Development and Evaluation of a Health Education System Based on the Transtheoretical Model

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Abstract With rapid advances in IT, online systems are playing a major role in the expansion of health-related information management and education. In the field of health education, face-to-face interventions are still the mainstay in Japan, with online systems playing only a very minor role in providing people with health information. We have developed “Caring for your eyes”, a health education system based on the transtheoretical model of behaviour change to further extend the reach of health education. The intervention targeted eye strain in office workers who use visual display terminals. Subjects were divided into one group using our system and another group using printed educational material, and the effectiveness of these two approaches was compared. The results confirmed that our education system was more effective in getting office workers to establish habits for alleviating eye strain. Keywords: health education, eye strain, transtheoretical model, behaviour change

1. Introduction

As Japan’s population continues to age and lifestyle diseases become more prevalent, there is a growing need to promote the nation’s health. This was the central priority of the Health Promotion Act of 2003(1), which emphasized the need for creating environments more conducive to health, starting with a range of health programs.

Against this background, developments in IT are enabling the on-line migration of management of health-related information, such as weight and blood pressure(2). IT-based health-support systems have also been developed(3), and validation of their effectiveness is underway in Japan, taking the lead from intervention studies in the US and Europe from the latter half of the 1990s.

These health support programs have mainly been implemented to improve lifestyle habits such as those associated with obesity(4), and they primarily use text-based materials to deliver knowledge-based instruction, only utilizing a fraction of the rich possibilities IT has to offer. These systems are also mostly used to support face-to-face exercise programs.

Implementing a health support program includes a number of problems. (i) Some people will refuse to participate right from the start, whether in a face-to-face program or otherwise; typically a certain proportion of dropouts can also be expected. (ii) Teaching content is standardized, and not readily adaptable to the different characteristics and lifestyles of individual participants. Hence, there is a need to create health support programs that adapt to the needs of participants.

2. Office Workers as the Target Population

In a Cabinet Office survey by the Japanese Government(5), the main reason people gave for not participating in exercise-based health support of the type mentioned above was “I don’t have any time because I’m too busy at work”, suggesting that working people in particular could benefit from intervention. The intervention used in this study aimed to overcome problem (i), and initially targeted office workers, who make up 35% of all workers in Japan(6).

To overcome problem (ii), we adopted the method of classifying workers by workplace, and used a preliminary survey of health problems at different types of workplaces to identify health-related needs for inclusion as the subject matter of the program. We also intended to create a program that took into account the environment at a single workplace, based on observation of the nature of the work done at that location.
3. Transtheoretical Model

We developed a health education system incorporating Prochaska’s transtheoretical model (TTM) of behaviour change in order to lower the barriers to participation and enable suitable support for participants as they continued. TTM is the main method in the field of health support and it focuses on an individual’s readiness to act on new healthier behaviour and on how people modify problem behaviour or acquire positive behaviour.

TTM consists of four central constructs: “stages of change,” “processes of change,” “decisional balance,” and “self-efficacy.” The stage construct is the main construct of this model and it divides human behavioural change into the following five stages.

- Precontemplation (PC): There is no intention to take action towards changing behaviour within the next 6 months.
- Contemplation (C): There is an intention to take action towards changing behaviour within the next 6 months.
- Preparation (PR): There is an intention to take action towards changing behaviour within the next 1 month.
- Action (A): There is a clear change in behaviour, but it has lasted for less than 6 months.
- Maintenance (M): There has been a clear change in behaviour lasting more than 6 months.

Prochaska and co-workers define the Processes of Change as “the covert and overt activities that people use to progress through the stages.” Ten processes have received the most empirical support in research to date. The first five are classified as Experiential Processes and are used mainly for the early stage transitions. The last five are classified Behavioral Processes and are used mainly for later stage transitions. Participants use the techniques associated with a particular stage to progress to the next stage (Figure 1).

“Self-efficacy” is the situation-specific confidence people have that they can cope with high risk situations without returning to their old habits. Generally, self-efficacy increases as a stage shifts.

The Decisional Balance construct reflects the individual’s relative weighing of the pros (benefits) and cons (costs) of changing. Generally, unlike early stage participants, later stage participants perceive benefits strongly, and perceive costs weakly.

4. Visual Display Terminal Syndrome as the Condition of Interest

Visual display terminal (VDT) syndrome is a major health issue causing a variety of diseases of the eye and muscle pain from using computers or watching television regularly for long hours. Physical symptoms, such as eye strain resulting from VDT work, have potentially harmful effects on health, and these problems are set to increase with the growing numbers of office workers engaged in long periods of VDT work, as evidenced by the growing number of case reports of eye disorders in such workers. In 2002, the Ministry of Health, Labour and Welfare in Japan established “New Guidelines for Occupational Health Management in VDT Work,” calling for the protection of workers using VDTs, but these guidelines are not being adequately implemented in the workplace.

When we surveyed company A, an education-relat-
ed company, about its health-related needs as part of this study, we discovered that the company had been commissioned to create teaching materials to counteract eye pain and dryness and muscle stiffness resulting from long periods of computer use. TTM focuses primarily on changing participant’s behaviour and, therefore, is suitable for improving health problems such as lifestyle-related diseases by changing problem behaviour. We focused on VDT syndrome since it could be alleviated to some extent by changing lifestyle behaviour. We therefore decided to use this topic for our program.

Alleviation of eye strain has also been studied in a different approach using stereoscopic image systems(10).

5. Research Method

5.1 Overview

We developed the TTM-based health education system “Caring for your eyes”, uploaded it to the internet, and investigated its effectiveness in a 7-month intervention study. This study lasted for 7 months and it consisted of the preliminary questionnaire, using the system for 1 month in the intervention training, participants’ action or inaction (for 6 months) and finally a post-training (7 months after) questionnaire. This system was equipped with all the functions needed for intervention using the TTM such as automatic stage-matched instructions, a function to generate a scale of self-efficacy and decisional balance and an individual feedback function. In addition, the system had an accessory function of self-assessment to check participant’s behaviour. Participants enter onto the form a self-assessment score (from 1 to 5) of the act, including such items as frequency and duration.

Two types of message were fed back to participant individually. One was an automatic message according to the stage and cumulative score in self-assessment. The other was a message from the mentor who checked the progress and cumulative score. We assumed that participants changed their behaviour according to the instructions and the mentor’s advice.

The educational goal of the system was for users to learn and put into habitual practice, daily eye care techniques and methods for alleviating eye strain, with the overall goal of preventing serious eye-related disorders.

Office workers at education-related company A who worked at VDTs for prolonged periods were selected as the population for study, and a total of 28 workers (16 male, 12 female), including full- and part-time staff, volunteered to take part in the trial. For this study, we classified participants into 5 stages and measured self-efficacy based on the stages of change scale and self-efficacy scale and decisional balance scale used by Oka(11,12), who adapted the TTM to changes in exercise behaviour and proved the reliability and validity of the measure. Participants were divided into two groups of 14: a system-user group and printed material group given printed versions of the system’s teaching contents; the groups were compared based on the stage classification described above.

We prepared five kinds of printed material and distributed them among the participants after classification into groups. The printed material adopted a flowchart form which provided instructions such as “Please jump to page 8 if your total act time was within 10 minutes”, as a substitute for automatic stage-matched instructions. The instructions for the printed material group were the same as those for the system-user group and the two types of message described above were pre-described in the printed materials. The former group used the self-assessment form attached to the back of the printed material. Except for the mentor’s real-time check in the system-user group, there were no differences between the two sets of instructions. System-based instruction was supervised by a mentor involved in health behaviour change programs, whose daily task, for about 1 hour from 12 AM, was to check on participants’ use of the system and give message-based instruction.

Before and after intervention, both groups completed questionnaires, took a test on their knowledge about eyes, and kept a record of subjective symptoms. These data were used to measure the effectiveness of the intervention system. The post-training questionnaire after the intervention was administered seven months after the intervention.

5.2 Details of questionnaires

A preliminary questionnaire was used to ascertain participants’ circumstances and experience before intervention; sections covered (1) history of PC use and current situation regarding VDT work, (2) record of subjective symptoms of VDT syndrome, and (3) stage, self-efficacy and decisional balance of participant. The post-training questionnaire was used to investigate the effects
of introducing the system, and in addition to repeating sections (2) and (3) questions, it also covered sections (4) daily practice of teaching content (video content or print illustrations) and (5) evaluation of and suggestions for teaching materials.

The TTM stage for each participant was identified before and after the intervention by participants selection of the statement that applied to them from the following five statements, based on the stages-of-change scale described above: “I am not taking any action for my eye health, and don’t plan to do so in the future (pre-contemplation)”, “I am not taking any action for my eye health, but am thinking of starting in the near future (within 6 months) (contemplation)”, “I am taking action for my eye health, but it is not regular (preparation)”, “I have been regularly taking action for my eye health, but for under 6 months (action)”, “I have been regularly taking action for my eye health for more than 6 months (maintenance)”. In the statistical processing later, these stages were converted to ordinal scale (1/H11005PC, 5/H11005M).

The instructional method used to present participants with teaching content was adapted to suit these stages.

Self-efficacy was evaluated using 4-item questionnaire on a scale of 1 to 5, with 1 being ‘Not at all confident’, to 5 being ‘Completely confident’, with regard to how confident participants were to exercise when other things got in the way, which included; “Physical fatigue”; “No time to spare”; “Stress”; and “Inconvenient to access”. The self-efficacy score totalled the scores of these 4 items.

Decisional balance scale indicated how important each statement was with regard to a participant’s decision to exercise or not to exercise and used a 20-item questionnaire (10 items on benefits and 10 items on costs) on a scale of 1 to 5, with 1 being ‘Not Important’ to 5 being ‘Extremely Important’. Decisional balance score was the difference calculated by subtracting the total scores of costs from total scores of benefits.

Changes in subjective symptoms of eye strain were evaluated in line with “Study of Eye Strain Evaluation Methods”(13) published by the National Rosai Ophthalmology Project Team led by Nakamura. Each symptom was graded on a 5-step scale (very severe, severe, moderate, mild, no symptoms), and changes in symptoms before and after the intervention were evaluated as follows: improvement by two or more steps, or complete resolution=marked improvement; improvement by one step=improvement; no change=no change; deterioration by one step=deterioration; deterioration by two or more steps, or to most severe=marked deterioration.

In a confirmation test at the beginning of the intervention and again after 7 months, practical skills were assessed by a performance test in front of the mentor, and knowledge was evaluated by a written test. Scores for the performance test and written test were 50 points each, making a total of 100 points. We surveyed participants to determine how well they were able to practice the teaching content in daily life. Participants reported 100% positively that they had.

6. Design of System

6.1 Overview of learning objectives and design

The specific learning objective of this system was “to adopt the habits of looking at things as distant as possible, always keeping a suitable distance of 30 cm when looking at objects, and avoiding long periods of work with the eyes in a tensed state”. Since the main factor in symptoms associated with VDT is straining of the eye’s accommodative function through long periods of viewing close objects(14), alleviation of this strain was the focus of this system.

The flow chart of “Caring for your eyes” is given in Figure 2(a) and examples of screens are reproduced in Figures 2(b)~2(d). Participants entered their personal data, such as decisional balance and self-efficacy, before and after intervention (Figure 2(b)). This system for attaining the described targets consisted of a technique training section showing an exercise on video which was linked to a knowledge section; once a learning unit was completed the participant progressed to the next step.

Two message displays A and B were also set up; display A automatically presented a different message to participants in each stage. In the early stages, the behavioural processes were used, whereas the experiential processes were used in the late stages. In display B, the mentor presented messages to each individual after reflection on the self-assessment score and the progress of the participant.

The system was built from a combination of Flash, PHP and MySQL; stored data was displayed in batches on the administrator screen; and all in-site selections made by participants were displayed to the mentor. Each participant was provided with their own page requiring
ID and password to log in.

6.2 System flow

Upon log in, the individual’s information is identified and an automatic message is displayed, which changes with every log in. This is followed by a technique training message about a “Caring for your eyes” exercise linking alleviation of eye strain to recovery of accommodation function, strengthening of eye muscles, and other factors. The exercise is then taught. Before moving to the technique training screen, the participant is shown a personalized message from the mentor (Figure 2(c)). In the technique training section (Figure 2(d)), one lesson is completed after two viewings, after which the system moves on to the next lesson (a viewing to the end of the video counts as one viewing). An area at the bottom of the screen also shows the log in status of other users, giving information about the activity of fellow participants. In conjunction with video viewing, the knowledge learning section provides lessons giving a variety of facts and health information about the eyes. When the system recognizes that a video has been
viewed, a lesson is automatically added, and the new information is displayed to the participant. A total of 14 lessons were prepared, with the aim of getting the individuals not just to change their behaviour, but also their work environment and lifestyle habits. We also set up an anonymous electronic bulletin board system which, as well as showing the log in status of other participants, also offered the benefits of helping relationship.

7. Results

7.1 Characteristics of participants

Participants had a mean age of 37.4 years, a mean PC usage history of 10 years, a mean daily PC usage time of 5.7 hours, a mean daily mobile phone usage time of 0.94 hours, and 3.78 hours spent on other tasks; the overall daily mean time spent on tasks entailing eye strain was 10.43 hours.

7.2 Number of subjective symptoms, stage changes and confirmation test scores

The results of stage classification at the start and 7 months after intervention are shown in Table 1. A Wilcoxon signed-rank test applied to the number of people in each stage before and after intervention revealed a significant difference in the system-user group: $z=3.44$, $p<0.01$ (mean score before: 2.14; mean score after: 4.00). The intervention had a significant effect on the rate of progress through the stages in the system-user group compared to the printed-material group.

The results for subject symptoms before and after the intervention are shown in Table 2.

A Mann–Whitney $U$ test was applied to get the improvement factors of both groups. The system-user group showed a significant improvement compared to the printed material group in six categories: “eyes feel tired” ($p<0.014$), “dry eyes” ($p<0.008$), “red eyes” ($p<0.026$), “muscle stiffness” ($p<0.007$), “head feels heavy” ($p<0.029$), and “headache” ($p<0.023$).

Similarly, a Wilcoxon signed-rank test was applied to decisional balance, self-efficacy, and confirmation test scores (Figures 3–5).

The decisional balance scores revealed a significant difference in the system-user group: $z=3.30$, $p<0.001$ (mean score before: 8.36; mean score after: 1.07), the self-efficacy scores revealed a significant difference in the system-user group: $z=3.33$, $p<0.001$ (mean score before: 6.36; mean score after: 10.71), and confirmation test scores revealed a significant difference in the system-user group: $z=3.23$, $p<0.001$ (mean score before: 27; mean score after: 63.71)

7.3 Other results

All 14 participants in the system-user group regularly logged in for one month training and completed the post-training questionnaire. The mean total number of log in per person was 9.71, and the completion rate was 100% with no dropouts. The access records of all participants showed a marked focus of activity between the hours of 8 PM and 12 AM (peaking at 11 PM). Mean “daily practice of teaching content” was 63.57% in the system-user group and 25.35% in the printed-material group.

Finally, when interviewed about working hours and work details, the mentor who took part in this study responded that it was possible to give guidance to participants without delay simply by checking once a day for about 1 hour from 12 AM, but that the maximum number of people being supervised should be limited to 20.

Table 1. Stage Changes.

| Group       | Stage             | Number | Before | After |
|-------------|-------------------|--------|--------|-------|
| System-User | Precontemplation  | 3      | 0      |
|             | Contemplation     | 6      | 0      |
|             | Preparation       | 5      | 2      |
|             | Action            | 0      | 10     |
|             | Maintenance       | 0      | 2      |
|             | Wilcoxon signed-rank test | $p<0.01$ |
| Printed Material | Precontemplation   | 2      | 2      |
|             | Contemplation     | 7      | 4      |
|             | Preparation       | 5      | 7      |
|             | Action            | 0      | 1      |
|             | Maintenance       | 0      | 0      |
|             | Wilcoxon signed-rank test | n.s.  |
|             | Mann–Whitney $U$  | n.s.   | $p<0.01$ |
8. Discussion

After intervention, the system-user group showed a significant progress through the stages compared to the printed-material group, and no participants regressed. Decisional balance, self-efficacy, and confirmation tests scores before and after intervention, together with changes in number of subjective symptoms, further indicated that this system was more effective than printed material. The rate of increase in scores and the improvement rate in subject symptoms were considered to be influenced by whether the mentor’s feedback was in real-time or not because the instructions were the same. It was considered that quick feedback affected a participant’s morale. Hence, it appeared that message contents taking account of the factors of benefits and costs, and instruction using the transtheoretical model, were well suited to this type of health education system. “Caring for your eyes” based on the transtheoretical model was therefore considered to be effective.

9. Conclusions

The study results demonstrated the effectiveness of the transtheoretical model-based health system “Caring for your eyes".
for your eyes” in equipping office workers with the knowledge, techniques and habits needed to alleviate eye strain resulting from VDT work. There is good potential for the development of new health education systems using the same model by changing the content of videos, texts, and messages depending on the specific needs of each topic.

This transtheoretical model-based system could easily be adapted to educate participants in other health fields such as correction of posture and improvement of skin condition which could be alleviated to some extent by changing lifestyle behaviour.

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