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ORIGINAL ARTICLE

Effect of Web-based diabetes training program on diabetes-related knowledge, attitudes, and skills of health professionals: A randomized controlled trial

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Abstract

Aim: To determine the effect of a Web-Based Diabetes Training Program (WB–DTP) on the diabetes-related knowledge, attitudes, and skills of health professionals.

Methods: This was an experimental pretest–post-test with a 1 month follow-up study design that included a control group. The results of the power analysis suggested that 50 individuals with diabetes should be in both the intervention and the control groups. The WB–DTP was developed in accordance with the Effective Teaching Instruction Model.. Measures included the information form, Achievement Test (AT), Diabetes Attitudes Scale (DAS), and skill observation forms. The Wilcoxon's Signed Rank test, Mann–Whitney U-test, and Friedman test were used to analyze group differences on these measures.

Results: There was a significant difference between the AT post-test and the follow-up test scores of the intervention and control groups. No significant difference was present for the DAS post-test and follow-up scores between the intervention and control groups. A significant difference emerged on the Insulin Injection Skill Observation Form score between the intervention and control groups. In addition, there was a significant difference in the measurement level of blood glucose by the Glucometer Skill Observation Form between the intervention and control groups.

Conclusions: As a result, it was determined that the WB–DTP is effective in increasing the diabetes-related knowledge and skills of healthcare professionals. However, the program was not adequate at increasing the diabetes-related attitudes of health professionals.

Key words: diabetes education, health professionals, in-service training, type 2 diabetes, Web-based education.

INTRODUCTION

Diabetes is a significant health problem that has become increasingly essential to understand in Turkey and throughout the world because of its complications and frequency of occurrence (SEMT, 2016). Teaching the management and care of the disease to individuals with diabetes and their family is an important part of the treatment plan. According to the World Health Organization, education is critical in controlling and managing diabetes (Haas *et al.*, 2014). In order to prevent and efficiently treat diabetes, it is important to implement continuous training for individuals with diabetes, their next of kin, and health professionals. In 2011, The Ministry of Health in Turkey published the "Diabetes Prevention and Control Program" and "National Diabetes Program." The common target that was described in these reports was to

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inform society and the training of health personnel and patients (CDC, 2014; IDF, 2015b; TPHI, 2014a, 2014b).

Type 2 diabetes is the most commonly encountered type of diabetes and the rates of chronic complications are higher in this type, compared to type 1 diabetes (ADA, 2015). Furthermore, most individuals with type 2 diabetes are between 40 and 59 years of age (IDF, 2015a). Usually, individuals with type 2 diabetes are treated in healthcare institutions for health problems other than their diabetes and related complications. This requires that all health professionals, especially nurses, apart from diabetes teams, who provide treatment and care services, have adequate diabetes-related knowledge and behavior. Thus, effective health services can be consistently provided to individuals with diabetes, as information,attitude, and behavior deficiencies related to diabetes mellitus can be solved through education and counseling.

As part of in-service training, diabetes-related sessions are organized for health professionals in healthcare institutions and presented using traditional, in-person training methods. However, the heavy workloads of health professionals reduce nurse participation in the training sessions and negatively affects the effectiveness of the training. Additionally, in-service training is held during office hours; at any given time, the number of nurses who are working during a specific shift might be low. As such, these training sessions must be constantly repeated, leading to a loss of time and workforce productivity. When all of these elements are taken into consideration, using distance education for training activities makes it much easier for healthcare professionals to reach their training goals.

Distance education began as a form of education that was conducted through the mail and it gradually developed into online forms of education called "Web-based education." With the development of technology and informatics, Web-based education reaches a wide audience. It allows the trainer and trainee to occupy different times and spaces. Additionally, the training can be tailored to suit individuals' personal differences (Avşar, 2012; Chang, Feng, & Hwang, 2011; Gülbahar, 2009; İşman, 2011; Yurdakul, 2007). Online diabetes training programs can be tailored to match health professionals' learning styles and offer a viable alternative to traditional in-service training methods. This type of program is important because it could increase the probability that health professionals will implement what they have learned to the care of individuals with diabetes.

The aim of this study was to determine the effect of a Web-based Diabetes Training Program (WB–DTP) on the diabetes-related knowledge, attitudes, and skills of health professionals.

METHODS

Study design and setting

This was an experimental pretest–post-test with a 1 month follow-up study design that included a control group. It was conducted between January and April, 2015 in a training and research hospital in Istanbul, Turkey.

Sample size and randomization

In the selected hospital, there were 492 nurses and 57 midwives; 167 nurses working in the operating room and pediatric clinics were excluded from the study because they did not actively work with patients with type 2 diabetes. A power analysis was calculated with the data that had been obtained from the literature to determine the required sample size. The standard deviation (SD) value of the Diabetes Attitudes Scale (DAS) was accepted as 0.83; the smallest scale point difference that could be significantly detected was accepted as 0.50 points (on a 5-point scale) (Babelgaith, Alfadly, & Baidi, 2013). The power analysis demonstrated that the sample size for a 0.05 significance level and 0.95 sample capacity was 38. Thus, in order to account for potential data loss, the aim was to have 50 persons in both the intervention and the control groups.

The nurses and midwives were interviewed face-to-face and were invited to participate in the study. Once 100 participants (89 nurses who were working in surgery and internal clinics and 11 midwives who were working in gynecology clinics) were obtained under these conditions, the interviews were terminated. A simple random method was used to assign the 100 participants to the intervention and the control groups. By using the lottery method, the participants in each clinic were assigned a number, after which numbers were randomly selected for the intervention and the control groups. This procedure was repeated for each clinic. After randomization, the comparisons revealed that the intervention and the control groups were similar to each other in terms of age, occupation, and mean score on the DAS and Achievement Test (AT) pretest.

Six participants from the intervention group never started the training and 41 of the 44 participants (93.1%) completed the training. In the control group, four participants incorrectly or only partially completed the measures; these participants were excluded from the research. Thus, the study was completed with 46 health

professionals in the control group and 44 in the intervention group (Fig. 1). According to this, the study power was found to be 96%.

Data-collecting tools

Information form

This form was prepared by the researcher using the existing literature. The nine questions focused on the health professionals' demographic characteristics, previous diabetes education, and experience with professional distance education.

Achievement Test

The AT was created to evaluate the amount of knowledge that had been gained by health professionals after the WB–DTP. The researchers developed this measure by using the content of the WB–DTP and adhered to the test preparation technique. It consists of 40 multiple choice questions. Each question is worth 2.5 points. The reliability analysis was calculated with the Kuder Richardson-20 (KR-20) formula to examine the internal consistency between the test scores in the ATs (Büyüköztürk, 2009). In this study, the reliability coefficient of the knowledge test, consisting of 40 items, was high (KR-20 = 0.754).

Diabetes Attitudes Scale

This scale was developed as a result of the studies that had been conducted by the National Diabetes Commission in the USA and took its final form when studies that showed the efficacy of the scale were carried out with a diabetes care team and individuals with diabetes. Turkish validity and reliability studies of the scale have been conducted by Özcan (1999). The scale consists of 34 items and seven subscales. The scale's items are rated on a 5-point scale, ranging from "I strongly disagree" (1) to "I strongly agree" (5). If the mean article point is <3, it shows negative attitudes and if it is >3, it shows positive attitudes. The Cronbach's alpha of the scale is stated as 0.70 (Özcan, 1999); it was 0.79 for this study.

Insulin Injection Skill Observation Form

This form was prepared in light of the literature and was arranged by expert opinion (Demirel, 2003; TPHI, 2014b). The form consists of 21 process steps, where the steps can be observed as (1) "Must be improved," (2) "Adequate," and (3) "Good." The scores that are obtained from the skill observation form range between 21 and 63; the arithmetic mean was used to evaluate it. The reliability of this skill observation form was tested by evaluating the conformity between two independent observers. For this purpose, the Kendall Tau coefficient was calculated to be $r = 0.917$, indicating

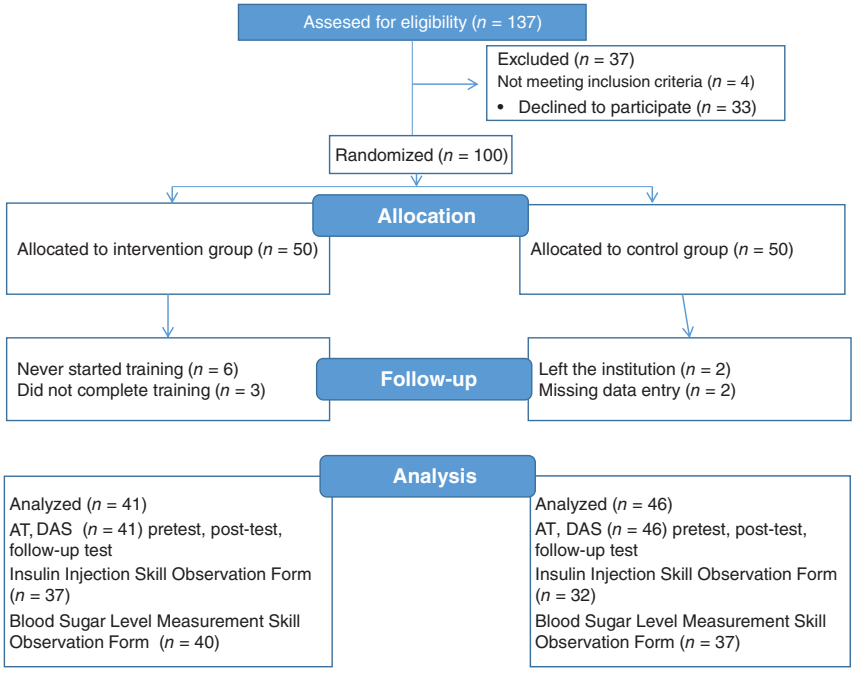

Figure 1 Study flow diagram. DAS, Diabetes Attitudes Scale; AT, Achievement Test.

that the reliability of the skill observation form was "very good" (Büyüköztürk, 2009).

Blood glucose level measurement with glucometer skill observation form

This form also was prepared by one of the researchers of the study and was arranged by expert opinion (Demirel, 2003; TPHI, 2014b). This form consists of 12 process steps, where the steps can be observed as (1) "Must be improved," (2) "Adequate," and (3) "Good." The scores that can be obtained range between 12 and 36 and the arithmetic mean was used to evaluate it. The reliability of the skill observation form was tested by evaluating the conformity between two independent observers. The Kendall Tau coefficient was $r = 0.859$, indicating that the reliability of the skill observation form was "very good" (Büyüköztürk, 2009).

Interventions

All the midwives and nurses were provided with diabetes education through traditional face-to-face training that was given by the diabetes nurse at the hospital where the study was conducted. In the current study, the WB–DTP was administered to the intervention group; in the control group, no training was given by the researchers, other than the education that was given by the diabetes nurse.

The AT and DAS were implemented pretraining to the intervention and control groups at similar times. The WB–DTP was given to the intervention group after the pretest and 4 weeks were given to the participants to complete the program. After this time period, the AT and DAS were implemented as post-tests to the intervention and control groups at similar times. Then, 1 month after the training was completed, the AT and DAS were implemented as follow-up tests to the intervention and control groups at similar times. In addition, 1 month after the training was completed, the intervention and control groups were evaluated with skill observation forms while doing insulin injections and measuring blood glucose levels with a glucometer (Fig. 1).

The WB–DTP program development process is described below and outlines the phases of the model. The subject matter consists of five modules (introduction of diabetes, treatment, complications, education, counseling) and 13 sections. Videos, pictures, animations, and schematics were used at the beginning of each section and throughout the program. The storyboards and scenarios within the videos and animations were created by the researcher with the support of professionals (software specialist, computer programmer etc.) through service purchase. After the website design, the videos, animations, and all the teaching materials were voiced by a professional actor and the researcher. The WB–DTP was presented in the Turkish language. The Learning Management System software was integrated into the website "www.onlinediyabet.com." An interface from the WB–DTP is provided in Figure 2. After the program was completed, it was presented to 14 experts (e.g. diabetes nurses and physicians, nurse lecturers with expertise in diabetes, Web design specialists, Web-based education specialists etc.) who assessed its scientific context and design. A pilot study was conducted with 20 nurses. The developmental steps of the program and the validity findings were published as a separate article (Okuroğlu & Alpar, 2016).

Statistical analysis

The Statistical Package for the Social Sciences program (IBM Corporation, Armonk, NY, USA) was used for the data evaluation. The Shapiro Wilks test was used to assess whether or not the data had a normal distribution (Büyüköztürk, 2009); it was determined that the data did not show a normal distribution; thus, non-parametric tests were used for the analyses. In the statistical evaluation of the data, the means, percentages, frequencies, and mean values (minimum–maximum) were calculated and the Wilcoxon's Signed Rank test, Mann–Whitney *U*-test, Friedman test, and Kay–Kare test also were used. All the results were considered to be meaningful at $P < 0.05$ and at a confidence interval of 95%.

Ethical considerations

This study was approved by the ethical review boards at the authors' institution (approval No.: 21.12.2012-7). The necessary permissions were obtained so that the study could be conducted in the hospital. The healthcare workers were given the information form and completed the informed consent form. The control group also received the WB–DTP after the study was completed.

RESULTS

The intervention group consisted of 44 persons and their mean age was 29.09 years (SD: 5.94). The intervention group was 97.7% ($n = 43$) female. The control group consisted of 46 persons. Their mean age was

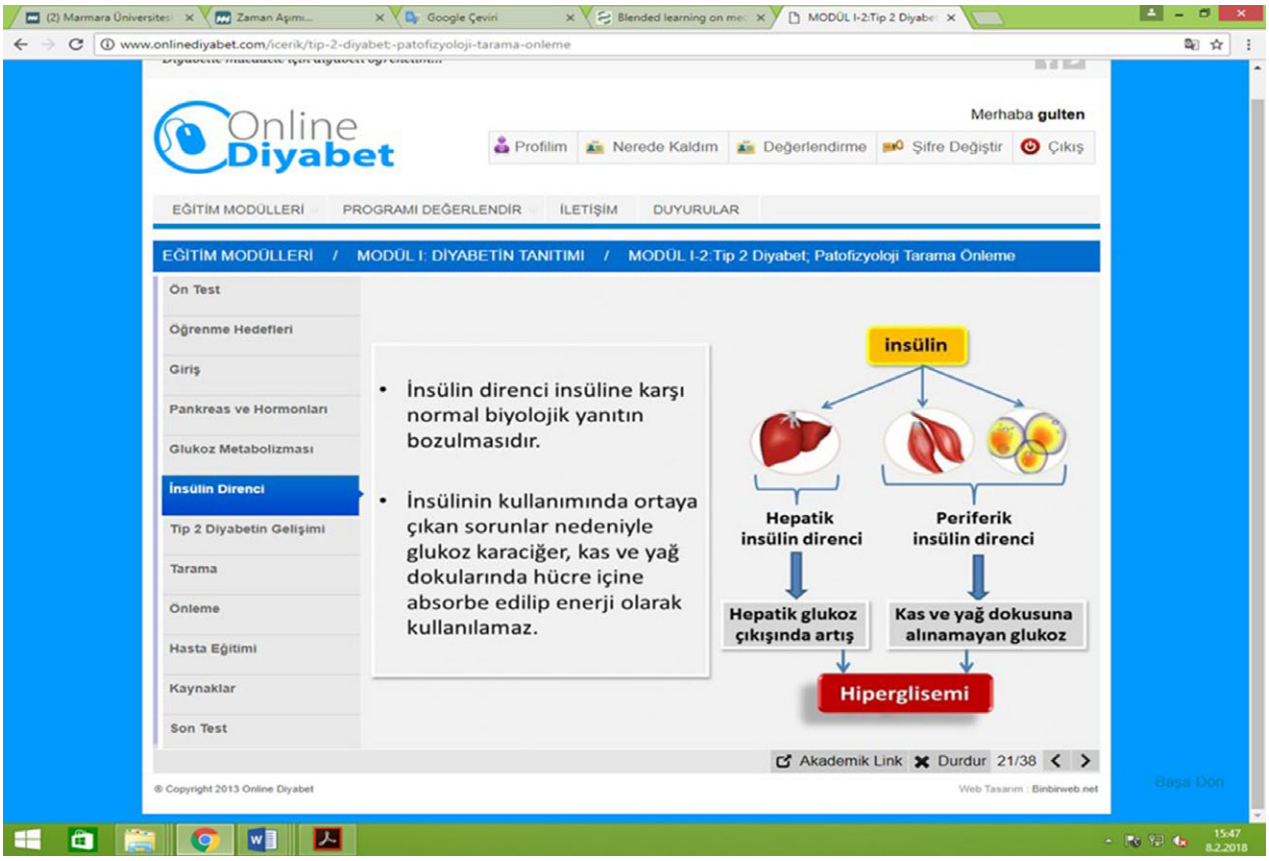

Figure 2 An interface from the Web-Based Diabetes Training Program.

28.69 years (SD: 5.06) and the group was 95.7% (n = 44) female. The intervention group comprised of 90.9% (n = 40) nurses and the occupational experience time was 7.02 years (SD: 6.15). The control group comprised of 93.5% (n = 43) nurses and the occupational experience time was 7.56 years (SD: 5.60). No significant differences between the mean ages (P = 0.96) and the occupational experience times (P = 0.34) were detected between the intervention and control groups (Table 1). The average number of sessions for a participant was 7.4. The study group's unit completion times are presented in Figure 3. The Definition, Classification and Diagnosis of Diabetes Unit were completed the quickest (8.8 min), while the Physical Activity and Exercise Unit took the longest time (23.67 min). The study group's program completion time was analyzed; 22% (n = 9) of the intervention group completed the program in 1 day, 25% (n = 10) completed the program in 2 days, 22% (n = 10) completed the program in 3 days, 12% (n = 5) completed it in 5 days, and 5% (n = 2) completed the program in 7 days.

The Friedman test was conducted to compare the scores of the AT pretest (before the training), post-test (right after the training), and follow-up tests (1 month after the training) within the groups. These results are provided in Table 2. The results of the Mann–Whitney U-test that was conducted to compare the groups with each other also appear in Table 2. There was a significant difference between the AT pretest, post-test, and follow-up test scores in the intervention group (P < 0.001). The Wilcoxon's Signed Rank test was conducted to determine the source of this difference. It was detected that the post-test score was significantly higher than the AT pretest score (P < 0.001), the AT post-test score was significantly higher than the AT follow-up test score (P = 0.002), and the AT follow-up test score was significantly higher than the AT pretest score (P < 0.001) (Table 2).

There was no significant difference between the AT pretest, post-test, and follow-up test scores in the control group (P = 0.38) (Table 2). Furthermore, there was no significant difference when the AT pretest scores of

Table 1 Baseline characteristics of the participants in the intervention and control groups

Variables	Intervention		Control		$U^{\dagger}/X^{\ddagger}$ *P*
	N (44)		N (46)		
Age (years) mean(SD)	44	29.09(5.94)	46	8.69(5.06)	1007.00† .96
Gender n (%)					
Female	43	97.7	44	95.7	NA
Male	1	2.3	2	4.3	
Education n (%)					NA
High school	2	4.5	4	8.7	
Undergraduate	3	6.8	4	8.7	
Bachelor Degree	35	79.5	33	71.7	
Master's Degree	4	9.1	5	10.9	
Occupation n (%)					NA
Nurse	40	90.9	43	93.5	
Midwife	4	9.1	3	6.5	
Occupational Experience Time mean(SD)	44	7.02(6.15)	46	7.56(5.60)	895.50† .34
Clinic the participants are working in n (%)					
Surgical Units	24	54.5	22	47.8	.406‡
Internal Units	20	45.5	24	52.2	.52
Participation in diabetes-related activities n (%)					NA
Congress/Symposium	1	2.3	0	0	
Training within Service	42	95.5	43	93.5	
None	1	2.3	3	6.5	
Using books/magazines to obtain diabetes-related information n (%)					NA
Yes	14	31.8	18	39.1	
No	30	68.2	28	60.9	
Using the internet to obtain diabetes-related information n (%)					NA
Yes	42	95.5	38	82.6	
No	2	4.5	8	17.4	
Previous distance training n (%)					NA
Yes	3	6.8	8	17.4	
No	41	93.2	38	82.6	
Total	44	100	46	100	

† *Mann Whitney U Test was used.*
‡ *Chi-squared Test was used.*
P < .05
NA: Not Applicable

the intervention and the control groups were compared ($P = 0.24$). In contrast, the scores of the AT post-test ($P < 0.001$) and follow-up test ($P < 0.001$) were significantly higher in the intervention group, compared to the control group (Table 2).

The differences between the DAS pretest, post-test, and follow-up test scores for the intervention and control groups were not significant ($P = 0.60$ and $P = 0.08$, respectively). Although it was determined that there was no significant difference when the DAS pretest scores of the intervention and the control groups were compared ($P = 0.48$), there also were no significant differences between the post-test ($P = 0.19$) and the follow-up test ($P = 0.53$) scores (Table 2).

The Mann–Whitney U-test was conducted in order to examine the differences between the intervention and the control groups on the scores for the Insulin Injection Skill Observation Form and blood glucose levels, as measured with the Glucometer Skill Observation Form. Table 3 shows these results. The scores on the Insulin Injection Skill Observation Form and the Blood Glucose Level Measurement with the Glucometer Skill

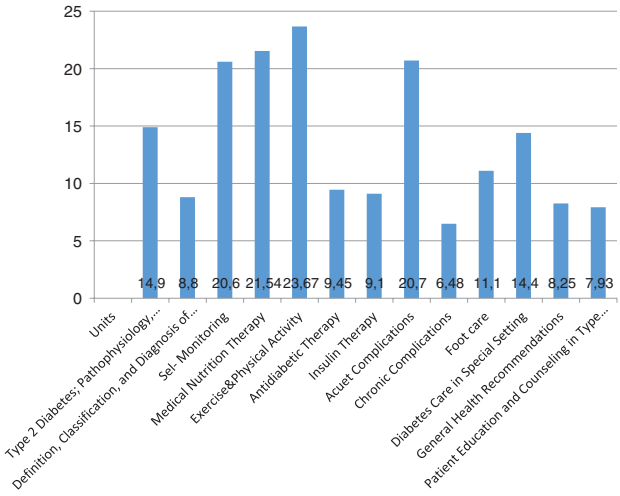

Figure 3 Intervention group's amount of completion time of units (min).

Observation Form were significantly higher in the intervention group than in the control group ($P < 0.001$) (Table 3).

DISCUSSION

The fact that the AT post-test and follow-up test scores were higher than the pretest scores shows that the WB–DTP increased the diabetes-related knowledge of the participants. Similarly, in a study conducted by Bell, Patel, and Malasanos (2006), where they evaluated the efficacy of a Web-based type 1 diabetes training program that consisted of 15 modules, the post-test scores of the nurses in all the modules were significantly higher than the pretest scores.

In a study conducted by Wilkinson, Forbes, Bloomfield, and Fincham Gee (2004), their evaluation of the efficacy of Web-based training consisting of four modules demonstrated a significant difference between the pretest–post-test scores of the nurses for the diabetes module. In a study conducted by Hall, Corman, Drab, Smith, and Meyer (2010), they tested the efficacy of the WB–DTP that they had developed for pharmacists; the Web-based training increased the diabetes-related knowledge of the pharmacists. These findings are parallel to the results in this study.

Furthermore, when the literature about the subject sample is examined, Web-based diabetes interventions are mostly developed for patients; these interventions have increased the diabetes-related knowledge of the individuals with diabetes and improved their metabolic

Table 2 Comparison of the scores of the intervention and the control groups in the Achievement Test (AT) and diabetes attitudes scale (DAS) pretest, posttest and follow-up tests within the groups and with each other

Variables		Pretest (1) Median (min-max)	Posttest(2) Median (min-max)	Follow-up Test(3) Median (min-max)	$X^{2\dagger}$	P	Post Hoc ($Z^{\S}$/P)
Achievement Test (AT)	**Intervention (N = 41)**	37.5 (7.5–57.5)	72.5 (57.5–82.5)	67.5 (55–80)	66.076	**<0.001**	2>1–5.588/<0.001
							2>3–3.148/0.002
							3>1–5.588/<0.001
	Control (N = 46)	35 (22.5–52.5)	37.5 (10–52.5)	37.5 (25–57.5)	1.920	.38	NA
	U‡	807.50	0.000	3.000			
	P	.24	**<0.001**	**<0.001**			
Diabetes Attitudes Scale (DAS)	**Intervention (N = 41)**	3.70 (3.41–4.21)	3.82 (3.50–4.29)	3.76 (3.41–4.79)	.994	.60	NA
	Control (N = 46)	3.77 (3.21–4.68)	3.73 (3.21–4.68)	3.70 (3.21–4.68)	5.015	.08	NA
	U‡	861.00	789.00	870.50			
	P	.48	.19	.53			

† Friedman Test was used.
‡ Mann Whitney U Test was used.
§ Wilcoxon Sign Rank Test was used.
P < 0.01.
P < 0.001.
NA: Not Applicable.

Table 3 Comparison of the scores of the intervention and the control groups for the insulin injection skill observation form and blood glucose level measurement with glucometer skill observation form

Skill Observation Form Score	Intervention N	Intervention Median (min-max)	Control N	Control Median (min-max)	*U*	*P*
Insulin Injection Skill	37	55 (41–62)	32	34 (26–36)	127.50	***<0.001***
Blood Glucose Level Measurement Skill	40	45 (40–59)	37	30 (24–34)	273.00	***<0.001***

Mann Whitney U Test was used.
$P < 0.001$.

control (Avdal, Kızılcı, & Demirel, 2011; Gerber *et al.*, 2005; Hadjiconstantinou *et al.*, 2016; Heinrich *et al.*, 2012; McMahon *et al.*, 2005; Porter, Chapman-Novakofski, & Scherer, 2009). There are also studies that reported on Web-based or online training programs that had been prepared for healthcare staff and nursing students on subjects other than diabetes that had increased the knowledge of the participants about the related subjects (Chau *et al.*, 2012; Gerdprasert, Pruksacheva, Bhinyo, & Ruenwongsa, 2010; Horiuchi, Yaju, Kayo, Sakyo, & Nakayama, 2009; Sheen, Chang, & Chen, 2008; Song *et al.*, 2009).

In contrast, the fact that the post-test scores were higher than the follow-up scores indicates that after 1 month post-training, the participants forgot some of the information that they had learned. This finding is an expected result and is parallel to the fact found in the literature that learned knowledge will start to be forgotten after a certain amount of time post-training completion (Fer, 2011). However, the fact that the follow-up test scores were higher than the pretest scores is positively interpreted in terms of the recollection level of the participants 1 month post-training.

There were no significant differences between the AT pretest, post-test, and follow-up test scores for the control group. This finding indicates that the diabetes-related knowledge level of the control group did not increase during the training and was interpreted as an important finding in terms of the WB–DTP efficacy.

Although it was determined that there was no significant difference when the DAS pretest scores of the intervention and the control groups were compared, the post-test and the follow-up test scores of the intervention group were significantly higher than those of the control group. This finding indicates that prior to training, the AT scores of the intervention and the control groups were similar. This is another finding that shows the WB–DTP is successful at increasing diabetes-related knowledge.

There were no significant differences between the DAS pretest, post-test, and follow-up test scores between the intervention and the control groups. However, the fact that the DAS scores for the intervention and control groups were >3 indicates that their diabetes-related attitudes were positive. This finding regarding the DAS pretest scores is parallel to findings by Babelgaith, Alfadly, and Baidi (2013) and Bani-issa, Eldeirawi, and Tawil (2015) that focused on determining the diabetes-related attitudes of healthcare staff. The fact that there was no significant difference between the DAS pretest scores between the intervention and the control groups indicates that the groups were similar regarding the DAS scores. In contrast, the DAS post-test and follow-up test scores of the WB–DTP intervention group were higher than the pretest scores, though this difference was not statistically significant. Attitudes are defined as the emotional and mental preparation state that is capable of affecting an individual's attitude towards all objects and situations in which the individual is interested; it is known that attitudes are hard to change because they form as a result of experiences. Also, it is known that connotation, reinforcement, and imitation processes are effective in the development of attitudes (Köklü, 1995). For these reasons, it is not surprising that there was no significant difference in attitudes as a function of the intervention. Therefore, as a consideration for future research, reminder posters could be hung in working areas and the staff could be continuously observed with reward and punishment reinforcements as an effective way to enhance diabetes-related attitudes after Web-based training.

It was determined that the Insulin Injection Skill Observation Form scores and the Blood Glucose Level Measurement with Glucometer Skill Observation Form scores of the intervention group were higher than those of the control group. The most important element that shows the success of training programs is that learning goals are converted into behavior (Demirel, 2009). According to this, the WB–DTP can be evaluated as a

successful training program, in terms of providing planned behavior change to the participants. It is possible that visual tools, such as skill videos, animations, pictures, and the various schematics and graphics that were used in the context of the WB–DTP contributed to the development of the participants' knowledge and skills. Sheen *et al.* (2008) also reported increased caretaking skills in nurses that experienced an online training program. Also, **Bloomfield, Cornish, Parry, Pegram, and Moore (2013) and Chang *et al.* (2011) mentioned findings in their studies about the increased skill levels of nursing students who used Web-based and remote training methods.

Limitations of the study

The healthcare professionals who had been selected in this study were limited to nurses and midwives. The study data were limited to the hospital where the study was conducted. Both of these considerations might limit the generalizability of the results. In addition, in this study, training to the control group was education provided by the diabetes nurse, rather than anything from the researchers. This is a limitation.

CONCLUSION

As a result, it was determined that the WB–DTP was effective at increasing the diabetes-related knowledge and skills of the healthcare professionals. However, the program was not adequate for enhancing the diabetes-related attitudes of health professionals. In accordance with the results that were obtained from this study, it is suggested that the WB–DTP be used in all healthcare institutions as an alternative in-service training program. Also, future researchers may want to consider conducting further diabetes-related attitudes studies in order to evaluate the efficacy of the WB–DTP by adapting it for other healthcare occupations.

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DISCLOSURE

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

G. K. O. and Ş. E. A. contributed to the conception and design of this study; G. K. conducted the statistical analysis and drafted the manuscript; Ş. E. A. critically reviewed the manuscript and supervised the entire study process. Both authors read and approved the final manuscript.

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