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Research on the application of health management model based on the perspective of mobile health

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Abstract

The aim of the present study was to explore the application and its effect of mobile medical treatment to chronic disease health management in physical examination population, and to provide references for comprehensive intervention and management of chronic diseases.

From January to December 2016, 300 medical examiners in a general hospital health management center were randomly divided into health management group (155 cases) and control group (145 cases). The control group completed routine physical examination and health-risk assessment and provided corresponding reports, repeated annual physical examination and health-risks assessment. In addition to the routine physical examination and health-risk assessment, the health management group reminded the examiners to pay attention to their lifestyle and dietary habits by moving online and offline dynamic health interventions and provide targeted guidance for high-risk population such as diabetes, obesity, hypertension, etc. A review was made after 2 years. The clinical indexes and chronic disease behavior of patients before and after management were compared, and the effect was evaluated by statistical analysis.

After management, all the clinical indexes were significantly improved, and the patients' dietary structure, bad living habits, psychologic state, and other chronic disease behaviors were obviously improved. The proportion of patients with high risk of hypertension, diabetes, and obesity in health management group was significantly lower than that before intervention and control group ($P < .05$).

Using mobile network online, offline dynamic health intervention model can reduce the risk of common chronic diseases in health management objects, this health management model of chronic disease is worth popularizing.

Abbreviations: BMI = body mass index, DBP = diastolic blood pressure, FPG = fasting blood glucose, HDL-C = high-density lipoprotein cholesterol, LDL-C = low-density lipoprotein cholesterol, SBP = systolic blood pressure, SUA = serum uric acid, TC = total cholesterol, TG = triglyceride, WHR = waist-to-hip ratio.

Keywords: chronic disease management, health assessment, health intervention, lifestyle, mobile health

1. Introduction

At present, it is an important task to deepen the reform of medical and health system. The traditional medical mode is changing to the mobile medical mode, which is a new technology and a great change with the subversion brought by new situation. With the popularity of smartphones and the rapid development of information technology, a new Internet-based medical model emerged. Mobile healthcare has become a global trend. The aging population and the high incidence of chronic diseases have become a major social problem.[1] The situation of prevention and control of chronic diseases is very severe, which increases the social and family economic burden.[2,3] According to the relevant data in the 2015 report on the status of Nutrition and Chronic Diseases among Chinese residents, in 2012, 533 people died of chronic diseases per 100,000 people in China, accounting for nearly 90% of the deaths. Patients with chronic diseases account for 70% of the total medical expenses.[4] Healthy lifestyle management model is proposed as a means of self-managing chronic disease. Faced with the high mortality and disability rate of chronic diseases, there is a growing demand for mobile medicine to be used in chronic disease management.[5] Based on the health examination data, we carried out 2 consecutive years of health check-up and mobile medical line, and analyzed the population health status and influencing factors. The baseline data survey before and after the implementation of the medical examination service model was carried out to explore the dynamic health intervention model and the evaluation effect based on the mobile health perspective line in the context of the new medical reform. The aim of the study is to explore the application and its effect of mobile medical treatment to chronic disease health management in physical examination population, and to provide reference for comprehensive intervention and management of chronic diseases. The results are reported in the following sections.

2. Objects and methods

2.1. General information

A total of 300 residents, 190 males and 110 females, aged 20 to 72 years, with an average age of 40.4 ± 8.0 years, were selected from January to December 2015. Inclusion criteria: voluntary health assessment; age >20 years; self-care and normal physical activity; recognition of the assessment tools used; households and/or work units have more stable Internet connections and are able to send and receive e-mail and view SMS, WeChat messages, WeChat public numbers, and be able to use health management App software correctly. Exclusion criteria: coronary heart disease, stroke, malignant tumor, and other diseases are not suitable for this health assessment. The subjects who met the inclusion criteria were divided into control group (145 cases) and health management group (155 cases) according to random digital table method. The subjects were informed and agreed.

2.1.1. Ethics statement. The permission was obtained from the Ethics Committee of Qilu Hospital of Shandong University, China. Date of approval by the ethics committee is 2016-01-2 (approval number: KYLL2016007). Participations in our study were completely voluntary, and patients provided written informed consents.

2.2. Health management methods
2.2.1. Establish personal health information. Including the general situation of individuals, such as gender, age, and lifestyle, eating habits, physical activity, smoking and drinking history, family history, etc. Physical examination and laboratory results before and after management. The results of investigation were input into the information management system, and the personal health records were established.

1. General examination: The height, weight, waist circumference, and hip circumference of the subjects were measured according to the standard method, calculated waist-to-hip ratio (WHR) and body mass index (BMI). Blood pressure was measured using Omron Sphygmomanometer. Before the blood pressure was measured, the subjects took a rest at least 5 minutes, and took the average of the 2 measured values. If the difference between 2 values of systolic (SBP) or diastolic (DBP) is more than 5 mm Hg, it should measured again and taken the average value of 3 times. Fasting venous blood was collected in the morning. Serum uric acid (SUA), fasting blood glucose (FPG), triglyceride (TG), total cholesterol (TC), low-density lipoprotein cholesterol (LDL-C), and high-density lipoprotein cholesterol (HDL-C) levels were measured by 7600 automatic biochemical instrument (Hitachi, Japan). The reagents used are supplied by Roche.
2. Questionnaire: Questionnaire included personal basic situation, medical history, family history, lifestyle (including smoking, alcohol consumption), and diet questionnaire (Diet status of subjects in the past week, average daily intake, and movement were calculated. The above contents were completed by self-filling with computer software). Setting the criteria of the questionnaire, and a one-to-one survey shall be used in the investigation. There are quantitative food molds on the spot. If uncertainty about the quantity of the food, it is given to the person under investigation to refer to the food mold for quantitative analysis. Review the data on the spot, uniform number and record.

3. Establish personal information file and assess risk: Through individualized information collection and analysis to identify health-risk factors and estimate health risk, to predict the patient's current situation and development trend and maintain health and prevent disease through the link with the intervention measures.

2.2.2. Health education management. Going to the medical channels after physical examination, there are information health education platform and consultation expert system online, which are easy for patients to learn online and consult free, and to develop appointment registration, drug counseling, blood pressure monitoring, propelling health information, and other functional modules with WeChat public number platform. Self-health management: Organizing health education activities, providing interactive diet and exercise management for the subjects, changing unhealthy eating habits, and bad life behaviors. Control health-risk factors and implement personal health management plan.

2.2.3. Personal health plan and improvement guidance. Control group: Completing routine physical examination and health-risk assessment and providing corresponding report at the time of selection, the senior physician of the health management center will receive telephone consultation from the medical examiner, and annual repeated medical examination. Health management group: In addition to routine physical examination, health-risk assessment and subsequent health management were carried out in the health management group. The basic data investigation was combined with the data of patient self-health management, physical examination results and so on, to carry out rehabilitation knowledge and rehabilitation skills to the population with moderate risk, high risk, or related chronic disease, and so on. Developed one-to-one interventions, targeted rational diet, exercise and improvement of bad ways, stress regulation, and specific intervention programs, such as the diet of diabetics, stopping or reducing alcohol and smoking for high blood pressure patients, persisting in perennial moderate exercise, and so on. Physical index such as body weight, blood pressure, blood sugar, and so on were detected regularly once a week in the 1st month and once 2 weeks later. Blood lipids were checked once 3 months, records were made, treatment plans were adjusted according to monitoring results, monthly follow-up, regular reexamination. Mobile communication devices (telephone, WeChat, QQ, mobile App) were specially used to provide the comprehensive consultation service at any time, included supervising self-monitoring, reminding them to record the latest medication, checking data of blood pressure and blood sugar, and so on. All the information related to the health management of the physical examiner was recorded in the computer software system. The fluctuation trend is generated automatically by the software, which is taken as the objective basis for dynamic observation of the health state of the physical examiner. The time limit of effectiveness assessment to health management is 2 years.

2.3. Diagnostic criteria

"Expert consensus and Group Standard on body weight Management of overweight or obese population,"[6] 2010 revised edition of "Chinese guidelines for the Prevention and treatment of Hypertension,"[7] "The guidelines for the Prevention and treatment of Adult dyslipidemia,"[8] and "the Dietary

guidelines for Chinese residents"[9] were used as the basis for the determination of overweight and obesity, hypertension, dyslipidemia, and lifestyle. Judging standard of bad life style: Physical activity was insufficient: daily work was mainly light activity, or moderate physical activity was <5 days per week, cumulative weekly activity time was <150 minutes; Smoking: it refers to those who smoke >1 cigarette a day on average and drink alcohol for >1 year; Drinking: men drink >25 g and females drink >15 g per day; Insufficient intake of cereal potato: <250 g of potato intake per day; Excessive intake of livestock and poultry meat: more than 75 g per day; Insufficient intake of fruit: <200 g of fresh fruit per day; Insufficient intake of vegetables: <300 g of fresh vegetables per day.

2.4. Statistical analysis

The statistical analysis was carried out by SPSS 22.0 software package. The statistical data were expressed as $\bar{x} \pm s$ by normal distribution. T test was used to compare the 2 independent samples, and the rank sum test was used to measure the data that did not conform to the normal distribution. The count data were compared by Chi-squared test. $P < .05$ was statistically significant.

3. Results

3.1. Demographic characteristics

A total of 155 cases (110 males, 45 females, mean age 42.5 ± 6.6 years in the health management group, 145 cases (106 males and 39 females) in the control group, with an average age of 43.1 ± 6.2 years. There was no significant difference in sex composition and age between the 2 groups.

3.2. Comparison of physical and biochemical indexes between the 2 groups at the time of entering the group and 2 years after follow-up

After 2 years follow-up, the BMI, waist circumference, and WHR, SBP, DBP, FPG, SUA, TG, TC, LDL-C in the health management group were significantly lower than those Entry time, while the HDL-C level was significantly higher than that entry time. The difference was statistically significant ($P < .05$). There was no significant change in BMI, waist circumference, and WHR, SBP, DBP, FPG, SUA, TG, TC, LDL-C, HDL-C level in the control group ($P > .05$). In the 2nd year of follow-up, the BMI, waist circumference, and WHR, SBP, DBP, FPG, UA, TG, TC,

LDL-C level in the health management group were significantly lower than those in the control group, and the HDL-C level was higher than that in the control group ($P < .05$) (Tables 1 and 2).

3.3. Comparison of unhealthy lifestyle between the 2 groups after admission and follow-up for 2 years

The proportion of health management group and control group who had insufficient physical activity, smoking, drinking, fruit intake, vegetable intake, cereal potato intake, excessive intake of livestock and poultry meat, and poor lifestyle score were compared. The difference was not statistically significant ($P > .05$). After 2 years of follow-up, the proportion of physical activity, smoking, drinking, fruit intake, vegetable intake, cereals intake, and excessive intake of livestock and poultry in the health management group was significantly lower than when they entered the group. The difference was statistically significant ($P < .05$). Compared with the control group, the proportion of the above indexes in the health management group were significantly lower than that in the control group ($P < .05$, $P < .01$). There was no significant difference in the proportion of bad lifestyle between the 2 groups ($P > .05$), as shown in Table 3.

3.4. Comparison of the high risk of chronic diseases between the 2 groups after 2 years follow-up

After 2 years follow-up, the high risk of hypertension, diabetes, and ischemic cardiovascular disease in the health management group was significantly decreased ($\chi^2 = 4.116$, 4.215, 4.231, respectively; $P < .05$), and the hypertension in the health management group was significantly lower than that in the control group. The high risk rates of diabetes mellitus and ischemic cardiovascular disease were significantly lower than those of the control group ($\chi^2 = 5.678$, 8.624, 12.410, $P < .05$). There was no significant difference in the incidence of high risk of hypertension, diabetes, and ischemic cardiovascular disease in the control group after 2 years follow-up ($\chi^2 = 0.209$, 0.124, 0.151, $P > .05$), as shown in Table 4.

4. Discussion

With the rapid development of information technology, traditional medicine and healthcare are gradually introducing some new models.[10] MHealth is an emerging branch of medicine that uses technology to influence healthcare. As access to smartphones and mobile devices increases, the availability and usage of mHealth resources increase. Supporting self-manage-

Table 1

Comparison of physical examination indexes between the 2 groups when beginning and 2 years after follow-up.

Groups	Number of examples	SBP, mm Hg	DBP, mm Hg	Waist circumference, cm, $\bar{x} \pm s$	BMI, kg/m², $\bar{x} \pm s$	WHR, $\bar{x} \pm s$
Control group	145					
Entry time		116.00 (14.00)	81.00 (14.00)	89.08 ± 8.34	25.31 ± 2.84	0.91 ± 0.48
Second year of follow-up		119.00 (21.00)	80.90 (11.00)	88.88 ± 8.07	24.39 ± 2.76	0.87 ± 0.49
Health Management group	155					
Entry time		112 (14.00)	76.00 (9.00)	87.18 ± 9.86	24.68 ± 3.21	0.87 ± 0.07
Second year of follow-up		110 (16.75)[*,†]	71.00 (10.00)[*,†]	83.97 ± 9.61	24.68 ± 3.21	0.88 ± 0.06[*,†]

Data outside parentheses are median and data in parentheses are quartile spacing, comparison with group entry.
BMI = body mass index, DBP = diastolic blood pressure, SBP = systolic pressure, WHR = waist-to-hip ratio.
[*] $P < .05$; compared with the control group for the 2nd year of follow-up.
[†] $P < .05$.

Table 2

Comparison of biochemical parameters between the 2 groups when entering the group and following up for 2 years.

Groups	Number of examples	TG, mmol/L,$x\pm s$	TC, mmol/L,$x\pm s$	LDL-C, mmol/L,$x\pm s$	HDL-C, mmol/L, $\overline{x}\pm s$	FPG, mmol/L	SUA, μmol/L,$x\pm s$
Control group	145						
Entry time		1.66±0.81	5.11±0.89	3.22±0.78	1.12±0.24	5.20 (0.90)	368.51±81.97
Second year of follow-up		1.75±0.84	5.08±0.98	3.35±0.84	1.17±0.28	5.18 (0.70)	373.98±77.37
Health Management group	155						
Entry time		1.65±0.82	4.91±0.88	3.10±0.72	1.17±0.25	5.09 (0.79)	363.96±75.29
Second year of follow-up		1.49±0.67[*,†]	4.79±0.83[*,†]	2.97±0.70[*,†]	1.24±0.30[*,†]	4.95 (0.66)[*,†]	356.12±79.10[*,†]

Data outside parentheses are median and data in parentheses are quartile spacing, comparison with group entry.
FPG=fasting blood glucose, HDL-C=high-density lipoprotein cholesterol, LDL-C=low-density lipoprotein cholesterol, SUA=serum uric acid, TC=total cholesterol, TG=triglyceride.
[*] $P<.05$; compared with the control group for the 2nd year of follow-up.
[†] $P<.05$.

Table 3

Comparison of unhealthy lifestyle between the 2 groups when entering the group and 2 years after follow-up.

Groups	Number of examples	Smoking	Drinking	Insufficient vegetable intake	Insufficient intake of cereal potatoes	Excessive intake of meat for livestock and poultry	Insufficient fruit intake	Insufficient physical activity
Control group	145							
Entry time		48 (33.0)	92 (63.1)	67 (45.9)	67 (46.1)	79 (54.8)	96 (66.3)	76 (52.5)
Second year of follow-up		45 (31.2)	91 (62.6)	68 (46.7)	71 (48.3)	87 (59.9)	95 (65.2)	77 (53.4)
Health Management group	155							
Entry time		47 (30.5)	95 (61.2)	68 (43.9)	70 (45.3)	87 (55.9)	99 (63.7)	79 (50.9)
Second year of follow-up		34 (22.0)[*,‡]	92 (59.5)[†,‡]	49 (31.9)[†,‡]	51 (33.1)[†,‡]	67 (43.4)[†,‡]	81 (52.4)[†,‡]	60 (38.9)[†,‡]

Data outside parentheses are the number of examples and data in parentheses are percentages (%), comparison with the control group for the 2nd year of follow-up.
[*] $P<.05$.
[†] $P<.01$, comparison with group entry.
[‡] $P<.05$.

ment is an integral goal of healthcare.[11] Given the enormous burden of chronic diseases worldwide, the focus of mHealth implementation research is on implementing self-management strategies for patients with chronic diseases.[12] There is no clear consensus on the best way to intervene with mHealth for chronic diseases.

Medical staff showed great interest and enthusiasm for mobile medicine.[13] The health network of chronic disease management is constructed, and the interactive information service platform of doctors and patients is realized. In this study, health-risk assessment was used to group the health examiners into high risk groups, and the individualized health management guidance program was established according to the evaluation report. It was carried out point-to-peer health knowledge promotion and health guidance through Internet network software and platforms, e-mail, SMS, telephone, etc, to strengthen health education for medical examiners, establish innovative business of chronic illness management based on mobile Internet, serve the public, and provide continuous health services integrated online and offline, to form a new model of individualized chronic health management centered on physical examination personnel, mobilize the subjective initiative of the management object, strengthen the self-management ability of the examiners, ensure the long-term implementation of the health management program, make them gradually understand the role of unhealthy lifestyle in promoting disease, so as to consciously participate in

Table 4

Comparison of the high risk of chronic disease in the 2 groups after admission and follow-up for 2 years.

Groups	Number of examples	Ischemic heart disease	Diabetes	Hypertension
Control group	145			
Entry time		40 (27.6)	87 (59.9)	58 (40.2)
Second year of follow-up		42 (28.7)	89 (61.5)	63 (43.5)
Health management group	155			
Entry time		33 (21.2)	89 (57.4)	64 (41.2)
Second year of follow-up		19 (12.1)[*,†]	72 (46.6)[*,†]	47 (30.6)[*,‡]

Comparison with the control group for the 2nd year of follow-up.
[*] $P<.05$.
[†] $P<.01$, comparison with group entry.
[‡] $P<.05$.

physical exercise, to be low salt low fat diet and stop smoking and limit alcohol.[14–16] On the basis of health examination, the results of personal medical examination, health-risk assessment and health intervention are recorded, dynamically monitored and managed at any time by using the Internet software of health management. By means of health-risk assessment, the subjects were stratified, high risk groups were selected for key surveillance and key interventions to reduce the risk of high risk groups and save social health resources. Following up for 2 years, the BMI, waist circumference, and WHR, SBP, DBP, FPG, SUA, TG, TC, LDL-C in the health management group were significantly lower than those before intervention, the HDL-C was obviously increased, and the indexes were lower than those in the control group. After 2 years follow-up, the BMI, waist circumference, and WHR, SBP, DBP, FPGS, SUA, TG, TC, LDL-C, HDL-C in the control group were not significantly different from those in the control group. The health management members in this study can improve the awareness of self-care, learn the method of self-care, and transform it into self-control and self-management ability, which can detect abnormal cases early and diagnose early, thus effectively reducing or avoiding the occurrence of diseases. In the health management group, the proportion of smoking, drinking, insufficient physical activity, insufficient fruit intake, insufficient vegetable intake, insufficient cereal and potato intake, excessive intake of livestock and poultry meat, and poor lifestyle scores were significantly decreased, and were significantly lower than those before intervention. After management, patients' unhealthy habits, dietary structure, exercise habits, psychologic state, and other behaviors related to chronic diseases were obviously improved compared with those before management. On the one hand, although the traditional physical examination model provides the examiners with detailed medical examination reports and health advice, those whose physical examination indexes reach the critical value but do not meet the clinical diagnostic criteria tend to ignore the results of the physical examination and do not take corresponding measures, which leads to the annual physical examination without obvious improvement of the health status. On the other hand, some people in the traditional physical examination mode are only simple physical examination, and have never paid attention and taken measures to the abnormal condition of physical examination index and unhealthy lifestyle after examination. Therefore, in terms of compliance and effectiveness evaluation of health indicators, the dynamic health intervention mode on-line and off-line of mobile health perspective is superior to the traditional health examination mode.

The results show that this health management mode can reduce the risk of common chronic diseases, promote their lifestyle changes, improve blood sugar, blood lipid, blood pressure, and other indicators. This study provides an effective and convenient health management model for medical staff in general hospitals to carry out health management for a large number of people, especially those at high risk of chronic diseases, and can be used for postexamination services in health examination centers. MHealth improves patient education in a convenient and interactive way and it was used to intervene the health examination population, strengthen their knowledge and confidence in chronic diseases, improve chronic disease control and self-management, reduce related healthcare costs, and save resources.

The health management of patients with chronic diseases requires a long time and a lot of investment.[17,18] Mobile medicine also shows its added value in the management of chronic diseases, all of which will drive the development of mobile medicine.[19–21] Mobile medical app is the most common form. Currently, 2/3 of mobile medical App belong to health management, including fitness, lifestyle and stress, diet and nutrition, and about 1/4 belong to disease management. Especially in the management of chronic diseases, such as congestive heart failure, chronic obstructive pulmonary disease and diabetes, the cost of treatment of these diseases is high. Mobile medical App can significantly increase patients' compliance and effectively monitor patients' physiologic indicators and improve the effect of medical treatment. We need to strengthen offline diagnosis, treatment and health education, etc, to prevent and treat chronic diseases. On the contrary, by using the established medical and health information platform, electronic health files and various mobile medical methods, we can integrate all medical and health service institutions in the region and open up the services between the online and offline mobile medical services, to establish a new model of chronic disease management, promote the systematization, refinement, and continuous management of chronic diseases and medical services. This study integrated the mobile medical and health management deeply, the development trend of this model is to gradually form a closed loop of online and offline healthcare services to provide continuous medical services for patients. Two years later, the high risk ratio of hypertension, diabetes mellitus, and ischemic cardiovascular disease were all significantly decreased after reassessment by the health-risk assessment software, which indicated that the health management model was effective in the prevention and control of chronic diseases. Under the background of big data era, the innovation mode of chronic health management with mobile health provides a new vision and new ideas to realize the sharing of regional medical resources, improve the accessibility of quality medical resources, the quality of medical services, and the ability and efficiency of medical management,[22] which is worth popularizing. The mobile-health-based model acknowledges the importance of a healthy lifestyle for managing chronic and mental health. This approach enables patients to adopt healthy lifestyle choices by using innovative technologies and provide a useful way to improve health literacy and self-monitoring. These pathways enable those at risk of chronic disease to manage their lifestyles in a healthy way. We believe that the mobile healthy lifestyle management model can be used as a means to attract physical examinees to make self-care and self-decision and adopt sustainable and healthy lifestyle behaviors.

Limitations of the study were its small sample size and the ability to extract data from participants needs to be improved. Future efforts will be to expand the sample size, streamline the program, and improve efficiency. Through assessment and self-management education, each participant makes a contribution to self-management education. Healthcare workers provide one-on-one education and guidance to participants. In addition, hospital staff coordinate efforts with teams to ensure ongoing care for participants.

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Author contributions

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