Economic Evaluation of Screening for Type 2 Diabetes: Case Study of Iran

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Abstract

Objective: In health economics, one of the important methods of economic evaluation is cost-effectiveness analysis. The usual procedure in this method is to consider effectiveness of Disability-Adjusted Life Years (DALYs) as a measure criterion.

Material and Methods: This was a cross sectional study of economic assessment type or Cost-Effectiveness. All over 30 years old population of Shiraz (543,820 people) were target population of the study. Indeed, in this study, all over 30 years old population being screened for diabetes in any governmental health centers and health stations in Shiraz (69 health stations and 30 healthcare centers) and 10 clinics related to Shiraz University of medical science, were included. Costs in this study included screening and surveillance costs and effectiveness was DALYs created for diabetes and its complications and finally, the results were analyzed using Incremental Cost Effectiveness Ratio (ICER).

Results: The rate of DALYs due to diabetes, in the absence of screening and identifying diabetic patients was 748.0745 years. The rate due to diabetic retinopathy was 10.3886 years, in diabetic neuropathy was 29.5624 years, in diabetic foot was 0.0343 years and in diabetic nephropathy was 83.8728 years. In this study, total screening and surveillance costs were 42,821,873,941 Rials. The obtained ICER was 49,111,444 Rials.

Conclusion: From governmental view, in this study, the plan saved 871.9327 years of individual lives covered by the program. According to the World Health Organization criteria, screening in this study is cost-effective.

Keywords: Cost-effectiveness, Type 2 diabetes, Screening.

Introduction

Development of healthcare around the world and as a result of the increased costs imposes an incremental financial burden on the healthcare systems of the countries. However, less developed countries due to the limited financial resources have not been able to provide all health services offered in developed countries (1). Cost-effectiveness assessment of these services is one of the developed world's concerns playing an essential role in designing and evaluation of health systems (2). Type 2 Diabetes is considered a serious threat to global health because more than 250 million people are suffering from the disease. By the spread of industrial machinery life pattern in developing countries accompanied by physical inactivity and excessive caloric intake, stress, and mental

distress, the incidence of type 2 diabetes has been greatly increased.

Based on studies conducted in various cities of Iran, prevalence of diabetes in Tehran, Bushehr, Zanjan and Yazd, has been reported 7%, 8%, 13%, 4% and 16%, respectively (6). Amini et al. calculated economic costs of diabetes in 22,349 diabetic patients received care in Isfahan Endocrine and Metabolism Research Center. In this study, direct medical costs of diabetes were estimated using "The incidence of any adverse effect on the clinical course of diabetes" method and estimation of needed care and services at each stage and calculating the price of the mentioned services and multiplying the results by cause cognitive fraction (7).

Another study conducted by Abolhassani et al. in 2001, the burden of diabetes by YLLs was calculated. Other studies on diabetes have formed the basic data of this study which includes three indicators of prevalence, recovery and the relative death risk (8).

The main objective in the present study is the analysis of cost-effectiveness of diabetes screening in over 30 years old population of Shiraz who referred to all governmental health stations and healthcare centers for diabetes screening.

Materials and Methods

This was a cross sectional study of economic assessment or cost-effectiveness type. All over 30 years old population of Shiraz (543,820 people) were target population of the study. Indeed, all over 30 population screened for diabetes in any governmental healthcare stations and centers in Shiraz (69 stations and 30 healthcare centers) and 10 clinics related to Shiraz University of Medical sciences were included.

The required data for this study is divided into three parts: demographic data, screening data and costs data. Effectiveness measuring criteria in this study were DALYs (9) caused by diabetes in the urban population of Shiraz in 2011. Before calculating any component of this criterion, a set of indicators of diabetes and any of its complications including the incidence, age- and sex- specific mortality rates, disease duration and age at onset were needed; But it should be noted that all of these indicators were not available. For this reason, and also because they lacked the internal consistency, the epidemiological models were needed to be used. So, we collected available diabetes pathological and epidemiological information, and required indicators were determined through existing epidemiological indicators using Dismod software.

The second part is DALYs caused by diabetes. Then for the comparison of the results, the incremental cost-effectiveness ratio (ICER) was used. After calculating the cost-effectiveness of screening in the second stage, by counting screening cost and the costs of care per identified patient based on living standards of diabetics and imposing a 3% discount rate as well as considering prevented DALYs we calculated cost-effectiveness by the following equation (1):

$$\text{ICER} = \frac{\text{COSTa} - \text{COSTb}}{\text{DALYa} - \text{DALYb}}$$

Then, to enhance the validity and accuracy due to the essential uncertainty of data, we used the sensitivity analysis.

Results

Finding of this research showed that from 171,067 individuals participated in screening program, 66,523 were men and 104,544 were women. The individuals were divided into 10-year age groups; in men, most of the subjects were respectively in 40-49, 30-39, 50-59, 60-69 and over 70 age groups. In women, these frequencies were among the 30-39, 40-49, 50-59, 60-69 and over 70 age groups, respectively.

Table 1 represents the number of individuals identified as new diabetic patients. According to Table 1, among 171,067 screened cases, 1614 (0.94%) were newly identified diabetic patients based on laboratory tests, of which 575 were men and 1039 were women. The total costs paid for the program can be divided

into two main parts: capital costs and current costs.

All those participated in the screening program were171, 067 people and the total cost of the project was 8,959,115,020 Rials; so, based on the following equation, on the average 52,372 Rials were paid for any individual person participated the program:

Cost of screening per any individual person=

$$\frac{\text{total cost of the program}}{\text{screend individuals}}$$

The cost per person is regardless of being man or woman and being diagnosed as diabetic or non-diabetic. If we want to calculate the cost spent to diagnose each diabetic person, we should divide total cost spent on screening program by the number of diagnosed diabetic persons by the screening program. It means that based on the following equation, for diagnosing each diabetic person by screening program 5,550,877 Rials was spent:

Cost per person diagnosed with diabetes=

$$\frac{\text{total cost of the program}}{\text{number of diagnosed diabetic individuals}}$$

For calculating the DALYs due to diabetes by considering the nature of the disease which is a progressive one, YLL and DLAYs of diabetes and its complications if not diagnosed on time and treatment complications have been addressed.

Total DALYs of 5 above cases can be stated as the output of diabetes screening program in which 1,614 new cases have been diagnosed as diabetic. In this study, because of the screening program, WHO disability measures were used (10).

According to Table 2, DALYs due to diabetes, in the absence of screening and identifying diabetic people was 748.0745 years, which was 208.7897 years for men and 539.2848 years for women. DALYs due to diabetic retinopathy was 10.3886 years; this was 4.5902 years for men and 5.7984 years for

Table 1- Percentage of new diabetic patients in screening program and screened population sorted by sex and age groups in Shiraz

	male		female		total	
Age group	**Screened Population**	**Diabetic Group n (%)**	**Screened Population**	**Diabetic Group n (%)**	**Screened Population**	**Diabetic Group n (%)**
30-39	17560	29 (0.16)	33822	91 (0.27)	51382	120 (0.23)
40-49	20806	134 (0.64)	31611	279 (0.88)	52417	413 (0.79)
50-59	16077	197 (1.22)	24161	388 (1.6)	40238	585 (1.454)
60-69	7698	139 (1.8)	10446	211 (2.01)	18144	350 (1.92)
>70	4382	76 (1.73)	4504	70 (1.55)	8886	146 (1.64)
Total	66523	575 (0.86)	104544	1039 (0.99)	171067	1614 (0.94)

Table 2- Disability Adjusted Life Years and its components for diabetes and its complications

Sex	**Age Group**	**Calculated DALYs for diabetes and its complications**				
		DALY(D)[1]	**DALY(F)[2]**	**DALY(NEU)[3]**	**DALY(NEPH)[4]**	**DALY(R)[5]**
Male	30-39	10.0409	0.0001	0.1987	0.5344	0.0152
Male	40-49	47.2957	0.0014	1.2712	3.9538	0.5146
Male	50-59	94.7147	0.0055	3.7502	14.6122	1.2346
Male	60-69	46.9860	0.0058	4.1345	12.1516	1.5956
Male	<70	9.7524	0.0054	3.1117	8.8742	1.2302
All Men		208.7897	0.0183	12.4662	40.1263	4.5902
Female	30-39	37.0953	0.0003	0.6333	1.3736	0.0426
Female	40-49	127.2279	0.0019	2.4569	6.1866	0.9661
Female	50-59	249.5595	0.0061	6.2226	18.9629	1.9990
Female	60-69	114.1671	0.0049	5.4516	11.5890	1.9997
Female	<70	11.2350	0.0028	2.3318	5.6344	0.7910
All Women		539.2848	0.0159	17.0962	43.7465	5.7984
Total		748.0745	0.0343	29.5624	83.8728	10.3886

1: DALY (D): Disability Adjusted Life Years related to diabetes itself, DALY (F) 2: Disability Adjusted Life Years related to diabetic foot, DALY (NEU) 3: Disability Adjusted Life Years related to neuropathy, DALY (NEPH) 4: Disability Adjusted Life Years related to nephropathy, DALY (R) 5: Disability Adjusted Life Years related to retinopathy

women. According to Table 2, DALYs due to diabetic foot was 0.0343 years; it was 0.0183 years for men and 0.0159 years for women.
According to Table 2, DALYs due to diabetic neuropathy, was 29.5624 years; it was 12.4662 years for men and 17.0962 years for women. DALYs due to diabetic nephropathy was 83.8728 years; this was 40.1263 years for men and 43.7465 years for women.
Therefore, based on the calculated costs (42,821,873,941 Rials) and total prevented years (871.9327 years) and assuming that the cost of no screening is equal to zero, the ICER was calculated to be 49,111,444 Rials by using the following equation:

$$\text{ICER} = \frac{\text{cost of diabetes screening} - \text{cost of no screening}}{\text{prevented DALYs by screening} - \text{prevented DALYs by no screening}}$$

Then by assuming that 1,614 diabetic patients would not identified if there were no screening program and would follow a normal pattern, and based on this assumption for comparison of costs of care for 1614 diabetic patients, the care cost per capita of 7,893,868 Rials in Amini and colleagues study in 1998 was used. By taking into consideration the inflation rate of 2011 (21.5%), care cost per capita of any diabetic patient was calculated 99,261,443 rials and the cost of treatment of 1,614 patients a year, was calculated 160, 207, 969, 002 Rials. According to diabetic patients standard of living and applying a discount rate of 3%, care costs of 2,518,894,582,955 Rials was calculated for 1,614 diabetic patients. So, ICER was calculated to be -283975092 Rials.
Diabetes screening is part of the national screening program planned for all over 30 year populations. If it is possible to target screening at age 40 and over is one of the research questions. Answering this question requires comparing costs and effectiveness of the screening performed for the entire population and in the next step to include only 40 years and older individuals. Total DALYs associated with the identification of new diabetic patients and its complications in total was 871.9976 years and for identifying diabetic patients 8,959,115,020 Rials have been spent. If subjects aged less than 40 years were excluded from the study, 50,032 would be excluded and 120 newly identified diabetic patients would not be identified and in the absence of timely recognition of the 120 diabetic patients, we would have 49.9346 DALYs and would pay totally 821.9976 years versus 6,338,839,116 Rials of screening costs. In the economic evaluation of health and care plans "don't perform any action" option should always be considered.
We compared the strategies of screening program. For screening of 40 years and older individuals in Shiraz, over 6,338,839,116 Rials has been spent and for screening of 30 years and older individuals 89,599,115,020 Rials has been spent. Incremental cost for screening individuals aged 30-39 in this study was 2,620,275,904 Rials. Effectiveness or saved DALYs due to early diabetes identification for people aged 40 and over is equal to 821.9976 years and if those aged 30-39 years were also screened by early detection of diabetes in this age group; DALYs saved amounts to 871.9322 years. Incremental effectiveness of screening of 40 years and older individuals compared to no screening was 821.9976 years. Incremental cost-effectiveness ratio of screening 40 years and older group to no screening was 7,711,505.62 Rials. Incremental cost-effectiveness ratio in the 30 years and over age group per any DALY was 52,474,154.27 Rials.

Sensitivity Analysis

Considering that both the costs and DALYs, we firstly, examined sensitivity analysis with a discount rate of 3 percent and 6 percent rates; but there was no change in the results in both discount rates.

Discussion

A review of studies on the cost-effectiveness of diabetes shows their emphasis on economic evaluation of third-level preventions of pharmacological interventions and behavioral interventions and very few studies have been conducted on economic evaluation of

interventions aiming at secondary prevention or screening for diabetes and less than 10% of the total studies in 1997-2003 are about diabetes cost effectiveness (12). Among the studies in this category, there is a research conducted by Center for Disease Control in the US. In this study, effectiveness of diabetes screening is estimated by quality of life years' criteria. The cost per year of obtained quality of life is estimated 73, 500 $ (13). The study is focused on the screening for type II diabetes.

Another study conducted in Canada notes that the philosophy of screening for diabetes is that if treated before the appearance of clinical symptoms, its complications can be prevented or delayed (14).

However, most studies have emphasized that diabetes is expensive and causes heavy human and economic burden on societies. Diabetes imposes a heavy burden on the entire society; it would reduce revenues by reducing productivity and would reduce the quality of life of diabetics, their families and friends. Many studies have emphasized that effective control of blood glucose can reduce the incidence of diabetes as well as the costs of its complications. So, diabetes prevention and control is regarded as a priority in all countries (15).

It seems that the findings of this study may be useful in estimating the burden of the disease or improving what has been done. However, among the studies conducted for assessing the cost-effectiveness of interventions at different levels in Iran, this was the first study to evaluate the cost-effectiveness of second level prevention by DALY criteria. Reviewing the existing studies on the cost-effectiveness of different interventions by primary outcome criteria due to various interventions will answer the question of how much is the effect of the short-term and the medium-term of implementing intervention programs. But by studying researches like the current study which evaluate the cost-effectiveness by DALYs, we can fully understand the long-term effects of studied intervention program.

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