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Effect of Tele-nursing on Blood Glucose Control among the Elderly with Diabetes: A Randomized Controlled Trial

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Abstract

Background: Diabetes is one of the most common debilitating diseases in the elderly requiring reasonable blood sugar control to prevent complications. Telenursing has been presented as a cost-effective method to control blood glucose levels.

Aim: This study aimed to investigate the effect of tele-nursing on blood glucose control in the elderly with diabetes.

Method: This clinical trial study was performed on diabetic elderly referring to the diabetes clinic in Rafsanjan City, Kerman Province, Iran. The participants (n=80) were randomly selected and randomly divided into the intervention and control groups. The intervention group was followed up via phone for 3 months. However, the control group received the intervention provided in the clinic. In addition to demographic characteristics and variables of diabetic patients, the fasting blood sugar (FBS) and glycated hemoglobin (HbA1c) were measured at the baseline and 3 months after the interventions.

Results: Before the intervention, the mean FBS and HbA1c of both groups showed no significant difference; nevertheless, there was a considerable difference after the intervention. Paired t-test showed that after the intervention, the amounts of FBS and HbA1c were reduced to 33.92±21.51 and 1.51±0.86, respectively.

Implications for Practice: Our results indicated that the use of tele-nursing in elderly patients with diabetes was an effective strategy that led to increased self-care, and consequently, control of blood sugar.

Keywords: Blood glucose, Diabetes mellitus, Elderly, Tele-nursing

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Introduction

Diabetes is one of the most common debilitating diseases in elderlies that imposes high costs on both diabetic patients and governments (1). The elderlies' inability to perform some activities (e.g., regular blood glucose measurement, compliance with the diet, and daily dietary adjustment) and their insufficient knowledge increase the necessity of training such patients (2). The follow-up and training can either be performed by nurses in hospitals, clinics, and other health centers or by remote nursing through phone and other telecommunication devices (3, 4).

The evidence indicated that in spite of training programs, misconceptions about the disease and its control are common among diabetic people (5). In addition to having training programs to support diabetic elderlies with self-care problems, performing a follow-up program to increase knowledge and enhance performance seems necessary (4). Most of the elderlies prefer home care and follow-up to hospitalization (6). Although performing a home visit program is possible in certain intervals, the high prevalence of diabetes and the importance of long-term follow-up increase the necessity of considering cheap and applicable follow-up methods for more patients (7, 8). Among various methods, tele-nursing can be regarded as a beneficial and effective one (9).

Tele-nursing refers to remote nursing that allows nurses to enhance care service by conducting measures, including training, information collecting, nursing interventions, pain controlling, and supporting patient's family using such communication devices as the internet, phone, and video (10, 11). Tele-nursing via phone follow-up has been presented as a cost-effective method to decrease and control blood glucose levels (BGL) and reduce diabetes-induced complications (11, 12). The employment of the tele-nursing method via phone follow-up in elderlies to control their diets, exercises, and correct pattern of medicine consumption leads to the prevention and control of numerous health problems in elderlies (13).

Tele-nursing was successful in enhancing the outcomes of diseases, such as asthma (14), myocardial infarction (15), and back pain (16). In recent years, the results of various studies confirmed the desirable effect of phone follow-up on enhancing the self-efficacy of patients and the lifestyle of patients after stroke (17, 18). Ghorbani et al. used the telephone counseling method to guide caregivers of cancer patients (19).

Numerous pieces of research have been performed to investigate the effect of tele-nursing on the control of BGL in diabetic patients. The findings revealed the positive impact of tele-nursing on controlling BGL. Kotsani et al. indicated the positive effect of tele-nursing on controlling BGL among type 1 diabetic patients (12). Furthermore, Savas et al. evaluated the effect of the tele-nursing method on type 2 diabetic patients with glucose intolerance disorder. They reported that after the 18-month follow-up, 65% of participants had normal BGL (20). However, in some other studies, the effect of the tele-nursing method on controlling BGL was not reported effective. Dunbar et al. examined the supportive role of the phone in the diabetes prevention program among type 2 diabetic patients (40-75 years) with medium to high risk. The results of the mentioned study indicated the ineffectiveness of tele-nursing in controlling BGL (21).

In Iran, the findings of numerous studies have reported the positive effect of the tele-nursing method on controlling BGL in diabetic patients. Zhai et al. showed the positive effect of tele-nursing on reducing Glycated Hemoglobin (HbA1c) in type 2 diabetic patients at the age range of 18-60 years old. In the mentioned study, the patients were followed up by a special application installed on their cell phones (22). Hemati et al. evaluated the effect of remote training via phone call and short message service (SMS) on diabetic patients aged 18-55 years old. The findings demonstrated the effectiveness of phone follow-up in reducing fasting blood sugar (FBS) and HbA1c level (23). Shahsavari et al. showed the positive effect of phone follow-up on HbA1c levels of diabetic patients (illiterate patients aged 50 years and older) (9). Soliman et al. conducted semi-experimental research and evaluated the effect of the tele-nursing method on controlling glycemia and blood lipids in type 2 diabetic patients. The results showed that phone follow-up led to a reduction in HbA1c levels and serum lipids (24). Zolfaghari et al. performed a semi-experimental study to investigate the effect of phone and cellphone follow-up methods on adherence to the treatment regimen in diabetic patients. The findings revealed that phone calls and SMS follow-ups improved HbA1c level and adherence to the treatment regimen (25). In a study carried out by Salehmoghaddam et al., the method of E-learning Education was used to control the type 2 diabetic dietary regimen (26).

All mentioned studies focused on type 2 diabetic patients in all age ranges, and they have ignored elderlies separately. Since training elderlies can be different from other age ranges (27), it is possible to use a simple follow-up method. Using an application for training elderlies can cause problems, and it is not easy to use. Moreover, for elderlies, the training contents presented in phone follow-ups are different from other age groups (28). Consequently, the research team decided to evaluate the effect of the tele-nursing method on FBS and HbA1c levels among elderlies.

Methods

Study design and Participants

This randomized study was conducted to determine the effect of tele-nursing on blood glucose control among the elderly with diabetes. The statistic population of the present study included diabetic elderlies (n=100) referring to the diabetes clinic of Rafsanjan County, Kerman Province, Iran. Among the population, 80 patients fulfilled the inclusion criteria and were randomized into two groups (n=40 each). The last patient was assessed in 2017 during the three-month follow-up after the completion of treatment. Totally, 70 patients completed the study (CONSORT flow diagram in Figure 1).

The inclusion criteria of the present research were a) being older than 60 years old, b) having active diabetes for a year, c) having access to a phone, d) lacking hearing and speaking problems, e) lacking cognitive disorders, f) having the ability to answer phone calls and understand the conversations, and g) lacking severe physical disease. In the present study, the sample size was determined based on Musavifar et al. (29) with a confidence level of 95 and a test power of 80. The optimal sample size was 70 elderly patients.

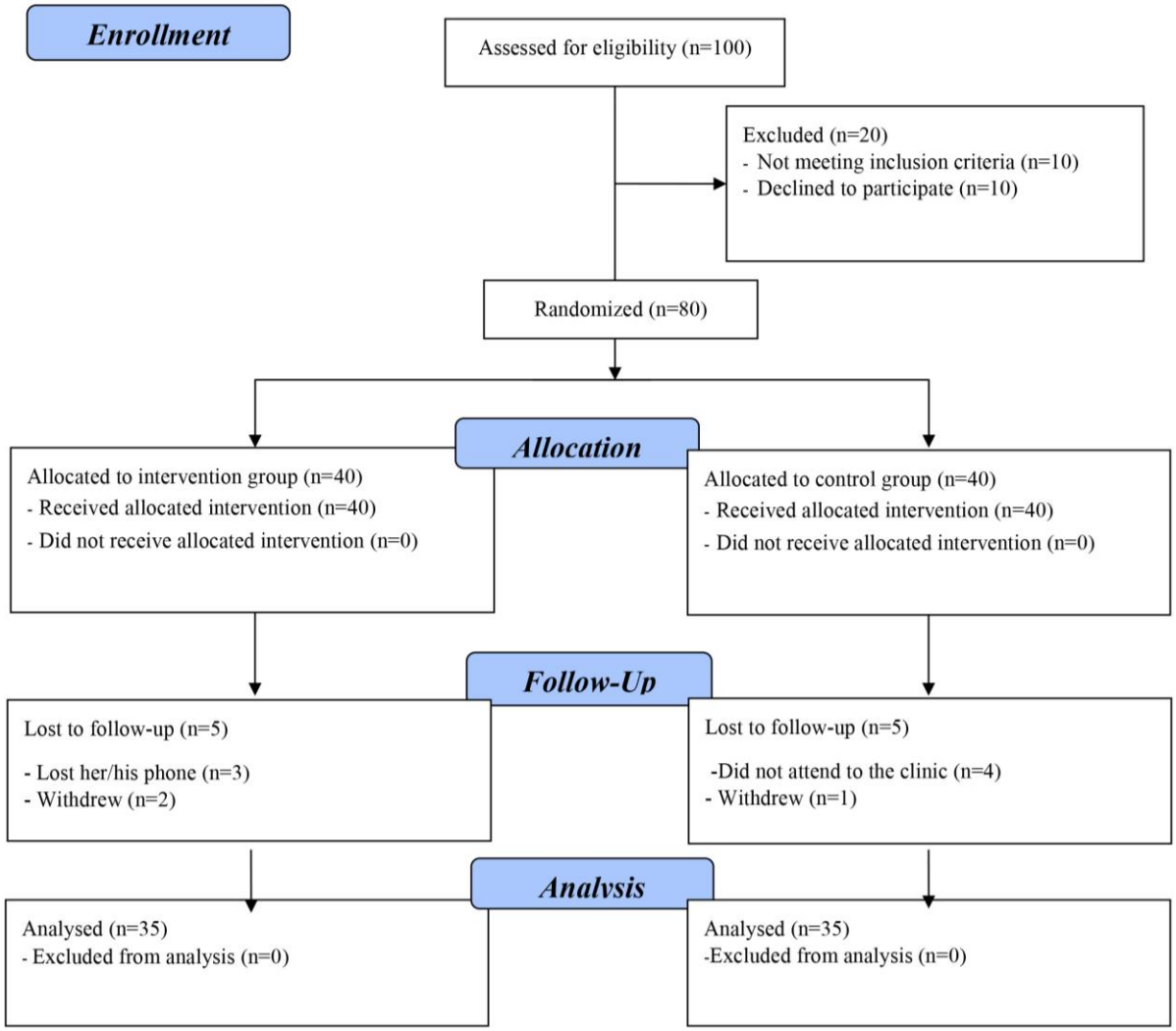

Figure 1. CONSORT 2010 flow diagram

Data collection tools and the method of using them

Data collection tools included a digital scale; tape meter; and checklist containing demographic information, such as age, weight, height, gender, marital status, place of residence, education level, and occupation. The demographic form also consisted of information about the disease condition, including the age of disease onset, duration of the disease, type and way of medication utilization, existence of other diseases, and records of the disease and blood glucose and HbA1c level. After obtaining the participants' written informed consent, their weight variable was measured using a digital scale with an accuracy of 0.1 kg. The variable of height was measured with a tape meter with an accuracy of 0.5 cm. Subsequently, body mass index (BMI) was calculated and recorded using the formula of weight in kilograms divided by height in meters squared. Demographic information was collected through face-to-face interviews, and FBS and HbA1c were measured by taking 5 cc of venous blood from the patient. Afterward, using block randomization in the Excel program (2013 version), the participants (n=80) were randomly assigned to intervention and control groups (n=40 each).

Variables of blood glucose were measured using an FBS sample through biochemical tests by BT3000 device (Italy) and Pars Azmoon blood glucose kit (Iran). Moreover, HbA1c was measured by ion-exchange chromatography using a biosystem kit (30). In 2011, according to the world health organization, the cut-off point of HbA1c was considered to be 6.5 for reasonable diabetes control (31). HbA1C of < 6.5 and ≥ 6.5 indicates reasonable diabetes control and low blood glucose control in patients, respectively (24).

Procedure

The present clinical trial study was performed among diabetic elderlies referring to the diabetes clinic in Rafsanjan County in 2017. The diabetes clinic of Rafsanjan County was established in 2004 in Ali Ibn Abi Taleb Hospital, Rafsanjan, Kerman Province, Iran, and supported about 5,000 diabetic patients. In this clinic, 600-800 diabetic patients are visited monthly. Internal specialists, endocrinologists, and neurologists are available in the clinic 4 days a week. In this clinic, nutrition counseling is also performed once a week for patients. The prominent aspect of this diabetes clinic is that it trains patients rather than curing them. Treatment can be provided in all doctors' offices; however, patient training (e.g., self-care training) takes a long time, therefore, it is impossible to perform it in offices (13, 14). In the clinic, training about nutrition, lifestyle, exercise, and adhesion to diet (how to inject insulin) are taught to patients. Moreover, their BGL and HbA1c are checked.

In the first month, the phone call was made two times a week, while in the second and third months, it was performed once a week. The mean duration of the conversation was about 15 min and the intervention time was from 8 am to 8 pm. The intervention group was able to call the researcher to solve their problem. The content of the conversations was associated with the problems related to diabetes, specific complaints of each patient, situation analysis with individual help to solve the problem, provision of a solution to solve the problem, and answer to the personal questions. Therefore, a conversation form was provided. Accordingly, first, the common problems of diabetes, advice on exercise, diet, and medication and insulin administration were provided, and then special needs of each patient were considered. In the control group, no phone call was made to measure FBS and HbA1c, and the subjects in this group were only asked to refer to the laboratory at the end of each month.

It is noteworthy that a trained nurse was in charge of making the phone calls, following up for 3 months, helping participants to answer questionnaires, collecting blood, and taking the anthropometric measurements (i.e., height and weight) of all participants (in both intervention and control groups).

At the end of the study, all coded collected data were entered into the software to perform the required analysis.

Analysis method of data

The collected data were entered into SPSS v.18 software. To evaluate BGL and HbA1c in both intervention and control groups, paired sample t-test was used. In addition, independent t-test and Chi-square test were utilized to compare both groups. Analysis of covariance was also performed to compare the mean BGL and HbA1C at three-month follow-up when adjusted for baseline BGL and HbA1C and age, gender, and education level. The p-values of < 0.05 were considered significant.

Ethical considerations

Regarding the ethical considerations, the research objectives were explained to all individuals, and they were informed of the right to leave the study at any time. Moreover, all participants were assured of confidentiality in this study.

Results

In the present study, most of the participants were female, and the number of males was higher in the control group than in the intervention group. The Chi-square test did not show significant differences between the two groups regarding gender, education level, marital status, residence, and occupation (Table 1). The mean age scores of the participants were obtained at 64.40±4.90 and 65.09±5.63 in the intervention and control groups, respectively. The mean BMI scores of the cases in the intervention and control groups were 27.89±4.89 kg/m^2 and 27.04±3.46 kg/m^2, respectively. Independent t-test showed no significant difference in terms of both age and BMI between the two groups.

The features of diabetes in both groups indicated that the mean duration of morbidity was higher than 8 years. Based on the results of the independent t-test, there was no significant difference between the two groups regarding the type of medication used to control BGL. Accordingly, 15 (42.9%) and 13 (37.1%) participants in the intervention and control groups consumed insulin, respectively. However, 20 (57.1%) and 22 (62.9%) subjects took anti-diabetic pills in the intervention and control groups, respectively. The Chi-square test showed no significant difference in the type of medication users between the two groups. The findings of the present study indicated that the amounts of FBS in the intervention and control

Table 1. Comparison of demographic characteristics in the intervention and control groups

Groups understudy		Groups understudy		Statistical values
		Intervention (n=30)	Control (n=30)	
Age (years)	Mean (SD)	64.4 (4.9)	65.09 (5.63)	T=-0.54 Df=68 P-value=0.59[a]
Weight (kg)	Mean (SD)	72.23 (11.49)	72.63 (10.39)	T=-0.15 Df=68 P-value=0.88[a]
Body mass index (Kg/M^2)	Mean (SD)	27.89 (4.89)	27.04 (3.46)	T=0.84 Df=68 P-value=0.40[a]
Diabetes history (years)	Mean (SD)	8.00 (4.50)	8.17 (5.40)	T=-0.14 Df=68 P-value=0.89[a]
Marital status	Married (n, %) Single (n, %) Divorced (n, %)	32 (91.4%) 1 (2.9%) 2 (5.7%)	31 (88.6%) 3 (8.6%) 1 (2.9%)	X^2=1.39, df=2 P-value=0.51[b]
Occupation	Housekeeper (n, %) Farmer Retired (n, %)	20 (57.1%) 4 (11.4%) 11 (31.4%)	19 (54.3%) 7 (20.0%) 9 (25.7%)	X^2=1.04 df=2 P-value=0.59[b]
Education level	Minimum literacy (n, %) Elementary AndSecondary (n, %)	13 (37.1%) 22 (62.9%)	18 (51.4%) 17 (48.6%)	X^2=1.45, df=1 P-value=0.23[b]
Gender	Mail (n, %) Female (n, %)	12 (34.3%) 23 (65.7%)	15 (42.9%) 20 (57.1%)	X^2=0.54, df=1 P-value =0.46[b]
Place of residence	City (n, %) Village (n, %)	24 (68.6%) 11 (31.4%)	22 (62.9%) 13 (37.1%)	X^2=0.25, df=1 P-value =0.62[b]

[a]: Independent t-test, [b]: Chi-square test

Table 2. Comparison of the mean of fasting blood glucose and glycated hemoglobin between the intervention and control groups

Group		Before	After	[a]P-value
		Mean±SD	Mean±SD	
FBS	Intervention	203.91±57.66	170.00±55.04	0.00[c]
	Control	219.29±71.59	216.17±76.14	0.28
[b]P-value		0.33	0.005	
HbA1c	Intervention	8.55±1.387	7.40±0.794	0.00[c]
	control	8.25±1.35	8.14±1.37	0.37
[b]P-value		0.36	0.007	

[a]: Paired t-test, [b]: Independent t-test, [c]: Significant
HbA1c: Glycated hemoglobin, FBS: Fasting blood glucose

groups were 203.91±57.65 and 219.29±71.59 mg/dl at the baseline, and the amounts of HbA1c level were obtained at 8.55±1.38 and 8.25±1.35%, respectively. Independent t-test showed no significant difference between the mean FBS and HbA1c levels before the study. After the intervention, mean scores of FBS and HbA1c levels were 170.00±55.04 mg/dl and 7.4±0.79% in the intervention group, respectively. However, in the control group, the mean scores of FBS and HbA1c levels were estimated at 216.17±76.14 and 8.14±1.36%, respectively. After the intervention, an independent t-test showed a significant difference between the two groups (Table 2).

After a 3-month follow-up, the analysis of covariance indicated that the mean scores of FBS (beta=-33.041, standard error=6.037, t=-5.473, P<0.001, partial eta squared=0.322, power=1.000) and HbA1c (beta=-0.914, standard error=0.189, t=-4.849, P<0.001, partial eta squared=0.272, power=0.998) levels in intervention group were significantly decreased, compared to the control group, when adjusted for baseline FBS and HbA1c levels and for age, gender, and education level. The results indicated that at the baseline, more than 94% (33) and 97% (34) of the patients in the intervention and control groups had abnormal FBS (over 126), respectively. Furthermore, more than 91% (32) and 77% (27) of the subjects had abnormal HbA1c levels (over 7), respectively. The Chi-square test showed no significant difference between the two groups. After the intervention, 6 (17.1%) and 1 (2.9%) patients in the intervention and control groups showed normal FBS, respectively. The Chi-square test showed a significant difference between the two groups. Moreover, although the number of patients with normal HbA1c levels was higher after the intervention than that in the control group, the Chi-square test showed no significant difference between the two groups (Table 3).

Based on the intergroup comparison of intervention and control groups, the mean scores of FBS and HbA1c levels in the intervention group respectively were reduced by 33.92±21.51 mg/dl and 1.51±0.86%, respectively, after the intervention, compared to at the baseline. Independent t-test did not show any significant difference between before and after the intervention. However, in the control group, the mean scores of FBS and HbA1c levels were respectively reduced by 3.11±26.89 mg/dl and 0.1±0.92%, compared to before the intervention. The result of the independent t-test was not indicative of a significant difference before and after the intervention in the control group.

Table 3. Comparison of two levels (normal and abnormal) of fasting blood glucose and hemoglobin glycosylated between the intervention and control groups

		Normal and abnormal values	Group		[a] P-value
			Intervention	Control	
FBS	Pre-intervention	Normal (Less than 126)	2 (5.7%)	1 (2.9%)	0.56
		Abnormal (More than 126)	33 (94.3%)	34 (97.1%)	
	Post-intervention	Normal (Less than 126)	6 (17.1%)	1 (2.9%)	0.05[b]
		Abnormal (More than 126)	29 (82.9%)	34 (97.1%)	
HbA1c	Pre-intervention	Normal (Less than 7)	3 (8.6%)	8 (22.9%)	0.10
		Abnormal (More than 7)	32 (91.4%)	27 (77.1%)	
	Post-intervention	Normal (Less than 7)	11 (31.4%)	7 (20.0%)	0.27
		Abnormal (More than 7)	24 (68.6%)	28 (80.0%)	

[a]: Chi-square test, [b]: Significant
HbA1c: Glycated hemoglobin, FBS: Fasting blood glucose

Discussion

The findings of this study showed that tele-nursing had a positive effect on FBS and HbA1c levels among the elderly patients referring to the diabetes center of Rafsanjan County. It was also revealed that this type of phone follow-up was effective in controlling BGL. All type 2 diabetic participants had 8 years or higher morbidity age with an active document in a diabetes clinic, and they regularly referred to this center to receive health services. However, the findings of the present research showed that in the control group, receiving routine care without remote follow-up did not significantly affect BGL.

Hemmati et al. evaluated the effect of remote training via phone and SMS on controlling BGL in type 2 diabetic patients. Accordingly, the findings indicated the positive impact of remote training on the reduction of BGL in the intervention group. In the study, the FBS was decreased by 20.44 mg/dl in the intervention group, whereas the reduction of FBS in our study was higher. In addition, the FBS of patients before the intervention was 127.03 mg/dl, which was lower than that in the present study. Therefore, it reveals that due to better control of BGL by patients of this study, the reduction of BGL was more significant in the present study, compared to that in the research performed by Hemmati et al. In their study, both phone and SMS follow-ups were used; however, in the present study, only phone follow-up was employed due to the high age of participants (≥65) (23). Kotsani reported that a 3-month phone follow-up led to a reduction in FBS in the intervention group. Although the participants in the mentioned study suffered from type 1 diabetes and their mean age was 27 years, the results of this study were in agreement with those of the present research, which showed the positive effect of phone follow-up on control of FBS in diabetic patients (12). Savas et al. performed a study on type 2 diabetic patients and reported that 6 months after the intervention, the FBS in the intervention group was reduced by 0.4 mmol/l, and 65% of participants showed normal FBS after an 18-month follow-up (20). In the present study, the FBS in the intervention group was reduced by 34 mg (1.9 mmol/l), which was higher than that in the study conducted by Savas. In addition, in the study carried out by Savas, the mean FBS before the intervention was 111, while this value was obtained at 203 in the present study. Therefore, the reduction of FBS was more evident in the current research than in the study conducted by Savas.

Numerous pieces of research have evaluated the effect of remote training on HbA1c. In the present study, the HbA1c level was reduced by 1.15% in the intervention group after the intervention, compared to before the intervention. However, in the control group, no change was observed after the intervention. Although the comparison of normal and abnormal HbA1c levels showed that numerous patients in the intervention group achieved almost normal HbA1c levels, no significant difference was observed between the two groups. Borhani et al. reported that training through software (phone application) reduced HbA1c levels by less than 1%. The findings of the mentioned study indicated that phone follow-up might be more effective than phone application in controlling BGL (32). Hemmati et al. reported a 0.5% reduction of HbA1c level in the intervention group (23). Nesari et al. performed a semi-experimental study and indicated that phone follow-up reduced HbA1c level by 1.87%, which was higher than that in the present research. In the study conducted by Nesari et al., more than half of the participants were between 50 and 60 years, while the age of participants in our study was over 65 years old. Moreover, in their study, 30% of the participants in the intervention group had a university education, while the subjects in the present study had reading and writing literacy. Consequently, the BGL control was accomplished better by the participants in the study carried out by Nesari et al. due to their lower age and higher education level, compared to those in the present study (33).

Sadeghi et al. reported that phone follow-up led to a 1.23% reduction in the HbA1c level of participants in the intervention group. The majority of the patients had less than 5 years of morbidity age, and before the intervention, their HbA1c level was higher than that in the present study. In the aforementioned study, 60% of the cases in the intervention group were in the age range of 51-65 years old. Despite the difference in the mean scores of age and morbidity duration between the participants in the above-mentioned research and the present study, similar results were obtained due to the homogeneity of participants in the two studies in terms of the location of research and cultural and social similarities. In the study performed by Sadeghi et al., the FBS of patients was reduced by 34 mg/dl (34).

Jin et al. evaluated the variations of FBS and myocardial infarction (MI) risk among non-diabetic

people. The results showed that the risk of MI morbidity was increased in people with a mean FBS of higher than 5.7 mmol/l. Furthermore, a decrease in FBS led to a reduction in MI morbidity risk, and the HbA1c level of the intervention group was reduced by 1.15% (35). Kim et al. reported that a 1% reduction in HbA1c level resulted in a 35% decrease in the occurrence of microvascular complications (36).

The limitation of this study was related to difficulty in sampling the elderly due to poor hearing and vision in this population. The strengths of this study included saving the elderly's time and money using tele-nursing.

Implications for Practice

In the present study, although all participants were elderly and had low education, they were able to use SMS. The participants' morbidity age was over 8 years and they were referring to diabetes clinics regularly; nonetheless, the results of the study revealed that their BGL was not controlled. However, the employment of SMS follow-up led to a significant reduction in the FBS and HbA1c levels of the subjects in the intervention group, which showed the positive effect of tele-nursing, compared to the results of other similar studies. Therefore, it can be said that this simple, cheap, and applicable method can be used to follow up the BGL of diabetic elderlies.

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This study was approved by the Ethics Committee of Rafsanjan University of Medical Sciences, Rafsanjan, Iran (code: IR.RUMS.RES.1396.39), and was also registered in Iran Clinical Trial Center (code: IRCT201761822320N4). The authors would like to thank the Vice Chancellery of Research and Technology of Rafsanjan University of Medical Sciences, Rafsanjan, Iran, for their support. They also express their gratitude to the responsible authorities of the Geriatric Care Research Center of Rafsanjan University of Medical Sciences and the participants in the study.

Conflicts of Interest

The author(s) declare(s) that there is no conflict of interest.

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