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Research Article

An evaluation of Web-based education as an alternative to group lectures for diabetes self-management

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Abstract This study evaluated the efficacy of Web-based diabetes self-management education for newly diagnosed patients with type II diabetes as an alternative to group lectures. Using a non-equivalent control group, pretest-post-test design, the participants in the Web group ($n = 15$) took part in a Web-based diabetes self-management program, while those in the lecture group ($n = 16$) attended 3 h of group lectures provided by health-care professionals specializing in diabetes care. The outcome variables were measured at the baseline (T0), and 6 weeks (T1) and 3 months (T2) after the interventions. The glycosylated hemoglobin (HbA1c) percentage and diabetes care knowledge in the Web group improved significantly from T0 to T1, while the diabetes care behavior improved significantly from T0 to T1 and from T1 to T2. The diabetes care knowledge and diabetes care behavior in the lecture group improved significantly from T0 to T1, but the HbA1c percentage did not change significantly between any times. These results show the potential of the Web-based program as an alternative to group lectures for diabetes self-management education.

Key words diabetes care behavior, diabetes care knowledge, Web-based education.

INTRODUCTION

Chronic diseases are increasingly becoming global phenomena in both developed and developing countries. Diabetes is one of the fastest-growing chronic diseases in Korea, with reported morbidities of < 1% in 1970, 3% in 1980, and 5–8% in 2004 (Lee *et al.*, 2004), while there were 17.2 mortalities per 100 000 persons in 1995, 22.6 mortalities per 100 000 persons in 2000, and 24.2 mortalities per 100 000 persons in 2005 (Korea National Statistical Office, 2006).

People with diabetes should manage their lifestyles so as to control their blood sugar, blood pressure, and cholesterol, prevent complications, and maintain their functioning. Lifestyle modification, such as diet, exercise, and foot care, and its subsequent maintenance, is as important to patients with diabetes as is the adherence to medication for controlling the blood sugar level.

The most frequent strategy for improving self-management by patients with diabetes is the participation in diabetes education classes, such as group lectures and face-to-face, one-on-one learning with specialists (Brown, 1999). Education programs utilizing both methods are provided in most large hospitals in Korea. Group lectures are cheaper, but they cannot meet the individual needs of patients, as well as individual learning (Brown, 1999). Moreover, it is sometimes difficult for patients to attend lectures at particular places and times.

The development of Internet technology has led to the introduction of Web-based learning programs as an alternative method of teaching self-management to patients with diabetes (Tomky, 1999). The advantages of Web-based learning programs are their easy access and self-paced nature, as well as being an easy feedback system with no restrictions on time or location.

Internet access in South Korea is among the best in the world, with almost every household in urban areas having access in their home, which has made the use of the Internet a normal part of life among ordinary people (National Internet Development Agency, 2008). Koreans work the longest hours among the Organization of Economic Cooperation and Development countries (Olson, 2008) and many employed Korean people have difficulty finding the time to attend the diabetes self-management education classes that are offered by hospitals. Utilizing Web-based education as an alternative to attending hospital lectures could save time and money, as a short-term benefit, and prevent complications, as a long-term benefit (Lorig *et al.*, 2006).

Web-based self-management education has been found to be effective for childhood asthma (Krishna *et al.*, 2003), patients with back pain (Buhrman *et al.*, 2004), older people

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with heart failure (Westlake *et al.*, 2007), and hypoglycemia management education for patients with type I diabetes (Kubiak *et al.*, 2006). However, few studies have investigated the use of the Internet as a primary method for the delivery of self-management education for patients with diabetes. A study involving a large sample ($n = 958$) compared the effects of a Web-based chronic disease self-management program with the normal care provided and a small-group self-management program on health indicators, health behaviors, and medical service utilization over 1 year (Lorig *et al.*, 2006). No differences were found in any of the dependent variables. However, although 60% of the sample was diabetic, the physiological variables, such as the glycosylated hemoglobin (HbA1c) percentage and the fasting blood glucose (FBG) level, which are objective indicators of glycemic control, were not measured.

Studies involving smaller samples have used technological interventions, such as cellular phone-based and computer feedback-based methods, successfully for glycemic control (McMahon *et al.*, 2005; Kim, 2007; Kim & Song, 2008). In these studies, the patients needed to report their glucose level at least once daily and a physician or nurse had to give continuous feedback to all the participants by email or cellular phone according to the input glucose data, which required considerable time and effort from the health-care professionals, and it was also costly.

Some motivated people prefer to perform self-paced diabetes self-management learning and practice by themselves. It is our premise that the deployment of Web-based diabetes education with comprehensive guidelines, which allow more flexibility and self-control, will work as well as attending lectures in person.

The primary purpose of diabetes education is to increase knowledge, but knowledge does not always produce the desired behavior; hence, many recent studies related to self-management education have focused on behavior change (Sabate, 2003). Social support is an important factor in self-management behavior and most social support interventions improve self-management behavior outcomes (Gallant, 2003). The provision of Web-based social support (peer support), along with education, has been effective in producing desirable diabetes self-management dietary behavior (Barrera *et al.*, 2002). The results of these studies indicate that the inclusion of peer support with a Web-based education program will improve diabetes care behavior.

Most previous studies on Web-based diabetes interventions used the change in glycemic control as the outcome and did not consider knowledge or behavior changes (Kim, 2007; Kim & Song, 2008). Long-term self-management is required for patients with diabetes and behavior change is as important as glucose control. Some aspects of self-management, such as foot care, the optimal use of medical services, and the cessation of smoking, are not reflected in the level of glycemic control as a measure and, hence, it is necessary to measure knowledge, behavior, and the physiological outcomes when evaluating the effects of a diabetes self-management education program.

The purpose of this study was to develop a Web-based education program for newly diagnosed adult patients with diabetes and to apply it to voluntary participants, comparing their knowledge, behavior, and physiological outcomes with those receiving group lecture education. The purpose also was to assess the potential usefulness of a Web-based program as an alternative method of learning for newly diagnosed patients with diabetes.

METHOD

Research design

The study was a quasi-experimental investigation with a non-equivalent control group, pretest-post-test design that was carried out in collaboration with the College of Nursing and the endocrine department of a university-affiliated, tertiary care hospital in Seoul, Korea. There were two groups in this study. The participants in the Web group (i.e. intervention group) took part in a Web-based diabetes self-management education program, while those in the lecture group (i.e. the control group) attended the diabetes education lectures provided by health-care professionals specializing in diabetes care. They attended 1 h lectures (group size of 30–40 participants) every week for three consecutive weeks. The lectures in the first, second, and third weeks were provided by a diabetes care specialist nurse, a dietician, and a physician, respectively. The patients were not contacted other than during their usual bimonthly clinic visits.

The dependent variables (i.e. the outcome variables) were the patients' diabetes care knowledge, diabetes care behavior, and glycemic control (FBG and HbA1c), which were assessed at the baseline and at the 6 week and 3 month follow-up sessions.

Participants

The study's participants were patients with diabetes treated in the university-affiliated, tertiary care hospital from March to December 2006. We recruited the patients by posting the study's procedure in the outpatient endocrine clinic and a clinic nurse explained in detail the procedures to the potential participants. As some patients do not use the Internet or prefer a regular diabetes lecture class over Web-based education, only those patients who agreed to using the Web-based program were included in the Web group. The inclusion criteria ensured that the participants were adults who were newly diagnosed by a physician with type II diabetes and had never attended formal self-management education given by a health-care professional or over the Internet.

The patients for the lecture group were recruited at the same clinic based on the same inclusion criteria. The initial samples consisted of 31 patients in the Web group and 29 patients in the lecture group. At the 6 week and 3 month follow-up sessions, nine and seven patients had dropped out of the Web group, respectively, and six and seven patients had dropped out of the lecture group, respectively. Therefore, the final analysis was applied to the data from the remaining 15 Web group participants and 16 lecture group participants.

Web-based diabetes self-management program

A diabetes education website was developed with the goal of supporting patients and their family to manage diabetes properly by providing relevant information about the disease and its management and by providing the necessary feedback and support. The structural design of the course was influenced by two principles deemed fundamental by the authors: (i) a commitment to using a platform that would allow the course to be available to any patient; and (ii) providing course material in a format that was adaptable to different learning styles. These structural design principles were achieved by developing a Web-based course in a modular format that could be utilized by an instructor to educate patients. To achieve the desired flexibility, the authors developed the website course as a series of 6 week modules to make it similar to most self-management education programs for chronic illness (Lorig *et al.*, 2001). The 6 week modules comprised an introduction, understanding diabetes, dietary management, exercise management, drug and test management, stress management, and foot care.

The course content was designed to be comprehensive, covering all aspects of diabetes management. The content of the patient education material from the National Diabetes Education Program, the Korean Diabetes Association, and a diabetes self-management guidebook that was published by the university hospital were reviewed. The core content was outlined and reviewed by an endocrinologist and a diabetes specialist nurse and then the necessary modifications were made. Three patients used the initial Web-based program and further modifications were made based on their feedback.

The website was developed using a standard Web authoring tool to allow authorized users to access it via a personal computer (PC) and Internet browser. The graphical user interface components provided the user with a quick overview and supported straightforward navigation.

The website included a public space with information about diabetes management and a private, password-protected space that could be accessed only by the authors and the patients registered for the course. The secure space contained four features: "My glucose level", which provided a visual display of everyday variations of glucose levels; "Calculator of daily caloric intake", which calculated the caloric content of consumed meals; "My activity level", which measured the activity level of the user; and "Stress measurement", which measured the stress level of the patient during the day. Feedback could be provided by using the "Counseling the specialist" and "FAQ" (frequently asked questions) features. The patients and families could share the related information and emotional support by participating in an online patient community called "dang-nyo-sarang" (meaning "loving diabetes").

The developed content was posted in the "Diabetes classroom", which was a subwebsite that appeared below the official homepage of the College of Nursing, Seoul National University. The URL address of the website is "http://nursing.snu.ac.kr/diabetes/".

Outcome measures

The diabetes care knowledge was quantified by using the Michigan Diabetes Research and Training Center's *Diabetes Knowledge Test*. The original instrument was developed by Fitzgerald *et al.* (1998) and was translated into Korean and validated by Kim & Kim (2004). It comprises 23 items of three or four multiple-choice questions. The correct and incorrect answers to an item are scored 1 and 0 points, respectively; thus, the highest possible score is 23, with a higher score indicating higher knowledge. The reliability (Cronbach's alpha) at the development stage was 0.70 (Fitzgerald *et al.*, 1998) and it was 0.68 in this study.

The diabetes care behavior was quantified by using the Diabetes Self-care Behavior Scale of Gu (1996). The original scale consisted of nine, three, and three items on diet, exercise, and medication, respectively. We added four items related to foot care and one item related to stress management, producing 20 items scored on a four-point Likert-type scale. The total score ranges from 20–80, with a higher score indicating better behavior. The reliability (Cronbach's alpha) in this study was 0.73.

The glycemic control was determined by the HbA1c percentage and the FBG level. The HbA1c is a measure of long-term glucose control and is normally < 6.0%. It represents the hemoglobin-bound glucose and indicates the mean glucose level over the previous 2–3 months. In contrast, the FBG is an indicator of day-to-day glucose control. The tests were carried out in a laboratory at the university hospital. The FBG level was measured by using an absorbance photometry technique (Cobas Integra 800; Roche, Basel, Switzerland) and the HbA1c percentage was determined by an affinity chromatography technique (Variant II; Bio-Rad, Hercules, CA, USA).

Data collection procedure

The study's protocol was approved by the Institutional Review Board for Human Subject Research at the College of Nursing, Seoul National University, Korea, in 2005. The benefit and possible danger of participation in the study were explained to the voluntary participants in the intervention and control groups, who then provided written informed consent. The baseline assessment (T0) included the demographic characteristics, health-related characteristics (e.g. smoking, medication, and other diseases), diabetes care knowledge, diabetes care behavior, and glycemic control.

The participants in the Web group received lessons on using a notebook PC at an office in the outpatient clinic for 30 min. They were given the 10 page user manual of the Web-based diabetes self-management program and were encouraged to use its FAQ and "Q&A" (question and answer) sections.

The participants in both groups were interviewed and data were collected on their diabetes care knowledge and behavior when they visited the outpatient clinic at 6 weeks (T1) and 3 months (T2) after the interventions. Blood samples for HbA1c and FBG were obtained at the same time.

Data analysis

The homogeneity of the baseline data in the Web and lecture groups was tested using the χ^2-test and *t*-test. The differences between the two groups over time were assessed by using repeated-measures ANOVA. Paired *t*-tests for the HbA1c were applied to identify the times when there were differences within each group. SPSS (version 12.0; SPSS, Chicago, IL, USA) was utilized for the statistical analyses.

RESULTS

Characteristics of the participants in the Web and lecture groups

Table 1 presents the characteristics of the participants in the Web and lecture groups. The demographic characteristics, baseline glycemic control, diabetes disease-related characteristics, and diabetes care knowledge and behavior did not differ between the two groups.

Changes in the diabetes care knowledge of the Web and lecture groups

At T0, the diabetes care knowledge did not differ between the two groups ($P = 0.237$) (Table 1). Table 2 compares the diabetes care knowledge of the two groups at different times. The diabetes care knowledge was significantly higher in the Web group than in the lecture group ($P = 0.006$), but there was no interaction between the group and the time ($P = 0.112$). The paired *t*-tests revealed that the diabetes care knowledge differed significantly between T0 and T1 in both the Web group ($P = 0.001$) and the lecture group ($P = 0.010$) (Fig. 1a). However, there was no difference between T1 and T2 in either group. This indicates that the level of knowledge increased in both groups from T0 to T1 but not from T1 to T2.

Changes in the diabetes care behavior of the Web and lecture groups

The diabetes care behavior at T0 did not differ between the two groups ($P = 0.773$) (Table 1). Table 2 indicates that the diabetes care behavior of the two groups differed over time ($P = 0.001$) but that there was no interaction between the time and the group ($P = 0.118$). The paired *t*-tests showed significant increases from T0 to T1 ($P = 0.004$) and from T1 to T2 ($P < 0.001$) in the Web group. There was a significant increase from T0 to T1 ($P = 0.013$), but no difference between T1 and T2 ($P = 0.735$), in the lecture group (Fig. 1b).

Changes in the fasting blood glucose levels of the Web and lecture groups

No significant differences in the FBG levels were found at T0 ($P = 0.787$) (Table 1). Table 2 indicates that the FBG levels did not differ between the groups ($P = 0.823$) or the times ($P = 0.054$) and that there was no interaction between the group and the time ($P = 0.759$). The paired *t*-tests showed no differences in the FBG levels between T0 and T1 ($P = 0.209$) or between T1 and T2 ($P = 0.944$) in the Web group or

Table 1. Baseline demographic and clinical data of the Web and lecture groups

Characteristic	Web group ($n = 15$)	Lecture group ($n = 16$)	*t*-test or χ^2-test	*P*-value
Age (years)	56.26 ± 7.2	59.50 ± 10.2	–1.009	0.321
Sex			1.924†	0.333
Male	14 (93.3)	12 (75.0)		
Female	1 (6.7)	4 (35.0)		
Education			4.852	0.183
Up to middle school	4 (26.7)	5 (31.3)		
High school	3 (20.0)	8 (50.0)		
At least college	8 (53.3)	3 (18.7)		
Currently employed			4.951	0.084
Yes	11 (73.3)	9 (56.3)		
No	4 (26.6)	7 (43.7)		
Smoking			1.155	0.561
Yes	4 (26.7)	3 (18.8)		
No	11 (73.3)	13 (81.2)		
Medication			0.059†	1.000
Oral agents	5 (33.3)	6 (37.5)		
Insulin	0 (0.0)	0 (0.0)		
None	10 (66.7)	10 (62.5)		
Fasting blood glucose (mg/dl)	145.3 ± 26.5	145.9 ± 21.7	–0.273	0.787
Glycosylated hemoglobin (%)	7.7 ± 1.1	7.8 ± 1.4	–0.268	0.791
Diabetes care knowledge	14.1 ± 2.7	12.8 ± 4.6	1.209	0.237
Diabetes care behavior	46.4 ± 14.2	45.1 ± 11.3	0.291	0.773

†Fisher's Exact test. The data are the mean ± SD values or N (%) values.

Table 2. Changes in the diabetes care knowledge, diabetes care behavior, fasting blood glucose (FBG) level, and glycosylated hemoglobin (HbA1c) percentage in the Web and lecture groups from the baseline (T0) to the 6 week (T1) and 3 month (T2) follow-up sessions

Characteristic	Group	T0	T1	T2	Comparison	*F*	*P*-value
Diabetes care knowledge	Web ($n = 15$)	14.1 ± 2.7	18.4 ± 2.0	18.4 ± 1.7	Group	8.920	0.006
					Time	18.244	0.001
	Lecture ($n = 16$)	12.8 ± 4.6	15.8 ± 3.7	14.6 ± 3.5	Group × time	2.682	0.112
Diabetes care behavior	Web ($n = 15$)	46.4 ± 14.2	57.7 ± 10.8	62.4 ± 9.1	Group	2.652	0.114
					Time	24.913	0.001
	Lecture ($n = 16$)	45.1 ± 11.3	53.6 ± 7.5	53.3 ± 8.3	Group × time	2.599	0.118
FBG (mg/dl)	Web ($n = 15$)	145.3 ± 26.4	132.4 ± 24.0	131.3 ± 25.4	Group	0.051	0.823
					Time	4.028	0.054
	Lecture ($n = 16$)	145.8 ± 21.6	132.3 ± 27.2	136.0 ± 21.3	Group × time	0.096	0.759
HbA1c (%)	Web ($n = 15$)	7.6 ± 1.1	6.8 ± 0.8	6.8 ± 0.7	Group	1.511	0.229
					Time	14.524	0.001
	Lecture ($n = 16$)	7.7 ± 1.3	7.5 ± 1.4	7.3 ± 1.1	Group × time	1.303	0.263

Data are the mean ± SD values.

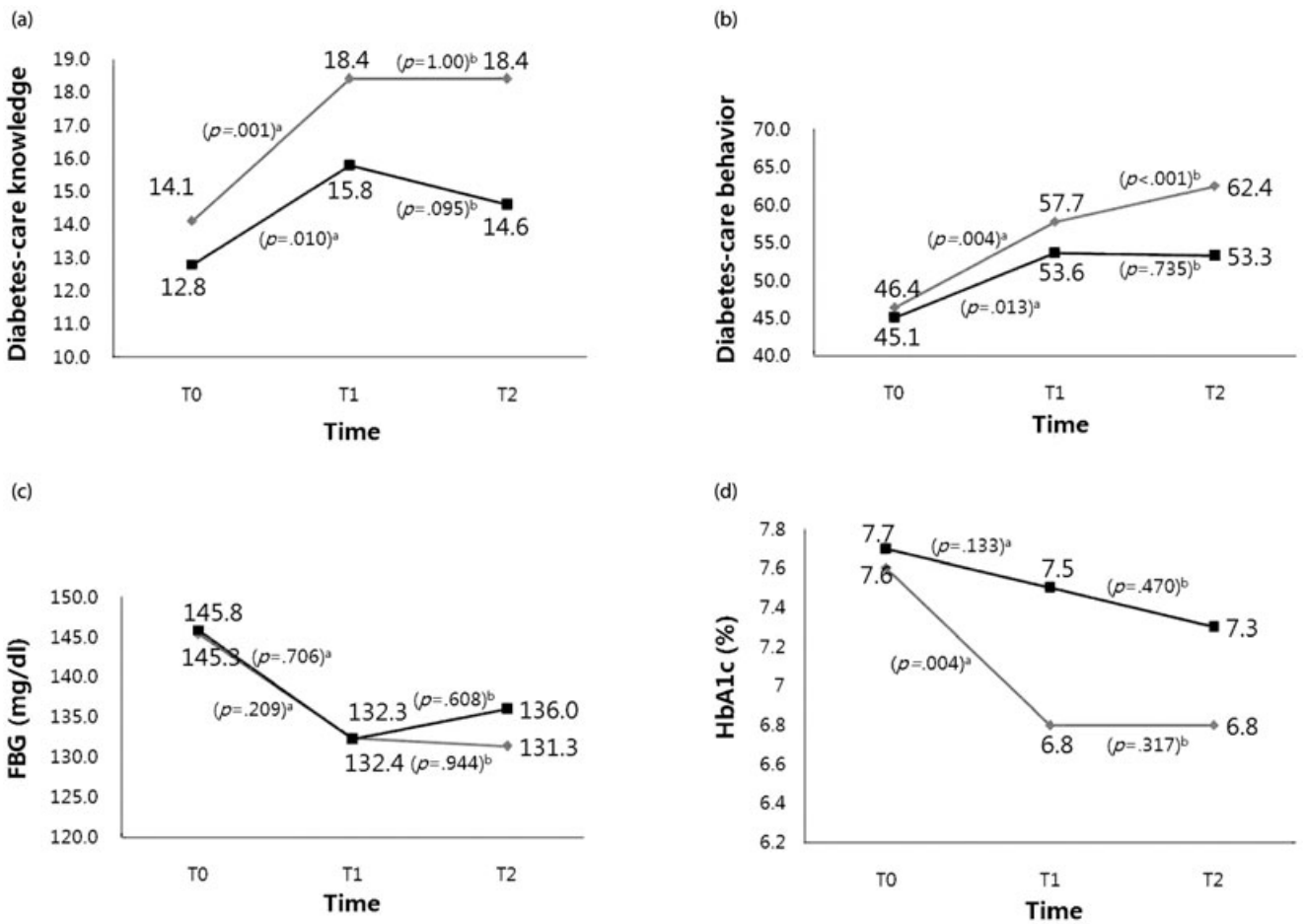

Figure 1. Changes in the outcome measures from the baseline (T0) to the 6 week (T1) and 3 month (T2) follow-up sessions in the Web ($n = 15$) (◆) and lecture ($n = 16$) (■) groups: (a) diabetes care knowledge, (b) diabetes care behavior, (c) fasting blood glucose (FBG) level, and (d) glycosylated hemoglobin (HbA1c) percentage. [a], T0–T1; [b], T1–T2.

between T0 and T1 ($P = 0.706$) and between T1 and T2 ($P = 0.608$) in the lecture group (Fig. 1c).

Changes in the glycosylated hemoglobin of the Web and lecture groups

The HbA1c percentages did not differ significantly between the groups at T0 ($P = 0.791$) (Table 1), but they did differ significantly over time ($P = 0.001$) (Table 2). The paired *t*-tests showed significant differences in the HbA1c percentages between T0 and T1 ($P = 0.004$), but not between T1 and T2 ($P = 0.317$), in the Web group and no differences between T0 and T1 ($P = 0.133$) and between T1 and T2 ($P = 0.470$) in the lecture group (Fig. 1d).

DISCUSSION

This quasi-experimental study evaluated Web-based education as an alternative to group lectures for diabetes self-management. The benefits of Web-based education include its easy access, without limitations in time and place, for those who have Internet access. The Internet is already utilized as a source of health-related information, especially by patients with chronic illness and diabetes (Millard & Fintak, 2002). The long-term self-management of diabetes as a chronic disease is very important (Sabate, 2003). Patients with diabetes need to change their lifestyles and, equally importantly, adhere to the regimen over their lifetime. They often perform well immediately after receiving education, but then subsequently fall back after a short time if they are not given booster education.

In this study, the effects of Web-based diabetes self-management education and group lecture education were compared using the outcome variables of diabetes care knowledge, diabetes care behavior, and physiological control. The knowledge of diabetes care improved significantly in both groups from the baseline to 6 weeks but not from 6 weeks to 3 months, indicating that both Web-based education and group lectures are effective in initial knowledge improvement. This result is similar to the result of the large randomized trial by Lorig *et al.* (2006). They compared the effects of a small-group self-management program and a Web-based self-management program on the health behavior of 780 people with chronic disease (62% with diabetes) and found the Web-based program was as effective as the small-group self-management program.

The diabetes care behavior improved significantly in both groups from the baseline to 6 weeks, but only in the Web group from 6 weeks to 3 months. This is probably related to the participants in the Web group visiting the website multiple times during this period to find answers to their questions, stimulating diabetes care behavior, and receiving peer support. We designed our Web-based education program to facilitate peer support because social support was found to be the most important factor in the adherence of behaviors (Sabate, 2003). We did not measure the number of times that the participants used the website, but all of the patients contributed in the community section.

The FBG levels did not change significantly between any time periods, which might be related to the mean baseline FBG (145 mg/dl) not being very high. The HbA1c percentages improved significantly from the baseline to 6 weeks only in the Web group, and subsequently remained low. The HbA1c percentages did not differ significantly between the baseline and 6 weeks or between 6 weeks and 3 months in the lecture group. Most studies on diabetes education have purposely sampled participants with poorly controlled HbA1c (Sarkisian *et al.*, 2003; McMahon *et al.*, 2005) when testing the effects of interventions, as the HbA1c was found to only change significantly in the participants with very poor glucose control at the baseline (Brown, 1999). Therefore, it is particularly meaningful that our participants showed significant changes even though their mean baseline HbA1c (7.6%) indicated fair glucose control.

The mean age of the participants in the Web group was 56 years, which is older than that in other studies of Web-based interventions in Korea. Our participants were instructed on the use of the Web-based program for 30 min and were given a user manual. They coped well with studying on the Web at home, with only a few questions being asked related to the use of the Web-based system during the study period (the mean number of questions per person from the baseline to 3 months was 4.2). This observation suggests that providing Web-based diabetes education to older adults will be possible in the future as the population ages.

In contrast to most Web-based glycemic intervention studies (Kim & Kim, 2004; Kim, 2007; Kim & Song, 2008), in the present study each participant was not contacted every day unless they specifically requested this to be done. The nurse in charge replied to the questions asked on the Web-based system once daily, which is a realistic approach for medical personnel wanting to run a Web-based program while they continue to perform their normal job responsibilities.

The study was subject to some limitations, such as high dropout rates and the use of non-randomization. Moreover, the results were measured for only 3 months; thus, a longer observation period would better represent the long-term effects of the intervention. The high dropout rates in both groups limit the ability to interpret the results. In a classical laboratory setting, the participants often feel compelled to stay and finish an experiment, whereas the participants in online education easily can leave a session at any time (Frick *et al.*, 2001). Many online participants would drop out of a class because of the requirements of work and/or family life in general and they could benefit more from a class if they take it when they have sufficient time to apply themselves to the class work. Furthermore, we do not consider high dropout rates as implicit evidence that online education is inferior to traditional education (Diaz, 2002). There could be many reasons why some participants remain and others drop out of an online class, such as general characteristics (i.e. demographics), the quality of the class, socioeconomic factors, or even the characteristics of the chronic disease itself. Gibson (1998) attributed the attrition in distance courses to student, situational, and educational system factors. Ultimately, until it is understood why participants drop out of courses, we should not discredit online education as a viable alternative means

of instructional delivery (Diaz, 2002). Meanwhile, future research should consider the above factors and a replication study with a larger sample should be carried out to confirm the results of the present study.

The use of non-randomization also needs to be considered. The purpose of the present study, which had a non-equivalent control group, pretest-post-test design, was to determine the effectiveness of replacing group lecture education for participants who are motivated and can attend lectures with Web-based programs, which are less costly and require less time from health-care professionals. We postulate that, even though the use of non-randomization could limit the generalizability of the results, this is offset by the absence of statistically significant differences in the general characteristics between the two groups and the use of a quasi-experimental design. Sometimes, a quasi-experimental study is more feasible and practical than a purely experimental study, especially when education is the intervention (Lee *et al.*, 1998). For the present study, the ability to use the Internet was one requirement for inclusion in the experimental group, which prevented the random assignment of the participants in this study. A future study that is designed with randomized controlled trials could further test the differences in the effects between lecture-based and Web-based program education.

CONCLUSION

The results of this study indicate that a Web-based diabetes self-management education program has potential as an effective alternative to group lecture education for diabetes self-management, in terms of improving diabetes care knowledge, improving diabetes care behavior, and improving the physiological variables, HbA1c and FBG. The HbA1c percentages improved significantly from the baseline to 6 weeks in the Web group but not in the lecture group. Moreover, the diabetes care behavior improved continuously for 3 months in the Web group but not in the lecture group. The Web-based diabetes self-management program was more effective than the group lectures for glycemic control and adherence to the diabetes care behavior.

The study's results show the value of using a Web-based program as a substitute for group teaching for patients who have access to the Internet. However, as the potential benefit reported here applies only to a specific group of interested users on one outcome at a specific point in time, further research into the full use of the available technology is imperative for improving the quality of nursing intervention.

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REFERENCES

Barrera M Jr, Glasgow RE, McKay HG, Boles SM, Feil EG. Do Internet-based support interventions change perceptions of social support?: An experimental trial of approaches for supporting diabetes self-management. *Am. J. Community Psychol.* 2002; **30**: 637–654.

Brown SA. Interventions to promote diabetes self-management: State of the science. *Diabetes Educ.* 1999; **25**: 52–61.

Buhrman M, Faltenhag S, Strom L, Andersson G. Controlled trial of Internet-based treatment with telephone support for chronic back pain. *Pain* 2004; **111**: 368–377.

Diaz D. *Online Drop Rates Revisited*. 2002. [Cited 25 Jan 2009.] Available from URL: http://ts.mivu.org/default.asp?show=article&id=1034.

Fitzgerald JT, Funnell MM, Hess GE *et al.* The reliability and validity of a brief diabetes knowledge test. *Diabetes Care* 1998; **21**: 706–710.

Frick A, Bächtiger MT, Reips UD. *Financial Incentives, Personal Information and Dropout Rate in Online Studies*. Lengerich, Germany: Pabst, 2001.

Gallant MP. The influence of social support on chronic illness self-management: a review and directions for research. *Health Educ. Behav.* 2003; **30**: 170–195.

Gibson CC. The distance learner's academic self-concept. In: Gibson CC (ed.). *Distance Learners in Higher Education: Institutional Responses for Quality Outcomes*. Madison, WI: Atwood, 1998; 65–76.

Gu MO. [The effect of a self regulation education program for the promotion and maintenance of self care behavior in chronically ill patients – for diabetic patients.] *J. Korean Acad. Nurs.* 1996; **26**: 413–427 (in Korean).

Kim H-S. Impact of Web-based nurses' education on glycosylated haemoglobin in type 2 diabetic patients. *J. Clin. Nurs.* 2007; **16**: 1361–1366.

Kim HS, Kim SI. [Effects of Internet-based diabetes education on plasma glucose and serum lipids in female type 2 diabetes patients.] *Korean J. Women's Health Nurs.* 2004; **10**: 311–317 (in Korean).

Kim HS, Song MS. Technological intervention for obese patients with type 2 diabetes. *Appl. Nurs. Res.* 2008; **21**: 84–89.

Korea National Statistical Office. [*Mortality Statistics in Korea*.] Daejun, Korea: National Statistical Office, 2006 (in Korean).

Krishna S, Francisco BD, Balas EA, Konig P, Graff GR, Madsen RW. Internet-enabled interactive multimedia asthma education program: A randomized trial. *Pediatrics* 2003; **111**: 503–510.

Kubiak T, Hermanns N, Schreckling HJ, Kulzer B, Haak T. Evaluation of a self-management-based patient education program for the treatment and prevention of hypoglycemia-related problems in type 1 diabetes. *Patient Educ. Counsel.* 2006; **60**: 228–234.

Lee EO, Im NY, Park HA. [*Research and Statistical Analysis in Nursing and Health*.] Seoul: Soomoonsa, 1998 (in Korean).

Lee SL, Kim YL, Lee SJ *et al.* [Effects of diabetes education on diabetic management in non-insulin-dependent diabetes mellitus patients.] *J. Korean Diet. Assoc.* 2004; **10**: 300–308 (in Korean).

Lorig KR, Ritter PL, Laurent DD, Plant K. Internet-based chronic disease self-management: a randomized trial. *Med. Care* 2006; **44**: 964–971.

Lorig KR, Ritter P, Stewart AL *et al.* Chronic disease self-management program: 2-year health status and health care utilization outcomes. *Med. Care* 2001; **39**: 1217–1223.

McMahon GT, Gomes HE, Hickson Hohne S, Hu TM, Levine BA, Conlin PR. Web-based care management in patients with poorly controlled diabetes. *Diabetes Care* 2005; **28**: 1624–1629.

Millard RW, Fintak PA. Use of the Internet by patients with chronic illness. *Dis. Manag. Health Out.* 2002; **10**: 187–194.

National Internet Development Agency. *2007 Internet Usage Report*. 2008. [Cited 24 Jan 2009.] Available from URL: http://isis.nida.or.kr/board/index.jsp?pageId=040100&bbsId=7&itemId=723.

Olson P. *In Pictures: The World's Hardest-working Countries*. 2008. [Cited 24 Jan 2009.] Available from URL: http://www.forbes.com/2008/05/21/labor-market-workforce-lead-citizen-cx_po_0521countries.html.

Sabate E. *Adherence to Long-term Therapies: Evidence for Action*. Geneva: World Health Organization, 2003.

Sarkisian CA, Brown AF, Norris KC, Wintz RL, Mangione CM. A systematic review of diabetes self-care interventions for older, African American, or Latino adults. *Diabetes Educ.* 2003; **29**: 467–479.

Tomky DM. Developing a computerized diabetes self-management education module for documenting outcomes. *Diabetes Educ.* 1999; **25**: 197–210.

Westlake C, Evangelista LS, Stromberg A, Ter-Galstanyan A, Vazirani S, Dracup K. Evaluation of a Web-based education and counseling pilot program for older heart failure patients. *Prog. Cardiovasc. Nurs.* 2007; **22**: 20–26.