6.5)	207(8.1)
Non-labor farmers	23(0.9)	19(0.7)
Agricultural laborer	33(1.3)	15(0.6)
Retired staff	1059(42.7)	864(33.9)
Student at school	4(0.2)	10(0.4)
Unemployment or unemployment	171(6.9)	90(3.5)
Smoking		
Never smoked	2068(83.4)	1942(76.1)
Quit smoking	61(2.4)	123(4.8)
Smoking now	351(14.2)	487(19.1)
Drinking		
No alcohol	2112(85.2)	2010(78.8)
Drinking	368(14.8)	542(21.2)
Unhealthy diet	1002(40.4)	467(18.3)
Sedentary method	84(3.4)	78(3.1)

Dyslipidemia	1900(76.6)	1804(70.7)

Table 5. Changes in behavioral risk factors after intervention in different study groups

Behavioral risk factors		**Smoking now**		**Unhealthy diet**		**Sedentary**	
Research group		Control group	Test group	Control group	Test group	Control group	Test group
Total people		2480	2552	2480	2552	2480	2552
Baseline	Number of people (%)	351 (14.2)	487 (19.1)	1002 (40.4)	467 (18.3)	84 (3.4)	78 (3.1)
Comparison between groups	χ^2	22.023		297.294		0.441	
	p	0.000		0.000		0.524	
Intervention 12 months	Number of people (%)	265 (10.7)	367 (14.4)	469 (18.9)	434 (17.0)	51 (2.1)	91 (3.6)
Comparison between groups	χ^2	15.640		3.100		10.449	
	p	0.000		0.084		0.001	
Intervention 24 months	Number of people (%)	210 (8.5)	338(13.2)	478 (19.3)	340 (13.3)	24 (1.0)	25 (1.0)
Comparison between groups	χ^2	29.573		32.723		0.002	
	p	0.000		0.000		0.010	
Comparison before and after intervention	χ^2	41.267	37.203	388.440	25.056	34.820	38.787
	P	0.000	0.000	0.000	0.000	0.000	0.000

Table 6. Changes in health literacy levels after intervention in different study groups

Demographic characteristic		Gender				Age					
		Male		Female		18-44 years old		45-59 years old		60-79 years old	
Research group		Control group	Test group	Control group	Test group	Control group	Test group	Control group	Test group	Control group	Test group
Total people		1072	1103	1408	1449	787	959	695	891	998	702
Baseline	Health literate (%)	203 (18.9)	344 (31.2)	297 (21.1)	440 (30.4)	143 (18.2)	334 (34.8)	170 (24.5)	297 (33.3)	187 (18.7)	153 (21.8)
Comparison between groups	X^2	43.345		32.072		60.407		14.796		2.408	
	p	0.000		0.000		0.000		0.000		0.124	
Intervention 12 months	Health literate (%)	161 (15.0)	307 (27.8)	227 (16.1)	405 (28.0)	116 (14.7)	284 (29.6)	110 (15.8)	272 (30.5)	162 (16.2)	156 (22.2)
Comparison between groups	X^2	52.863		57.992		54.154		46.144		9.723	
	p	0.000		0.000		0.000		0.000		0.002	
Intervention 24 months	Health literate (%)	346 (32.3)	455 (41.3)	475 (33.7)	629 (43.4)	230 (29.2)	366 (38.2)	284 (40.9)	427 (47.9)	307 (30.8)	291 (41.5)
Comparison between groups	X^2	18.823		28.183		15.366		7.869		20.659	
	p	0.000		0.000		0.000		0.005		0.000	
Comparison before and after intervention	X^2	102.011	48.340	128.601	89.430	54.921	15.828	113.923	66.493	70.373	86.883
	P	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 7. Comparison of BMI levels in obese people in different study groups

Obesity		BMI	
Research group		Control group	Test group
Total people		204	234
Baseline	Blood lipid	29.98±2.90	29.95±2.45
Comparison between groups	t	-0.100	
	p	0.921	
Intervention 12 month	Blood lipid	27.18±3.34	27.96±3.17
Comparison between groups	t	2.507	
	p	0.013	
Intervention 24 month	Blood lipid	27.03±3.39	27.77±2.83
Comparison between groups	t	2.480	
	p	0.013	
Intervention 12 month group comparison	F value	87.966	60.447
	P value	0.000	0.000
Intervention 24 month group comparison	F value	99.216	77.485
	P value	0.000	0.000

Table 8. Comparison of blood lipid levels in people with dyslipidemia in different study groups

Blood lipid		**TC**		**TG**		**HDL-C**		**LDL-C**	
Research group		Control group	Test group	Control group	Test group	Control group	Test group	Control group	Test group
Total people		1900	1804	1900	1804	1900	1804	1900	1804
Baseline	Blood lipid	4.97 ±1.20	4.88 ±1.13	2.11 ±0.84	2.04 ±0.80	1.55 ±0.66	1.54 ±0.53	2.64 ±1.01	2.79 ±1.07
Comparison between groups	t	-2.173		-2.648		-0.322		4.152	
	p	0.030		0.008		0.748		0.000	
Intervention 12 month	Blood lipid	4.48 ±1.28	4.62 ±1.08	1.84 ±0.76	1.88 ±0.74	1.55 ±0.59	1.58 ±0.57	2.57 ±0.92	2.76 ±1.00
Comparison between groups	t	3.726		1.602		1.464		6.258	
	p	0.000		0.109		0.143		0.000	
Intervention 24 month	Blood lipid	4.35 ±1.19	4.62 ±1.10	1.76 ±0.64	1.87 ±0.76	1.65 ±0.67	1.60 ±0.64	2.55 ±0.91	2.76 ±1.02
Comparison between groups	t	7.236		4.901		-2.431		6.665	
	p	0.000		0.000		0.015		0.000	
Intervention 12 month group comparison	F value	128.165	51.478	49.397	3.623	0.121	2.041	0.443	0.998
	P value	0.000	0.000	0.000	0.057	0.728	0.153	0..506	0.318
Intervention 24 month group comparison	F value	209.596	54.338	101.045	11,.314	23.034	3.734	5.122	2.489
	P value	0.000	0.000	0.001	0.001	0.000	0.053	0.024	0.115

Table 9. Changes in total scores of quality of life assessment in different study group populations

Demographic characteristic		Gender				Age					
		Male		Female		18-44 years old		45-59 years old		60-79 years old	
Research group		Control group	Test group	Control group	Test group	Control group	Test group	Control group	Test group	Control group	Test group
Total people		1072	1103	1408	1449	787	959	695	891	998	702
Baseline	Total quality of life	73.86 ±13.22	75.22 ±11.11	72.80 ±12.67	74.17 ±11.29	73.76 ±13.99	74.90 ±11.61	73.47 ±14.55	75.19 ±10.63	72.71 ±11.12	73.53 ±11.36
Comparison between groups	t	2.600		3.022		1.858		2.730		1.474	
	p	0.009		0.003		0.063		0.006		0.141	
Intervention 12 months	Total quality of life	69.48 ±11.62	70.68 ±10.83	68.85 ±11.58	69.68 ±10.93	69.76 ±10.23	71.69 ±9.63	70.03 ±11.25	70.43 ±10.77	67.99 ±12.71	67.57 ±12.15
Comparison between groups	t	2.493		1.974		4.044		0.711		-0.687	
	p	0.013		0.048		0.000		0.477		0.492	
Intervention 24 months	Total quality of life	81.17 ±14.20	80.91 ±17.26	80.61 ±15.21	78.80 ±19.41	82.47 ±11.38	81.64 ±15.34	82.72 ±15.79	81.09 ±18.39	78.27 ±16.02	75.34 ±21.75
Comparison between groups	t	-0.376		-2.767		-1.265		-1.870		-3.194	
	p	0.707		0.006		0.206		0.062		0.001	
Intervention for 12 months comparison	F value	75.188	104.323	84.227	136.621	45.705	45.789	30.537	104.530	86.876	104.530
	P value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Intervention for 24 months comparison	F value	167.835	92.980	230.649	64.688	211.826	128.488	138.151	70.397	84.875	4.119
	P value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.043

Table 10. Comparison of the proportion of people who were willing to accept general practitioners

Demographic characteristic		Gender				Age					
		Male		Female		18-44 years old		45-59 years old		60-79 years old	
Research group		Control group	Test group	Control group	Test group	Control group	Test group	Control group	Test group	Control group	Test group
Total people		1072	1103	1408	1449	787	959	695	891	998	702
Baseline	Willing to accept signing service (%)	954 (89.0)	991 (89.8)	1304 (92.6)	1299 (89.6)	703 (89.3)	855 (89.2)	637 (91.7)	792 (88.9)	918 (92.0)	643 (91.6)
Comparison between groups	X^2	0.419		7.754		0.013		3.349		0.083	
	p	0.531		0.006		0.938		0.075		0.788	
Intervention 12 months	Willing to accept signing service (%)	991 (92.4)	985 (89.3)	1278 (90.8)	1276 (88.1)	723 (91.9)	847 (88.3)	623 (89.6)	776 (87.1)	923 (92.5)	638 (90.9)
Comparison between groups	X^2	6.457		5.517		5.999		2.436		1.408	
	p	0.011		0.021		0.016		0.136		0.243	
Intervention 24 months	Willing to accept signing service (%)	999 (93.2)	1037 (94.0)	1320 (93.8)	1357 (93.7)	714 (90.7)	911 (95.0)	646 (92.9)	822 (92.3)	959 (96.1)	661 (94.2)
Comparison between groups	X^2	0.620		0.012		12.222		0.273		3.433	
	p	0.483		0.939		0.001		0.631		0.080	
Comparison before and after intervention	X^2	13.888	18.017	9.064	27.849	3.005	30.429	4.926	12.931	16.546	5.806
	P	0.001	0.000	0.011	0.000	0.233	0.000	0.085	0.002	0.000	0.055

Figures

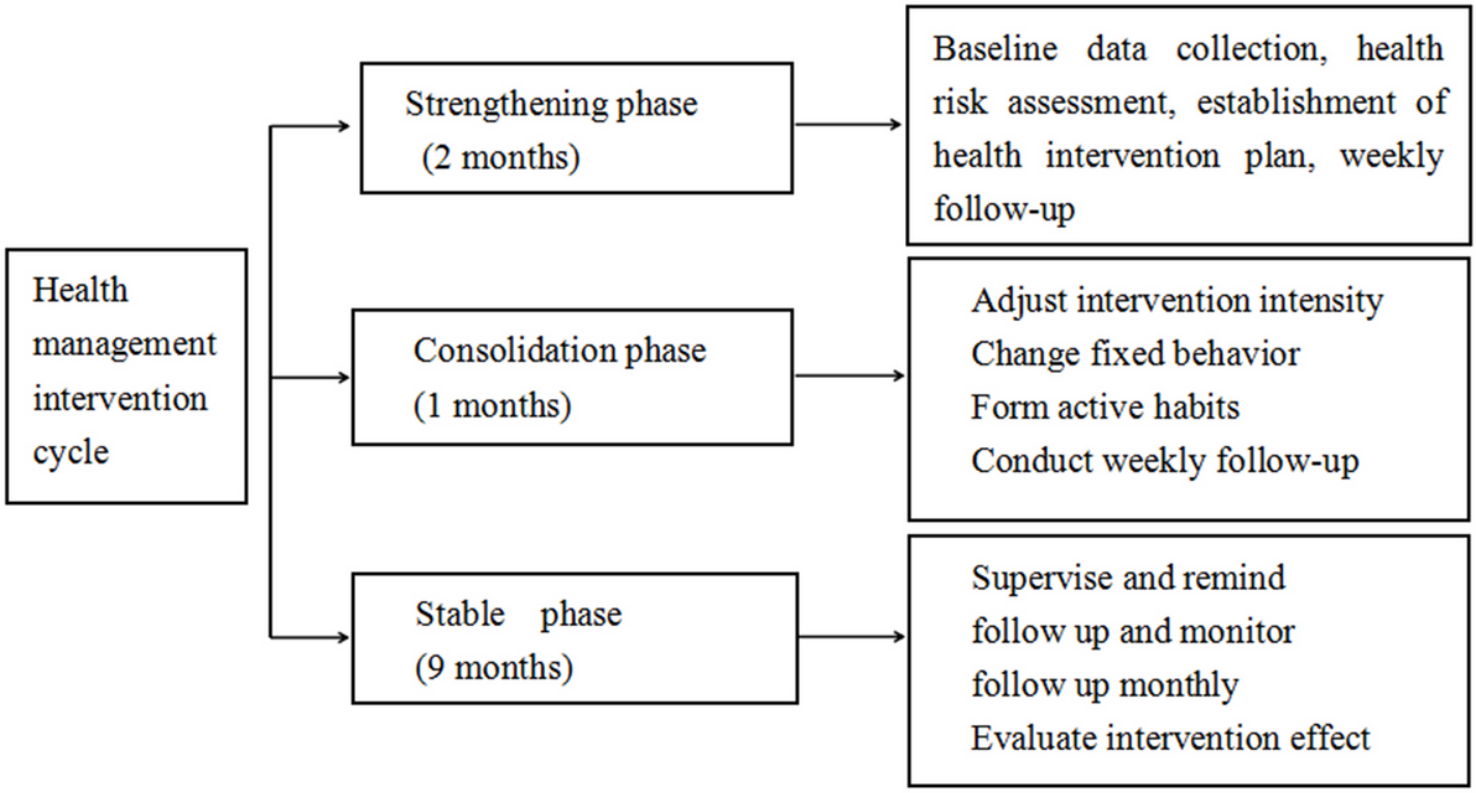

Figure 1

Health management cycle.

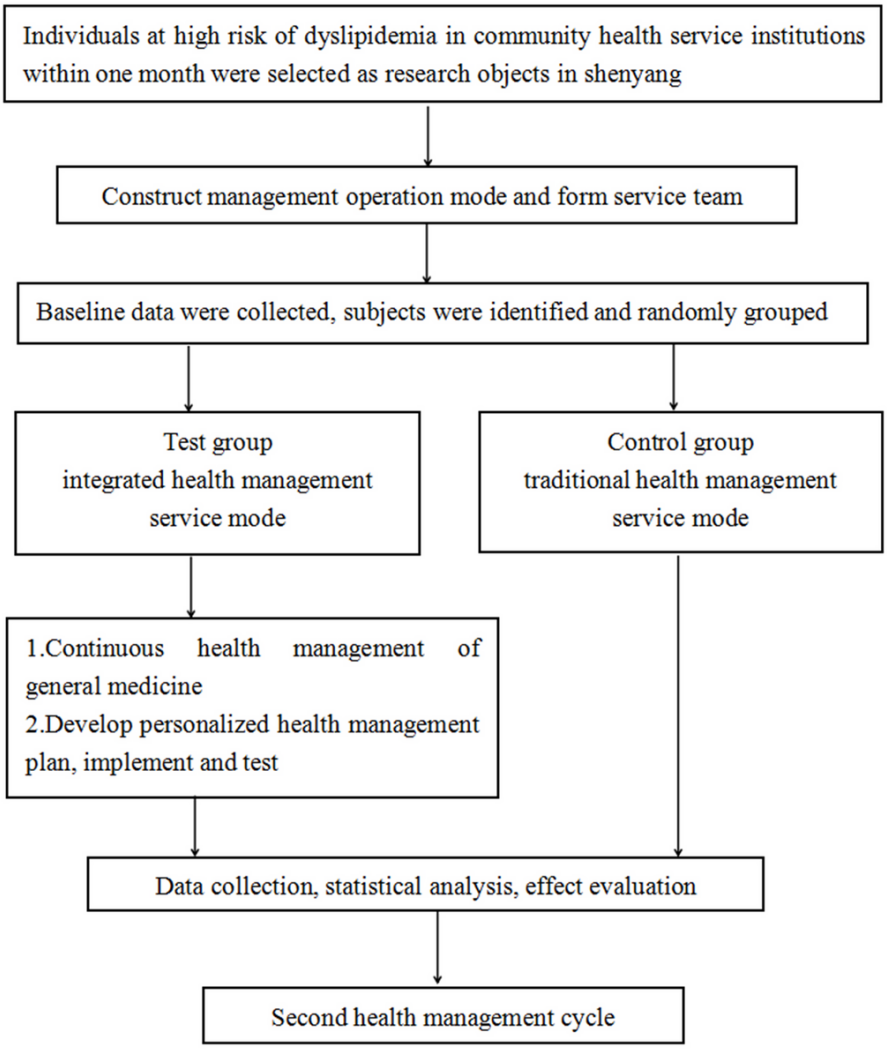

Figure 2

Technology road map.