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Cost Analysis of Gestational Diabetes Screening Methods in Pregnant Women Referred to the Gynecology Hospitals Affiliated with Medical Sciences Universities in Tehran.

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Abstract

Background: The American Diabetes Association defines gestational diabetes as no glucose tolerance in the second or third quarter of pregnancy. Gestational diabetes imposes a huge economic burden on the health system. Diagnosis of gestational diabetes is important because it not only predicts prenatal disorders but also affects the long-term outcomes of the mother and child. Since screening tests are costly, it is necessary to find a cheaper method with an acceptable feature.
Objectives: The present study aimed to examine the costs of gestational diabetes screening in pregnant women referring to gynecology hospitals affiliated with medical sciences universities in Tehran.
Methods: This was a descriptive-analytical study conducted in the selected hospitals affiliated with medical sciences universities in Tehran in 2016. The study population included all the pregnant women with no risk factors, referring to the selected centers. A multi-stage random sampling model was utilized, and the sample size was 392. The data were gathered through the forms designed for recording costs, as well as interviews, and were analyzed using SPSS18 software, *t*-test, and one-way ANOVA.
Results: The mean direct medical costs, direct non-medical costs, and indirect costs of the one-step method were $516,960, $71,593, and $142,162, respectively. Also, the mean direct medical costs, direct non-medical costs, and indirect costs of the two-step method were $262,890, $46,536, and $28,621, respectively.
Conclusions: The screening of pregnant women using the two-step method is cheaper to diagnose diabetes. The results of this study recommend gynecologists to use the two-step method to diagnose gestational diabetes with lower costs.

Keywords: Cost, Gestational Diabetes, Screening, Cost Analysis

1. Background

Diabetes is a prevalent chronic debilitating disease and a medical problem seriously threatening global health (1). Diabetes is also the ninth main cause of death (2) and a serious threat to the economy of countries, especially developing countries (3). According to the latest reports of IDF, about 5 - 20% of the costs of global health systems is assigned to screening, diagnosis, and treatment of diabetes side effects (4). One of the main stimuli contributing to the development of diabetes is the primary growth environment, i.e., the mother's intrauterine space. Recent studies have shifted their focus from the impact of lifestyle to that of the fetal environment, which requires studying and providing new approaches to diabetes prevention with a focus on mothers' and their infants' health (5) In this way, the most common status in the fetal environment occurs when a part of the hormones excreted from the placenta that prevents a decline in blood sugar makes it difficult to use insulin for the mother's body and subsequently, the blood glucose increases and gestational diabetes appears. (6, 7).

The glucose intolerance occurring during pregnancy for the first time is called gestational diabetes (8). Gestational diabetes is a growing disease throughout the world and is one of the most common metabolic side effects of gestation (9). It imposes a huge economic burden on the health system (10). With a cost of $636 million, gestational diabetes occurs in about 4.5% of all pregnancies (11). The prevalence of gestational diabetes differs from 1% to 28%

in different parts of the world (12). The studies conducted in Iran indicate that the prevalence of gestational diabetes varies from 1% in Kermanshah to 19% in Karaj (13). More than half of the women with gestational diabetes will develop diabetes in the next 15 years (14). Ninety-five percent of these pregnancies will have serious midwifery outcomes (15). Gestational diabetes has no clinical symptoms; for this reason, it must be quickly diagnosed during pregnancy to prevent undesirable outcomes (16). Therefore, it is necessary to screen pregnant women as a common standard method during midwifery care to timely diagnose gestational diabetes (17, 18). According to studies, it can be stated that any intervention that decreases the risk of the development of an unhealthy fetus or infant and mothers' outcomes will help reduce the costs of this disease (19-21). Accordingly, selecting a suitable model to diagnose gestational diabetes and taking effective actions decrease the costs imposed on the health system (22). A lot of studies have been conducted on the screening methods of gestational diabetes to determine the most suitable method by considering different criteria and their outcomes to reduce screening costs and restrict the number of individuals to undergo screening (23, 24). In 2016, two screening methods were proposed by different scientific associations, including ADA , NDDG , ACOG , WHO , and IADPSG . The first and the most common gestational diabetes diagnostic method is the two-step screening. In this method, if using 50 gr glucose results in a positive test, the glucose tolerance test is performed by administering 100 gr glucose. The second method was introduced in 2014 by the American diabetes association. In this one-step screening approach, gestational diabetes is diagnosed by using 75 gr glucose, followed by blood sugar measurement (25, 26).

2. Objectives

The present study was conducted to compare the costs of gestational diabetes screening methods and determine the factors affecting these costs. Finally, we proposed the most suitable method according to the economic models of the society.

3. Methods

This research was a descriptive-analytical study conducted in 2016 on the pregnant women referred to the gynecology hospitals affiliated with medical sciences universities in Tehran. The population included 2184 pregnant women referred to these centers for midwifery and perinatology examinations. Considering the prevalence of gestational diabetes, 0.05 accuracy, and the factors limiting the population (e.g., a history of delivering abnormal infants, history of diabetes in the family, abortion, and stillbirth), the sample size was determined 392 using the following formula in order to determine and compare the costs of two common gestational diabetes screening tests. Accordingly, 196 patients were screened through the one-step screening method, and another 196 patients were screened using the two-step screening method.

$$n = \frac{\frac{z^2 pq}{d^2}}{1 + \frac{1}{N}\left(\frac{z^2 pq}{d^2} - 1\right)} \quad (1)$$

Among the hospitals affiliated with medical sciences universities in Tehran, the following ones were selected via cluster sampling: Mahdiyeh, Shahid-Akbarabadi, Roein-Tan-Arash, and Yas-Sepid. Patients were classified into two groups according to the type of the diagnostic test. Then 196 patients were assigned through simple random sampling to each group. The researchers went to the maternity ward every day and interviewed patients and their companions to obtain the required data and examine their clinical conditions. The data were then recorded in a data collection form addressing the patients' demographic characteristics, their general health status, delivery records, insurance coverage, occupational conditions, educational levels, and the costs of diagnostic and medical services, as well as transportation and accommodation costs for each patient and her companion. Since the study was conducted for one year, the discount rate was not used to estimate the costs.

In this study, the cost estimation criterion was the patient's viewpoint, including direct medical and non-medical costs, as well as indirect expenses. Direct medical costs were those stated by medical services providers for clinical examinations and diagnostic tests, as well as the staff cost. Direct non-medical costs in this study included those related to traveling, foods, and diets. The indirect costs in this study included the patient's time and opportunities lost during the medical program implementation. The patient's or her companion's lost efficiency during the disease was the basis of computing the indirect cost. For this purpose, the number of the patient's or her companion's absences due to the disease was multiplied by the lost income during that period. Furthermore, to be able to compare these costs with those of other studies, they were converted to US dollars using the exchange rate (i.e., equaling each US dollar to 3,240 Rials in 2016). Finally, data were analyzed by SPSS software (version 18) using *t*-test and one-way ANOVA.

4. Results

Table 1 shows direct medical costs for both screening groups. As observed, the mean costs for visits, hospitalization, and ultrasound were 23,959$, 313,809$, and $171,131 in the one-step method, respectively, indicating higher rates compared to the two-step method. On the other hand, the mean costs of tests, supplies, and staff were higher in the two-step method ($8,354, $66,297, and $26,031, respectively) compared to the one-step method.

The direct non-medical costs of both screening methods have been shown in Table 2, according to which the mean costs of travel, accommodation, and food, and diet in the one-step screening method were $10,407, $40,868, and $20,318$, respectively, which were higher compared to the corresponding costs in the two-step method.

Table 3 represents the average indirect costs of both screening methods, obtained by computing the lost opportunities and time of the patients and their companions. Accordingly, mean indirect costs in the one-step method were $152,218 for the patients and $209,631 for their companions, which were higher than the respective costs in the two-step method.

Finally, Table 4 represents the mean total costs of the one-step and two-step screening methods. The means of total direct medical and non-medical costs were $516,960 and $71,593, respectively, and the mean of total indirect costs was $142,162 in the one-step screening method, which were higher than the corresponding values in the two-step group. Therefore, the means of the total costs of screening gestational diabetes were higher in the one-step compared to the two-step screening method ($730,715 vs. $315,393).

5. Discussion

Health care costs are worryingly increasing in all countries. Health care providers try to provide better services in a world where expectations are constantly changing and medical diagnostic methods are developing. In such conditions, health economic analysis is recommended in many countries as a solution to help decision-makers to prioritize technologies and interventions.

According to the analysis of the screening methods, it could be said that the mean of the direct medical costs was higher in the one-step (516,960$) compared to the two-step (262,890$) gestational diabetes screening method. Hence, it might be stated that the pregnant women who followed the one-step screening method were hospitalized more than those evaluated by the two-step screening method, which may be due to delayed diagnosis and treatment and the higher chance of suffering from preeclampsia. In fact, the mean hospitalization length in the one-step screening group was 34 days compared to nine days for the two-step group. It was also shown that the mean cost of hospitalization was higher in the one-step (313,809$) than the two-step (60,091$) method. Furthermore, the patients screened through the one-step method needed ultrasound for examining the fetus's health more than those in the two-step group due to the higher probability of undesirable outcomes of gestational diabetes. Hence, paraclinical costs increased in the one-step group. According to the cost analysis carried out in the present research, the mean of costs in the one-step group (17,131$) was higher than that of the two-step group (1,224$), showing a significant difference comparing direct medical costs between the two groups ($P < 0.05$).

The findings of the present study on the cost analysis of the screening methods showed that the mean of direct non-medical costs in the one-step group (71,593$) was higher than that of the two-step group (24,458$). It could be stated that due to the longer hospitalization of patients in the one-step group, their direct non-medical costs (accommodation and food (40,868 $), travel (10,407$), and other non-medical costs such as diet expenditure (20,318$)) were higher than the two-step group (accommodation and food (9,540$), travel (8,200$), and diet (6,718$)). There was also a significant difference comparing direct non-medical costs between the two groups ($P < 0.05$).

The cost analysis performed in this study also showed that the average of indirect costs was higher in the one-step (142,162$) vs. the two-step (28,045$) gestational diabetes screening method. The higher costs in the former group can be attributed to the longer hospitalization, the need for more home care after being discharged, and more leave of absence. There was also a significant difference between the indirect costs of the two groups (P-value < 0.05). Finally, according to our findings, the two-step method (315,393$) was less costly than the one-step method (730,715$), and there was also a significant relationship between the total direct (medical and non-medical) and indirect costs ($P < 0.05$).

In a study conducted by Meltzer et al. during 2001-2004 with the aim of minimizing the costs of gestational diabetes screening and diagnostic methods, 1594 pregnant women referring to the Royal Victoria Hospital of McGill University in Montreal were enrolled. The researchers described that the direct cost for any pregnant woman screened by 75 gr glucose (i.e., the two-step method) was 36.10$ (Canada) compared to 48.13$ (Canada) for those screened by 100 gr glucose (i.e., the one-step method). The total cost obtained for any pregnant woman under gestational diabetes screening test using the two-step method was 91.61$, but it was 108.38$ per individual in the one-step method (27). So, the results of the recent study were con-

Table 1. The Mean Direct Medical Costs of Gestational Diabetes Screening for the Studied Patients

Diagnostic Protocol & Costs	One-Step Method		Two-Step Method		ANOVA
	Mean ± SD	Percent Of Total	Mean ± SD	Percent Of Total	
Test	6,989 ± 5,916	2.03	8,354 ± 8,808	3.19	0.00
Supplies	57,753 ± 49,529	11.1	66,297 ± 69,901	25.24	0.00
Staff	18,681 ± 14,619	3.66	26,031 ± 19,276	9.9	0.00
Visit	23,959 ± 13,891	4.7	21,976 ± 16,665	8.37	0.00
Medication	78,729 ± 81,308	15.2	78,729 ± 81,308	29.96	0.00
Hospitalization	313,809 ± 176,038	60	60,091 ± 17,258	22.87	0.00
Ultrasound	17,131 ± 9,888	3.31	1,224 ± 677	0.47	0.00

Table 2. The Mean Direct Non-medical Costs of Gestational Diabetes Screening for the Studied Patients

Diagnostic Protocol	One-Step Method		Two-Step Method		ANOVA
Direct non-medical cost	Mean ± SD	Percent of Total	Mean ± SD	Percent of Total	
Travel	10.407 ± 10.818	14.5	8.200 ± 19.668	33.5	0.00
Residence and food	40.868 ± 32.277	57	9.540 ± 7.821	39	0.00
Diet	20.318 ± 49.371	28.5	6.718 ± 26.799	27.5	0.00

Table 3. The Mean Indirect Costs of Gestational Diabetes Screening for the Studied Patients

Diagnostic Protocol & Indirect Costs	One-Step Method		Two-Step Method		*t*-test
	Mean ± SD	Percent of total	Mean ± SD	Percent of total	
Companion's indirect costs	70.569 ± 93.087	49	19.187 ± 21.405	68	0.00
Patient's indirect cost	71.593 ± 52.850	51	8.858 ± 17.355	32	0.00

Table 4. The Mean Total Cost of Screening for Gestational Diabetes

Diagnostic Protocol Mean Costs	One-Step Method		Two-Step Method		ANOVA
	Mean	Percent Of Total	Mean	Percent Of Total	
Direct medical cost	516.960 ± 189.275	70.74	262.702 ± 156.149	83.35	0.00
Direct non-medical cost	71.593 ± 52.850	9,79	24.458 ± 46.536	7.75	0.00
Indirect cost	142.162 ± 130.341	19,47	28.045 ± 28.621	8,9	0.00
Total	730.715 ± 372.466	100	315.205 ± 231.306	100	

sistent with our observations, indicating that the one-step method costs 2.5 times as much as the two-step method. Poncet et al. conducted a study in 2002 to compare the costs of the gestational diabetes screening methods and found that the one-step method (75 gr glucose) cost 3.7 times as much as the two-step method (50 gr glucose) (28). The mentioned study's results were also consistent with those of the present study. In their study, Round et al. compared the following four strategies: the non-screening, 75 gr glucose screening, 100 gr glucose screening, and the consecutive strategy during which they performed an initial test with 50 gr glucose tolerance followed by 100 gr glucose tolerance. In line with our study, Round et al. concluded that the consecutive strategy (i.e., the two-step method) was more cost-effective than the others (29).

In a study carried out by Wilson et al. during 2011 - 2014, they introduced gestational diabetes screening criteria in order to lower screening costs and concluded that the two-step screening method took the technician 25 minutes more than the one-step method to be accomplished, increasing the cost by 12€. Therefore, for 100 women screened by the one-step method, about 14358.06€ could be saved in staff costs (20). These results were consistent with those of the present study, indicating that the two-

step method was performed in different sections, required more accessories, and sometimes needed to be repeated. In the present research, we noticed that the cost of accessories was higher in the two-step method (66,297$) than in the one-step method (57,753$). On the other hand, the fact that the former took technicians a longer period to perform the test resulted in more staff costs in the two-step (26,031$) than in the one-step (18,681$) method.

In contrast, Danisman et.al. (2012) in Zekai-Tahir-Burak hospital in Turkey conducted a study to compare the costs and hospitalization duration of the gestational diabetes one-step and two-step screening strategies and showed that for each pregnant woman screened by the former method, the total cost of tests, accessories, and diagnostic actions was 0.75 TL less than the latter (30). It is worth mentioning that this part of their results was consistent with the findings of the present study. However, in another phase of the study of Danisman et al., it was revealed that the time of accomplishing the test for any individual was 18.6 minutes longer in the one-step method (30). This was not consistent with the results of this study, stating that the staff cost in the two-step method was 1.5 times of that in the one-step method, and more time was spent on gestational diabetes screening in the two-step method.

5.1. Conclusions

The results of the present study showed that gestational diabetes screening using the two-step method resulted in lower costs than the one-step method, so the former may be more applicable to diagnose the disease and manage its outcomes. Therefore, the results of this study may guide gynecologists to recommend the two-step method as a cheaper gestational diabetes screening option to their patients. Since the provision of this service is not possible at home, doing paraclinical tests in health care centers results in high medical costs, and hospitalization may further impose high direct non-medical costs on patients. For this reason, health care institutions, the ministry of health, and in particular insurance companies, must provide more support to cover the costs imposed on patients.

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Footnotes

Authors' Contribution: Nahid Hatam supervised all the stages of the study. Nahid Alikhani, Aziz Rezapour and Sedigheh Hantoushzadeh participated in implementation of the plan, analysis and interpretation of the data. Nahid hatam and Nahid Alikhani wrote the manuscript. All the authors critically reviewed and revised the manuscript for important contents. All the authors have read and approved the final manuscript.

Conflict of Interests: None to declare.

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