Vol 3, Issue 3, Jul 2016
Journal of Health Management & Informatics
jhmi.sums.ac.ir
Original Article

Application of goal programming to improve human resource allocation for urban family physician plan in Iran

Mohammad Hossein Mehrolhassani[1], Vahid Kohpeima Jahromi[2,*]

Received 2 Feb 2016; Accepted 4 Apr 2016

ABSTRACT

Introduction: Family physician plan in Iran was conducted to establish service referral system. Its urban step began in 2012 and it was supposed that the effectiveness is enhanced and the costs are reduced. The implementation of this program has faced some challenges, especially in human resources management. The aim of this study was to optimally allocate human resources for urban family physician plan in Jahrom town, using goal programming model.

Method: This cross-sectional, case study was carried out in 2014 in Jahrom, Iran. Jahrom was studied as a case. Data were collected using a group discussion sessions, five structured interviews, reviewing documents, and field study. The participants were selected using purposive sampling method. After the emergence of goal programming components, the model was designed and problems were solved using software DS.

Results: The optimal number of urban family physicians was 37 with two working shifts and 15 with one working shift. Moreover, the optimal number of physicians was 25 in public health centers and 19 in private centers. In addition, the optimum number of family physician assistants was 52. On the basis of these results, the real number of urban family physicians was 33, 26, 25, 34 and, 57, respectively.

Conclusion: The results of this model showed that allocation of human resources in family physician program was not optimal and satisfactory based on the decision-makers' viewpoints. Thus, goal programming would provide a more favorable allocation when combined with mentality of the managers and logical optimal numbers.

Keywords: Family physician, Goal programming, Human resource allocation, Iran

►*Please cite this paper as:*
Mehrolhassani MH, Kohpeima Jahromi V. Application of goal programming to improve human resource allocation for urban family physician plan in Iran. J Health Man & Info. 2016;3(3):94-99.

Introduction

Health systems have been established globally to improve the health of people from all over the world. Every health system provides its services in different levels from villages to cities and from primary care to complex and specialized services. Providing health services as one of the main functions of a health system is possible in the family physician program (FPP) with the referral system (1). The referral system indicates that patients are treated at the first level referral center. However, if diagnosis and treatment is hard or impossible, patients are referred to higher specialized levels. In the referral system, if patients are directly referred to the specialized centers, their costs will not be covered by the insurance companies. In the referral system based on FPP, some physicians are selected based on their moral and scientific competence and are considered as the first level of health system. Then, their names are given to the insured people who will opt for one of them. People can change their physicians during the time period specified in the regulations (2). FPP plays a pivotal role in improving the quality, cost effectiveness, and equity in health systems in the world (3). In Iran, predicting the implementation of FPP and the referral system is one of the key issues in health system general policies (4), Iran's 20-year vision plan (5), and the fourth development plan (6). According to the requirements of the country, the FPP was implemented in 2005 in villages and towns with a population of under 20 thousand people. Following the implementation of this plan in rural areas, in spite of its advantages (3, 7-11) and disadvantages (2, 12, 13) mentioned in scientific texts and despite insufficient coverage of health system in towns, this plan has been commenced in urban areas with a population of over 20 thousand people since 2012. The FPP was initiated as a pilot study in two provinces of Iran, namely

[1] *Health Services Management Research Center, Institute for Futures Studies in Health, Kerman University of Medical Sciences, Kerman, Iran*

[2] *Research Center for Modeling in Health, Institute for Futures Studies in Health, Kerman University of Medical Sciences, Kerman, Iran*

*Corresponding Author: ***V Kohpeima Jahromi,*** *Department of Health Policy, Management and Economics, Kerman University of Medical Sciences, Haft Bagh Highway, Kerman, Iran, Phone: 03431325147, Email: vahidkouh@yahoo.com*

Fars and Mazandaran and it was conducted as provisions of the Iran Fifth Development Plan (14) in coordination with the Ministry of Health and Medical Education as a policymaker and service provider and Ministry of Cooperatives, Labor and Social Welfare as a financial supporter (2). One of the main goals of the FPP was to reduce the health system costs, because in the past two decades increase in the costs of health system has been twice more than the increase in total index of the costs in the country (15). However, several studies have indicated that a significant percentage of the financial resources of FPP have been spent on manpower wages. Since a huge part of these costs is not necessary and can be spent more effectively, applying better and more effective manpower seems crucial (16, 17). One of the suitable methods of planning and allocating is goal programming which was proposed in 1961 as one of the multi variant decision-making models in management (18). One of the features of this plan is that it is used for real situations in organizations in which managers face several goals or objectives. Goal programming emphasizes optimality along with satisfaction (19). This method has been used in numerous studies for optimal allocation of resources. Attaollahi et al. (20) used goal programming model to allocate hospital beds at Bandar Abbas hospitals. They reported a shortage of beds in special wards and expressed a need for additional beds in emergency rooms and general surgery wards. Jenal et al. (21) also used goal programming for designing nursing shifts. The study resulted in improved quality of work, employees' satisfaction, and organizational justice. Moreover, Abedi et al. used goal programming to allocate optimal resources in educational and university settings of Ministry of Health in Iran. Their research resulted in optimizing resources including the number of students, number of academics, and the amount of physical space (22). Fars and Mazandaran provinces, with a population of about 7 million and six hundred thousand people and as the first cities which have implemented the urban family physician plan (UFPP) constitute 10% of the population of Iran. In these two provinces, many cities have put UFPP into practice. Obviously, expanding UFPP to other parts of Iran depends on its success and the achieved goals in these two provinces. Therefore, the aim of this study was to allocate optimal resources in UFPP in Jahrom University of Medical Sciences using goal programming. Jahrom is located in Fars province, south eastern Iran, and has a population of about 210,000 people.

Methods

This cross-sectional research was conducted as a case study during September and December 2014 in Jahrom, Iran. The statistical population consisted of all towns covered by five universities that implemented UFPP in two provinces (including the cities under the coverage of Mazandaran, Babol, Fars, Fasa, and Jahrom universities). Because of greater access, we chose Jahrom as our case in this study. In the city, the UFPP was conducted in three urban areas including Jahrom, Bab Anar, and Ghotb Abad (Table 1). The background to this choice was that the above-mentioned universities were the first organizations that implemented the UFPP. In this research, the goal programming method was used as the research basis and data analysis. This method consists of three parts, namely decision variables, goal and systemic constraints, and objective function.

A) Decision variable (Xi): decision variable is a quantity under control of decision makers in order to determine its amount.

B) Goal and systemic constraints: goal constrain shows the given levels of every objective $(P_i)x_i \pm d_i^{\pm})$; systemic constraints are constraints that cannot be violated (Pi is goal priority and Xi is decision variable).

C) Objective function: objective function in goal programming model is intended to reduce the total weight of adverse deviations ($MinZ = \sum_{i=1}^{P} d_i^{\pm}$) ($d_i^{\pm}$ is desirable and undesirable deviation from the goal; Z is the total weight of deviation from goals).

In the study, we used both qualitative and quantitative methods consecutively; first, a focus group was held, some interviews were done and documents were reviewed. At this point, the model was designed and then the quantitative method was used for solving the problem. Study samples consisted of 15 individuals who were informed experts in FPP. They were selected using purposive sampling method. Participants were selected based on having at least four years of management experience, being familiar with UFPP, and willingness to participate in the focus group and interview. To collect the data in "the goal restrictions, the objective function, and the decision variables" sections, a focus group was held. The meeting lasted three hours and 15 officials, experts, and managers from Jahrom University of Medical Sciences attended. In addition, structured interviews were designed with five participants in the focus group. Usually, the interviews lasted one hour to one-half hour per participant. They included a university president, a university health deputy, a network development manager, and two experts in the network development center. Because our sample size-such as many qualitative works-relies on the concept of saturation, our findings were completed after these five interviews. To obtain the systemic constraints, the existing documents were reviewed and the field study was used. In reviewing documents, all rules and regulations of the urban and rural FPP since 2005, provincial committee agendas of FPP, and the rules of Iran's socio economic development were reviewed. In the field study, information of financial and administrative units of universities was employed. To solve the problems and to analyze the results, the goal programming model and DS software were used. In order to test the strength of the results, reduction of uncertainties, identification of potential errors in designing a model, and increased understanding of input and output variables, we used the sensitivity analysis test (23).

Results

The findings of this research revealed the ideal number of family physicians in different shifts and in different public and private health centers. We also made comparisons between the optimal numbers of family physicians with real numbers (Table 3). The UFPP started in Jahrom in

2012 with three urban centers (Table 1); moreover, 93% of the people in this city enrolled for this plan in 28 public health centers and 34 private offices. After analyzing the interviews, focus groups, and documents, the following results were obtained:

A) decision variables: decision variables included the optimal number of family physicians who worked in one shift (X1) and two shifts (X2) in Jahrom, the optimal number of family physicians in Bab Anar (X3) and Ghotb Abad (X4), the number of family physicians in public health centers (X5), the number of family physicians in private health centers (offices) (X6), and the number of family physician assistants (X7).

B) Goal and systemic constraints: systemic constraints of UFPP are shown in Table 2, based on the existing laws and regulations, version 02 of FPP and supplementary regulations.

The obtained goals and the goals targeted by the program managers and experts were prioritized in the form of systemic constraints in the focus group meeting. It was clear that managers were willing to register all the people of this city in the UFPP (goals 1, 2, 3). Secondly, they were also willing to provide the services in both public and private health centers, with priority of public centers (goals 4 and 5). Finally, providing UFPP services in all morning and afternoon hours (goal 6) by the appointed physicians were decided by the managers and experts in the focus group (Table 3).

After obtaining systemic constraints and goals, we were able to design the goal programming model of the UFPP as follows:

1. Systemic budget constraint model allocated to this plan was designed based on per capita payment of Health Insurance Organizaion and the population covered by physicians. In this model, incomes of family physicians were based on their working shifts, different urban areas, and their working places.

$52.5\ X1 + 105\ (X2 + X3 + X4) \leq 4634$
$52.5\ X1 + 105\ X2 \leq 3864$
$105\ X3 \leq 490$
$105\ X4 \leq 280$
$78.7\ (X5 + X6) \leq 4634$

2. Systemic constraints of the population covered by the physicians (considering low and high extremes) and the ratio of physicians to population showed that the given equation must be limited between 44.1 and 264.8 people.

$X1 + X2 + X3 + X4 \geq 44.1$
$X5 + X6 \geq 44.1$
$X1 + X2 + X3 + X4 \leq 264.8$
$X5 + X6 \leq 264.8$

3. Systemic constraints of the number of assistants

$X7 - (X1 + X2 + X3 + X4) \geq 0$

4. Non-negative systemic constraints
$X1, X2, X3, X4, X5, X6, X7, di-, di+ \geq 0$

5. Goal constraints of population covered in Jahrom

P1) $X1 + X2 + d1- - d1+ = 44.16$
$X5 + X6 + d2- - d2+ = 44.16$

6. Goal constraints of population covered in Bab Anar

P2) $X3 + d3- - d3+ = 5.66$

7. Goal constraints of population covered in Ghotb Abad

P3) $X4 + d4- - d4+ = 3.2$

8. Goal constraints of the number of governmental health and treatment centers with family physicians.

P4) $X5 + d5- - d5+ = 25$

9. Goal constraints of the number of private health and treatment centers with family physicians.

P5) $X6 + d6- - d6+ = 34$

10. Goal constraints of working shifts of family physicians.

P6) $X2 + d7- - d7+ = 44.16$
$X5 + X6 + d8- - d8+ = 44.1$
$(X1 + X2 + X3 + X4)- (X5 + X6) + d9- - d9+=0$

C) Objective function: the objective function obtained from the focus group was targeted to minimize the nine negative adverse deviations mentioned above; that is, according to mangers and experts participating in group discussions, the lower number of population coverage in three urban areas, the lower number of physicians in public and private health centers, and the lower number of physicians with two working shifts were considered as adverse deviations which must be minimized.

$Min\ Z = P1\ (d1- + d2-) + P2d3- + P3d4- + P4d5- + P5d6- + P6\ (d7- + d8- + d9-)$

Optimal results were obtained by solving the above-mentioned model and comparing the obtained results with the real values and goals in the UFPP (table3).

The optimal number of urban family physicians in different shifts in public and private healthcenters and the optimal number of their assistants showed that the adverse deviations were minimized and the objective function was obtained (Figure 1).

Discussion

The ideal number of family physicians working for two shifts and one shift in the central part of the city was 29 and 15, respectively. This is more desirable than having 51 family physicians on work shift and only half of them working in one shift. If a higher number of family physicians are available during morning and afternoon shifts in order to provide services to the population, the resultant is more visits and less costs.

Table 1. Demographic data of health and treatment centers in Jahrom

Name of city	Total population	Population recorded in the plan	No. of governmental health and treatment centers	No. of private health and treatment centers
Jahrom	120000	110400	22	29
Bab Anar	14000	14000	2	4
Ghotb Abad	8000	8000	1	1
Total	142000	132400	25	34

Table 2. Systemic constraints of Jahrom family physician plan

Code	Systemic constraint	Considerations
Sc1	Per capita payments by insurance companies to the physicians was 35000 in 2014	National instructions of urban family physicians in 2014
Sc2	Minimum population covered by each family physician is 500 people and maximum population coverage is 3000 and 1500 people for two shifts and one shift respectively	Article 33, chapter 5, version 2*
Sc3	4 family physicians are appointed for every ten thousand people	Chapter 3,version 2*
Sc4	80 % of the allocated per capita must be paid to physicians at the end of each month and the remaining 20% must be paid after monitoring and receiving feedbacks	Article 42, chapter 5, version 2*
Sc5	There must be at least one nurse or midwife assistant for each family physician	Chapter 3,version 2*

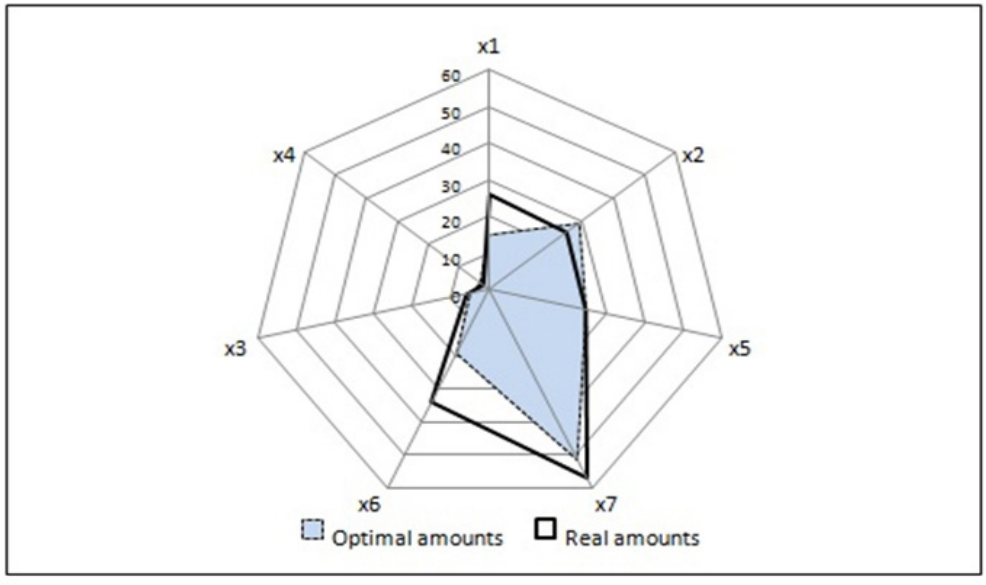
*Guidelines of family physician and referral system in urban areas, version 2

Table 3. Comparison of real, goal, and optimal amounts in Jahrom UFPP

Symbol	Decision variable	Real amounts	Goal	Optimal amounts
X1	number of family physicians with one working shift in Jahrom	26	0	15
X2	number of family physicians with two working shifts in Jahrom	25	51	29
X3	number of family physicians in Bab Anar	6	6	5
X4	number of family physicians in Ghotb Abad	2	3	3
X5	number of family physicians in governmental health and treatment centers	25	25	25
X6	number of family physicians in private offices centers	34	34	19
X7	Number of assistants	57	59	52

This optimum number of family physicians which is based on goals 1 and 6 can increase the managers' satisfaction as well. This finding is in line with the study carried out by Guler and Aydin (24) who designed the optimal working shifts by using the goal programming model. In addition to the number of physicians in the city center, the optimal number of physicians in Bab Anar and Ghotb Abad was 5 and 3, respectively (to achieve goals 2 and 3). Since the study by Farzadi et al. (25) represented a shortage of family physicians to perform FPP, applying the optimal number of physicians according to the goal programming model can compensate for this shortage. Moreover, the optimal number of family physicians was 25 and 19 in public health centers and private offices, respectively. Based on the priority of the fourth goal over the fifth one, it can be concluded that public centers are of great importance in the designed model. Although implementation of the UFPP is impossible without the participation of the private sector, most urban healthcenters considered in Primary Health Care (PHC) system help the physicians work in public sections and this can compensate for a shortage of physicians in his area (25). Also, if private physicians work in public centers, a part of per capita will be allocated to rental money and equipment. By achieving the optimum number of family physicians in public and private health centers, the managers' fourth goal will be accomplished, as well. Thus, both managers and family physicians working in the public health sections will be satisfied. Results obtained from this part of the model were in line with those of a study conducted by Shah Nazari et al. (26) who worked on manpower programming using fuzzy goal programming model. Finally, according to a study by Turguy and Taskin (27) and their proposed model in using the goal programming in reducing costs and increasing the satisfaction of customers in Turkey, it can be mentioned that the optimal results obtained from 7 variables of the goal programming model of the present study (less than the real value) revealed that the determined goals of urban family physicians were achieved in reducing the costs (Figure 1).

Figure 1. Comparison of the optimal amounts obtained from the goal programming model and real amounts of decision variables in Jahrom urban family physician plan



Considering the provinces (Fars and Mazandaran) and their cities where the UFPP was implemented in the first step of its initiation, one of the limitations of this study was its small setting. However, the results obtained from this study can be considered as a basis for other human resource studies related to UFPP. Moreover, obtaining goals proposed by managers in the two pilot sites will play an important role in achieving the optimal allocation of manpower in this plan.

Conclusion

Results revealed that the number of family physicians was not allocated optimally. Using goal programming, integrating goals proposed by managers, and systemic constraints of health system can lead to desirable presentation of manpower in the UFPP. The literature has identified three strategies to be used by policy makers when they seek to expand the UFPP across the country. The first was to take the goals of provincial authorities in human resource planning. This strategy helps top managers and policy makers to involve them in their programs to allocate family physicians optimally. The second strategy was to change the approach of using the private sector. The private sector can be involved to be provided a fair access to health services in UFPP. The third strategy was to use research experts' suggestions in order to reduce manpower shortages. Policy makers can use these strategies to manage health organizations effectively.

Acknowledgement

Authors express their sincere thanks to the manager of FPP in Jahrom, Mr. Mohammad Dori, and experts of network development center at health deputy of Jahrom University of Medical Sciences for their cooperation.

Competing Interest

None declared.

References

1. Nasrollahpour Shirvani D, Ashrafian Amiri H, Motlagh M, Kabir M, Maleki MR, Shabestani Monfared A, et al. Evaluation of the function of referral system in family physician program in Northern provinces of Iran: 2008. Journal of Babol University of Medical Sciences. 2010;11(6):46-52.
2. Family physician Iranian sociey of general practitioners; 2013; Available from: http://isgp.ir/doctor_family.
3. Khayyati F, Motlagh ME, Kabir M, Kazemeini H, Gharibi F, Jafari N. The role of family physician in case finding, referral, and insurance coverage in the rural areas. Iran J Public Health. 2011;40(3):136-9.
4. Health policies in Iran. Expediency Council; 2013; Available from: http://www.maslahat.ir/.
5. Twenty-year vision of Islamic Republic of Iran. Parliament Iran; 2013; Available from: http://www.parliran.ir/.
6. The Regulations of Fourth Development Plan. Parliament Iran; 2013; Available from: http://www.parliran.ir/.
7. Alipour A, Habibian N, Tabatabaee S. Evaluation the impact of family physician care program on family planning in Sari from 2003 to 2007. Iranian Journal of Epidemiology. 2009;5(1):47-55.
8. Barati O, al. e. [Family physician impact in health index]. Payesh journal. 2012;11(3):361-3.
9. Hatmi ZN, Malekpour M. Family physicians in Iran: success despite challenges. Lancet. 2010 Nov 6;376(9752):1541.
10. Kavari SH, Keshtkaran A. Evaluation of physicians and paramedical doctor's viewpoints on the family physician as a lost link in the medical system of Iran. Middle East Journal of Family Medicine. 2004;4(4).
11. Lankarani KB, Alavian SM, Haghdoost AA. Family physicians in Iran: success despite challenges. Lancet. 2010 Nov 6;376(9752):1540-1.
12. Shalileh K, Mahdanian A. Family physicians' satisfaction in Iran: a long path ahead. Lancet. 2010 Aug 14;376(9740):515.
13. Takian A, Rashidian A, Kabir MJ. Expediency and coincidence in re-engineering a health system: an interpretive approach to formation of family medicine in Iran. Health Policy Plan. 2011 Mar;26(2):163-73.
14. The Regulations of Fifth Development Plan. Parliament Iran; 2013; Available from: http://www.parliran.ir/.
15. Davari M, Walley T, Haycox A. Iranian health system economic chalenges. , 8(7):. Health information management. 2011;8(7):915-7.
16. Kiaei M, Mouseli L, Mohebbifar R, Shishechi R. Comparison of the distribution of human resources in university and private hospitals of Qazvin. The Journal of Medical Education & Development. 2013;6(2):45-52.
17. The world health report: health systems: improving performance: World Health Organization2000.

18. Charnes A, Cooper WW. Goal programming and multiple objective optimizations: Part 1. European Journal of Operational Research. 1977;1(1):39-54.
19. Momeni M. New topics in operations research. Tehran: Management School Publications. 2006.
20. Ataollahi F, Bahrami MA, Abesi M, Mobasheri F. A goal programming model for reallocation of hospitals' inpatient beds. Middle-East Journal of Scientific Research. 2013;18(11):1537-43.
21. Jenal R, Ismail WR, Yeun LC, Oughalime A. A cyclical nurse schedule using goal programming. Journal of Mathematical and Fundamental Sciences. 2011;43(3):151-64.
22. Abedi G, LAGSHAEI B, TABIBI S, Arianezhad M. Fuzzy goal programming model in resource allocation at education section of the ministry of health. 2007.
23. Pannell DJ. Sensitivity analysis of normative economic models: theoretical framework and practical strategies. Agricultural economics. 1997;16(2):139-52.
24. Güler MG, İdi K, Güler EY. A goal programming model for scheduling residents in an anesthesia and reanimation department. Expert Systems with Applications. 2013;40(6):2117-26.
25. Farzadi F, MOHAMMAD K, Maftoun F, LABAF GR, TABIBZADEH DR. General practitioner supply: family physician program and medical workforce. 2009.
26. Shahnazari-Shahrezaei P, Tavakkoli-Moghaddam R, Kazemipoor H. Solving a multi-objective multi-skilled manpower scheduling model by a fuzzy goal programming approach. Applied Mathematical Modelling. 2013;37(7):5424-43.
27. Turgay S, Taşkın H. Fuzzy goal programming for health-care organization. Computers & Industrial Engineering. 2015;86:14-21.