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Systematic Review

The Effect of Resource Allocation Decisions on Efficiency and Equity in the Health Sector: A Systematic Review

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A B S T R A C T

Background: The ultimate goal of health systems is creating a healthy community through the efficient and equitable provision of health services. The proportion of equity and efficiency of health systems indicates the quality of their practice. This systematic review aims to seek evidence that show any effect of resource allocation decisions on efficiency and equity in health worldwide.
Methods: Five databases including PubMed, Scopus, Ovid, ProQuest, and EBSCOHOST were searched from 1992 to 2014. Based on the inclusion criteria, 527 papers were identified, of which 11 were assessed and analyzed.
Results: The 11 included studies have been conducted in different countries including USA, North Africa, Greece, China, Australia, Taiwan, and South Africa. The main methods for resource allocation included: linear programming, Markov model, cost-effectiveness analysis, per capita resource allocation, modelling the resource allocation.
Conclusion: Linear and mathematical programming methods, and economic models such as Markov models can lead to equity and efficiency to some extent. These models take into account the details of treatment methods, the population under treatment, and costs of health services.
Keywords: Efficiency, Health Equity, Health System, Resource Allocation, Systematic Review
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Introduction

Health systems have four main functions including providing financial resources, health care delivery, resource generation, and stewardship (1).

The ultimate goal of health system is providing health benefits to community members efficiently and equitably. The concept of equity in access to health services is one of the controversial

issues, and various definitions and interpretations have been provided, but all discussions emphasize the equitable distribution of resources and services among individuals and groups in the society (2). Therefore, health care professionals are always trying to provide the community with the best and high quality healthcare services by allocating available resources equally (3) allowing more community members to benefit from them. In other words, one of the most important principles in today's health systems is addressing the issue of equity (4, 5). The fair access of all people in the community to health services promotes health level for social activities and develops an atmosphere for growth and development in the society.

Therefore, access to health services is a require for the development of equity in society (6, 7). However, existing evidence suggests that health systems and health care organizations are always challenged with limited resources, and do not have the resources to address simultaneously all the health problems of target groups (8, 9). Some believe that although relatively much financial resources are devoted to the health sector, a relatively large gap is found between the goals and the results achieved (10, 11). The rapid increase in health expenditures worldwide has challenged economic experts, managers, physicians, and nurses to find new ways to limit costs and increase efficiency (12, 13), and has even attracted the researchers' attention to the importance of efficiency in organizations, including the health system (14). Measuring the efficiency of service organizations as well as health systems is one of the necessities of policy making. In fact, the study on productivity and efficiency of health systems is an assessment of the management performance of these systems (15). This comparison, when carried out in macro levels and at the level of healthcare systems in different countries, illustrates the results of choosing the approaches and policies of health system managers (11). Therefore, it can be said that any health system that has a more efficient outcome has had better management in providing equitable services.

Resource allocation is the distribution of financial resources between competing groups of people or programs (12). Appropriate allocation of health resources and efficient use of these facilities is considered to be critical, and the assessment and proper correction of the health system seems inevitable, and this correction is possible through an examination of policies, increased efficiency, limitation of unnecessary costs, and responding to the needs of society (16, 17). Attempts to modify and correct resource allocation policies over the past years have been considered the key to the reform of health systems. In this regard, most countries have sought to provide a resource allocation formula that can direct resources to more competing groups. Of course, experience shows that when decisions are made to allocate resources in a geographical area or for a treatment center, factors other than those expressed in the formula are generally taken into consideration. Even in some countries, policymakers take into account their historical factors and their local experiences, not the existing formulas and criteria (8).

Therefore, considering the importance of efficient use of health resources and the need for the fair access of individuals to health services, and given the role of these two main components - equity and efficiency - in evaluating resource allocation decisions, we decided to conduct a systematic review to look for evidences that reflects the effect of resource allocation decisions on health efficiency and equity in the health system all over the world, in order to benefit from the experience of other countries in improving the health status in our country.

Methods

In this systematic review, a collection of papers, documents, and published texts related to resource allocation in the field of health has been examined to evaluate the impact of health resource allocation decisions on efficiency and equity. The search was conducted on five electronic databases (PubMed, Scopus, Ovid, ProQuest, Ebscohost) for peer reviewed articles published between 1992 to 2014. The search was limited to English and Persian language. three search keywords with the Boolean operator AND were combined as follows:((((Resource allocat*[Title/Abstract]) AND Health*[Title/Abstract]) AND efficien*[Title/Abstract]) AND Equit*[Title/Abstract]). Table 1 presents the exclusion and inclusion criteria of studies in the review.

Table 1. The Exclusion and Inclusion Criteria of Studies

Inclusion Criteria	Exclusion Criteria
Studies addressing the resource allocation and equality in the health sector	Population: sectors outside the health area in different countries
Studies addressing the resource allocation and efficiency in the health sector	Intervention: decisions unrelated to the resource allocation
Studies addressing the resource allocation and efficiency and equality in the health sector	Outcome: Studies with no outcomes (efficiency and equality), or reviewing unrelated outcomes
Selected studies in Persian and English language	Study design: Commentary, Letter, Editorial studies
Selected studies published from 1992 to the end of 2014	Old version of Studies with updated version
Empirical studies or literature review	

Review of Studies

Data extraction was performed to identify study population, intervention, and outcomes. After reviewing the searched sites, 527 papers were studied, of which 102 were repeated, thus 425 papers were screened based on the title and abstract. Finally, 375 papers were removed based on the parties' agreement, and the full text of 50 papers was screened (Figure 1). The four members of the research team screened the papers in such a way that three members initially evaluated 425 papers, so that each paper was screened separately by two members, then 10% of the total papers plus positive ones announced by other contributors were sent to the fourth member. Ultimately, 136 papers were considered positive by a total of four members. In the panel discussion, 50 papers (agreed by three members) were selected for full-text assessment. After reviewing the full text

of the 50 selected papers, it was found that 16 studies had contents consistent with the systematic review objective. These 16 papers were divided among the members of the research team to evaluate their quality using appropriate checklists. Finally, 11 papers were included into narrative synthesis.

Evaluation of the Quality of the Studies
To evaluate the quality of the final studies, checklists compatible with the type of the study were used. Evaluation of

the quality of studies showed that eleven studies had good quality, one had moderate quality, and four studies had poor quality. According to consensus of research team members, eleven studies of good quality were entered into the final analysis. Table 2 summarizes the included studies in the final analysis.
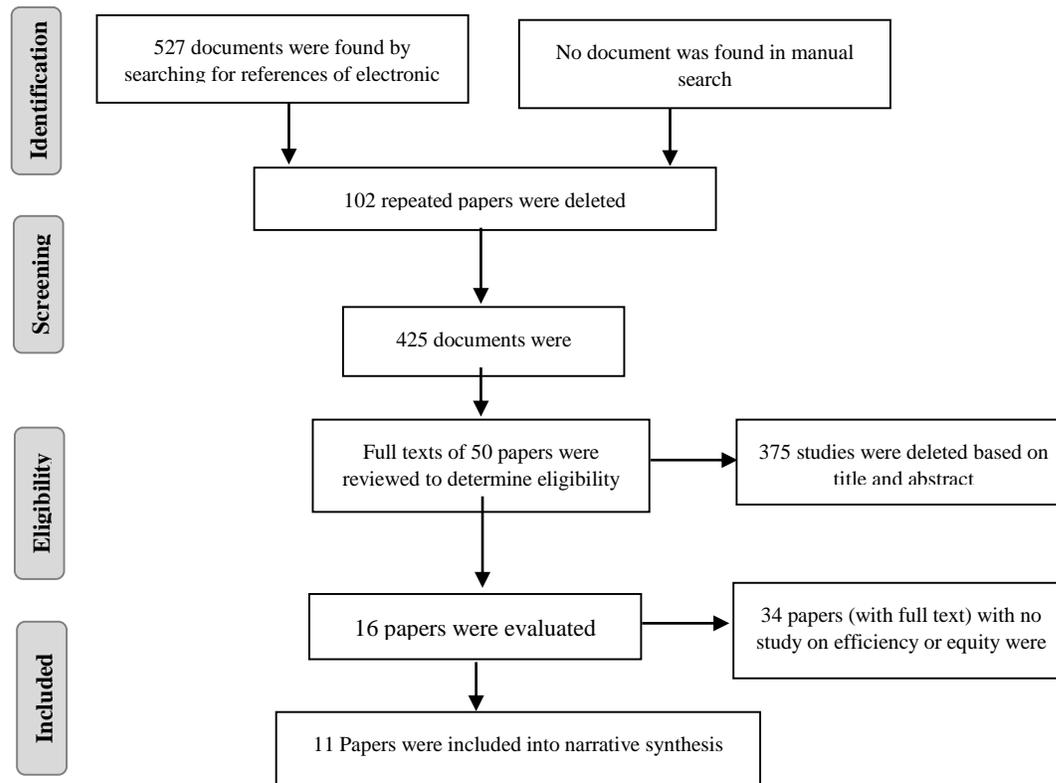

Figure 1. Selection Process of Studies in the Systematic Review

Results
Given the shortage of resources in health systems and the need to allocate limited resources in a just and efficient manner, most countries are looking for appropriate ways to meet the needs of the population with existing resources. To achieve this goal, different countries have evaluated different allocation methods and interventions. Obviously, taking advantage of the experiences of other countries will also be useful in this way. Hence, the purpose of this study was to investigate the effects of resource allocation interventions on health efficiency and equality in health field in different countries based on available literature and studies. After searching on the sites, 527 related studies were identified, of which 102 were repetitive; therefore, 425 remaining papers were studied based on the title and abstract, and 375 studies were excluded due to lack of relevance to the subject and 50 studies were downloaded for complete review. The full text of these papers was studied, and 39 studies were omitted thanks to the lack of consideration of the impact of resource allocation decisions on efficiency or equity. Finally,

16 studies entered the process of quality assessment and final analysis, of which four studies were excluded due to poor quality, and one study due to the moderate quality.
The studies have been conducted in different countries with different economic, social and political status. Except two studies that conducted by one author in Spain (18, 19), other studies were done in a wide range of countries included the United States (20), North Africa (21), South Africa (22), Greece (9), China (23), Taiwan (24), and Australia (25). This indicates the importance of resource allocation and, more importantly, the significance of equity and efficiency in the healthcare systems. This means that even developing countries, despite having the financial problems, are currently willing to develop equity and efficiency in exploiting their limited financial resources. In most studies, the effects of resource allocation methods have been tested exclusively on equity, and the effects of resource allocation along with equity and efficiency have been examined in limited cases.

Table 2. Summary of Included Studies in the Final Analysis

Author	Year	Country	Study Type	Study Method	Study Criteria	Results
Cleary et al. (22)	2010	African Countries	Review	The included articles were divided into 3 categories: The first group compared three HIV interventions in terms of balance between equity and efficiency. A mathematical program was designed to perform the comparison. In the second group, the effect of the model of care on equitable access was reviewed. The third group expressed vertical inequalities in exploitation, continuity, and outcomes of care. The criteria for treatment outcome included survival, failure to follow the treatment process and withdrawal from the CD4 cell count.	Equality and Efficiency	-More effective intervention is likely to result in more equity and faster service delivery. -Transmission of tasks and decentralization lead to more efficient decisions. - The need to adopt policies for the implementation of vertical equity
Liu et al. (23)	2002	China	before-after Econometric model	The multi-layered survey results obtained between 1994 and 1997 by the Ministry of Health were used. Information about children, spouses of insured persons and rural population was excluded from the study. Face-to-face interviews were also used to gather a part of the data.	Equality	-People who are not socioeconomically well-off use emergency services or hospitalization more than others. - In general, the insurance reform plan led to a reduction in inequality in access to hospitalization services
McDermott et al. (25)	1997	Northern Australia	Quantitative, modeling resource allocation formula	Standardized mortality rates were selected as a method for measuring needs. The socioeconomic status criteria including the relative socioeconomic deprivation index in the urban areas, the relative socioeconomic deprivation index in the rural areas, the economic resources index, and the education and employment index were used to develop the resource allocation formula.	Equity	The allocation of funds in some urban areas is more than 50% of actual costs, while less resources were allocated to some rural areas. The use of this method may result in inaccurate results due to errors in measurement methods.
Kreng et al. (24)	2011	Taiwan	Quantitative, measuring horizontal equity	The variables of socioeconomic status and input resources of health were used to measure health service delivery. The length of stay, bed occupancy rates, number of outpatient and inpatient visits, and number of emergency visits were used in order to measure the demand for health services. The variables of socioeconomic status, unemployment rate, and elderly population were used to adjust the demand.	Equity	According to the results of this study, most of the resources allocated in northern Taiwan have led to geographical disparities due to the unbalanced allocation of health resources.
Plans-Rubió et al. (19)	2012	Spain	Quantitative, economic assessment	Two management strategies were compared, and the difference in treatment costs and percentages of the population at risk between the ages of 40 and 59 were evaluated. Analysis was based on the assumption that 50% of people aged 40-49 years with unknown risk factors can be identified and treated at primary care centers. Sensitivity was analyzed with taking into account the highest and lowest percentages of identified and treated people.	Cost-effectiveness, social preferences	The amount of resources needed to treat all people at risk in the management of resources based on efficiency and equity were less than that in cost effectiveness-based decision-making procedures. In the second procedure, more resources were needed, but additional benefits came from available resources. The choice between the two procedures depends on social goals.
Wu et al. (26)	2007	United States	Quantitative, estimating effectiveness	Population size was determined using the meta-population SIR model; Determining the degree of vaccine effect using the multi-state leaky vaccine response pattern; and finally determining the maximization of vaccine allocation and sensitivity analysis.	Equality	Resource allocation is not equitable based on population, and proportional formulas are also used
Vaskantiras et al. (9)	2009	Greece	Review	The budget in the primary and secondary sections was separately considered as two independent variables. Three criteria were considered in the distribution of resources; demand for health services based on the related age groups, health status measured using SMRs, health services demanded. The weight of the above criteria was determined using the consensus achieved through Delphi method.	Equality	Using the per capita model to allocate resources has caused significant disparities in the area.
Okorafor et all. (21)	2007	North Africa	Case Study	Primary and secondary data have been used. In order to obtain secondary data, national and international literatures were reviewed. To obtain primary data, officials and authorities from the public sector and non-governmental organizations that have contributed to the financing of primary health care have been interviewed.	Equality	Fiscal federalism (decentralization of financing) did not have an effect on equality in the state level.
Plans-Rubió et al. (18)	2011	Spain	Quantitative, economic assessment	Two frameworks (Cost effectiveness as well as a framework based on cost effectiveness and social welfare) are compared. Initially, two therapeutic approaches were compared on the basis of cost-effectiveness ratios, and then on the basis of the cost-effectiveness and social welfare ratios.	Equality, Efficiency	Cost-effectiveness framework is effective for establishing equity, and cost-effectiveness framework along with social welfare, for establishing equality and efficiency. The first framework is preferred for utilitarian societies, and the second framework is better for non-utilitarian societies.
Cleary et al. (22)	2010	South Africa	Economic assessment	Markov modeling was used to compare the initial data and to calculate the pre-illness health costs of people, as well as the outcomes of treatment during the specified period. Three independent therapeutic strategies were studied and compared: I: Treatment with non-antiviral drugs, II: Treatment with first line antiviral drugs, III: Treatment with second-line antiviral drugs.	Equity and efficiency	First-line antiviral treatments are the best option for curing AIDS, providing the equitable treatment with the least expensive treatment programs. Equity and efficiency can be achieved through the implementation of this program.

Table 2. Continued

Author	Year	Country	Study Type	Study Method	Study Criteria	Results
Earnshaw et al. (20)	2002	United States	Economic assessment	A linear programming model was used to select a set of interventions to maximize QALY in diabetic patients. To select the study sample, 65 subgroups were formed based on age, blood pressure, smoking and cholesterol levels. The 4 intervention groups were: I: Blood glucose control through doing exercise, taking medicine and having a proper diet; II: Blood pressure control using taking beta-blocker medicine; III: Quitting smoking through 30-minute counseling sessions. IV: High lipid control using the previously taken drug in a higher dose	Equity	The authors agreed that if using this model of linear programming, 211,000 QALYs will be obtained for diabetic patients with no more expense, provided that they use the recommended interventions until the end of their lives.

Perhaps it is due to the possibility of fairly accurate measure of standards of equity through existing economic models. Another justification for this issue is the increasing emphasis of international organizations on the need for equity in access to health services, which has encouraged different countries to pay particular attention to equity.

A review of the study with regard to the research method showed that, except two studies that used the qualitative method (review), other studies used quantitative methods. Among these studies, five used economic evaluation, one applied case study, and others used different quantitative methods. The study method used in these researches demonstrates the importance and accuracy of quantitative methods for assessing the level of equity in access and use of health services. In other words, researchers using quantitative methods, particularly economic assessments, make the effects of health system decision makers on equity to be more tangible. Referring to the number of QALYs from any of the therapeutic interventions provides solid evidence for future decision-making in healthcare sector.

Discussion

In this section we will discuss about the identified methods for resource allocation in the included studies.

Linear programming model

This method is used to examine the impact of an intervention or a number of interventions on a specific group of population health level. For this purpose, the effect of the intervention is studied considering the characteristics such as age, sex, and blood pressure in the target population. In fact, the purpose of this method is ultimately to determine the number of QALYs obtained by using any of the interventions. Stefani Earnshaw et al. used a linear programming model to select a set of interventions to maximize QALY in diabetic patients. The four intervention groups were: Group I: Blood glucose control through exercise, medicine, and diet; Group II: Blood pressure control using beta-blocker medicines; Group III: Quitting smoking through 30-minute counseling sessions; Group IV: High fat control using the previous drug in a higher dose. The authors believed that, if the linear programming model is used, it will allow the selection of appropriate interventions for diabetic patients, provided that they use the recommended interventions from hereafter. In fact, the authors have come to the conclusion that it is necessary to strike between the various

interventions because of budget constraints and the need for equity in resource allocation (20).

Markov modelling

As one of the most accepted methods for identifying appropriate interventions and, consequently, resource allocation, it calculates the cost of treatment for individuals over their lifetime. In the study of Susan Cleary and colleagues, mathematics-based programming was used to determine the effect of the presumed rules for choosing a therapeutic strategy for the treatment of AIDS in South Africa. In this study, three independent treatment strategies were considered. I: Treatment with non-antiviral drugs; II: Treatment with first-line antiviral drugs; and III: Treatment with second-line antiviral drugs. The results of the study showed that given the available budget constraints, first-line antiviral treatments are the best option for the treatment of AIDS, and provide fair treatment with the least cost. In other words, equity and efficiency can be achieved through the implementation of this program (22).

Cost-effectiveness method

In this method, the estimation of costs and the effectiveness of the use of a particular drug or device is the main factor to decide on the resource allocation. In other words, if the analysis shows the cost-effectiveness of the method used, the decision to allocate resources will be considered. One study examined the cost-effectiveness of a certain drug and its effect on equity. The results of the study showed that the cost-effectiveness framework is suitable for establishing equity, and the cost-effectiveness framework along with social welfare is appropriate for establishing equity and efficiency. Furthermore, the first is suitable for utilitarian societies, and the second is better for non-utilitarian societies. The results of the study show the positive impact of the drug on increasing equity (19).

Per capita method

In this method, the main criterion for deciding is the population and its needs. A number of studies have examined the impact of this approach on equity, which resulted in an increase in inequity (9, 26). In the study of Vaskantiras and his colleagues, the budget in the primary and secondary care sectors was considered separately and as two independent variables. Three criteria were taken into account in the distribution of resources: demand for health services based on age groups, health status measured using SMRs, and requested health services. The criteria weight was determined using the consensus obtained

through Delphi. The authors of this study have recommended the use of other proportional formulas for resource allocation (9). In the study of Wu et al., vaccines were proportionately allocated to states population and in predetermined groups. The result of this study has shown that this policy is in contradiction with efficiency, and if the precautionary measures are taken, its potential benefits can be significant (26).

Modelling the resource allocation formula
Considering different factors and placing them in a formula is a method used to allocate resources by some organizations. In one of the studies, the relative coefficient of deprivation and demographic data such as age, sex, being native, and socioeconomic criteria including the relative social deprivation index, the relative socioeconomic deprivation index in urban areas, the relative socioeconomic deprivation index in rural areas, economic resources index, and education and employment index were considered for the development of resource allocation formula. The result of this study showed that if no comprehensive formulas are used, a budget will be allocated more than the actual need for different geographical regions, which is an example of inefficiency and inequity. The authors have suggested that, the resource allocation of outcome-based pattern be used for primary care services in order to improve efficiency and equity (27).

The study has had some limitations. First, only Persian and English papers were studied, hence the results of the study are not comprehensive enough. Second, in this study, we aimed to identify the impact of resource allocation methods on equity and efficiency at all levels of the health system, while it seems that limiting the subject of studies to a specific level of health system would probably result in more accurate and reliable outcomes. Third, the chosen period for the study was from 1992 to 2014, and new studies have not been investigated after this period.

Conclusion

In this study, we aimed to identify the effect of resource allocation methods on the development of equity and efficiency at different levels of the health system. Undoubtedly, the use of different methods has different effects on equity and efficiency, and this effect is different in various health systems. Investigating the findings showed that the method used to allocate resources with regard to the economic and social conditions, as well as the methods used to treat diseases are diverse. Based on the findings of the study, the linear and mathematical planning-based methods, as well as the use of economic models such as Markov's model, which carefully assesses the various details of the treatment method, the community under treatment and the costs, lead partly to equity and efficiency. Also, the findings of the study showed that using the per capita method to allocate resources exclusively is not appropriate and does not have much effect on equity. In other words, in addition to population and demographic characteristics, other factors must also be carefully considered for increasing decisions' accuracy related to resource allocation.

Ethical consideration:

Conflict of interest:

The authors declared no conflict of interest.

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