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ELECTRONIC PDA DIETARY AND PHYSICAL ACTIVITY REGISTERS IN A WEIGHT LOSS TREATMENT PROGRAM FOR CHILDREN: A DESCRIPTION OF THE ETIOBE PERSONAL DIGITAL ASSISTANT SYSTEM

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Childhood obesity is a significant health problem in western societies. Self-monitoring techniques, such as the use of dietary and physical activity registers, are considered to be central to cognitive-behavioral weight control programs. Traditionally, these conventional diaries have been created using pen and paper, however, this technique has several limitations. The objective of this paper is to describe an electronic Personal Digital Assistant (PDA) system for recording food and physical activity for the treatment of childhood obesity. The authors review the benefits and limitations of such electronic diaries.

Keywords: Personal Digital Assistant, Ecological Momentary Assessment, Obesity, Self-report, E-Health

Introduction

Children suffering from weight-control issues and obesity are increasingly common public health problems, and are the most common childhood disorders in Europe (European Association for the Study of Obesity, EASO; 2002.) According to a report from the International Obesity Task Force (IOTF) published in March 2005, this problem is rapidly worsening in some European countries, particularly in recent years. The treatment of childhood obesity must be multidisciplinary, taking both medical and psychological factors into account. As for psychological interventions, Cognitive-Behavioral Treatments (CBT) are currently considered the treatment of choice (Gilles et al. 2008.) CBT programs for obesity are based on the theory that instead of forcing a patient to follow a diet forever–a therapeutic target that is very difficult to achieve–it is more effective to attempt to change the user's habits, such as learning how to achieve balance in consumption. To this end, CBT programs designed to treat obesity include components designed to promote changes in behavioral, cognitive and emotional patterns that contribute to obesity (Sarwer, Foster, & Wadden, 2004.) These programs focus on modifying patients' eating habits and physical activity levels (Wilson & Brownell, 2002.) The guidelines that have proven to be the most useful from this point of view are the following–the use of self-register for self-evaluation and self-control (recording information about eating and physical activity), stimulus control, psychoeducation, cognitive techniques for changing thoughts and dysfunctional attitudes, interpersonal relationships and relapse prevention.

Self-register techniques are considered necessary for both assessment and treatment phases. The goal is to evaluate behaviors in a natural setting such as home or school. The patient is given a paper which explains the behavior to be recorded and the conditions under which it must be done. It is important that the behavior is recorded immediately, in order to minimize memory bias (Beasley, Riley, Davis & Singh, 2008.) The information obtained allows the clinic to identify the behavior cues and the thoughts and emotions associated with the behavior. A more accurate evaluation can therefore be made, and the treatment effects and the patient's evolution can be assessed.

For obesity, the most important targets to be self-monitored are: information about diet and physical activity. As assessment tool, a fundamental benefit of diary methods is that they permit the ex-

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amination of events and experiences in their natural, spontaneous contexts (Solhan & Trull, 2007); furthermore they allow patients to see the positive changes they are making, and to observe their progress..

As a therapeutic technique, self-monitoring is central to CBT weight control programs; some authors (Boutelle & Kirschenbaum, 1998) believe it to be the most effective technique for helping people lose weight and maintain a healthy weight (Perri, Nezu, & Viegener, 1993.) The use of diaries promotes self-awareness, thus increasing the capacity for self-control and self-regulation and enhancing patient motivation and readiness for change. Cooper, Fairburn & Hawker (2003) noted several useful functions of the self-register technique in weight loss treatments; for example, it helps patients make positive change by increasing their awareness of their behavior, enhances control over eating, helps them identify which behavior and patterns of thinking need to be addressed, and helps the therapist and patient examine patients' behavior, thoughts and emotions as well as cues that elicit the behaviors (Wilson & Vitousek, 1999.)

The frequency of dietary self-monitoring during weight loss treatments is a reliable predictor of success (Streit, Stevens, Stevens & Rossner, 1991.) Data suggest that adult subjects lose more weight during the weeks when they self-monitor (Helsel, Jakicic & Otto, 2007.) In a weight loss treatment for children, Kirschenbaum, Germann and Rich (2005) found no differences between low and high self-monitoring groups during the treatment; however, they found significant differences in weight change over three and six months of treatment.

Traditionally, the use of these conventional dietary and physical activity registers have been created using pen and paper; however, they have several limitations including the inconvenience, and the difficulties to record information in real time (Burke et al, 2008.) Another important limitation is poor rates of adherence to the treatment (Baker & Kirschenbaum, 1993; Germann, Kirschenbaum, & Rich, 2007), which worsen over time (Burke et al, 2005.)

It is necessary to design more efficient methods to simplify the process of self-monitoring and to improve the consistency and completeness of self-reports (Helsel, Jakicic & Otto, 2007.) Information and Communication Technologies (ICT) can help achieve this goal. In recent years, new mobile technologies such as personal digital assistants (PDAs) and mobile phones have become more readily available, thus generating new interest in developing systems adapted for these tools.

Research has indicated that the use of a PDA improves dietary self-monitoring frequency (Stone, Shiffman, Schwartz, Broderick & Hufford, 2002; Yon, Johnson, Harvey-Berino, Gold & Howard, 2007; Lee & Bakken, 2007.) Research also shows that electronic diaries improve adherence to treatments (Beasley et al. (2008) and levels of acceptability (Fowles & Gentry, 2008) over paper diary systems. Another benefit of electronic registers for dietary information is that nutritional feedback can be provided to the user in real time and can be compared with daily targets for these values; this helps shape dietary behavior (Beasley, Riley & Jean-Mary, 2005), provides a direct measure of compliance (Bolger et al, 2003), and improves responsiveness to users' questions. Thus, the system can adapt to the real time characteristics of the time, location and mood of the user.

In order to adapt electronic diaries for weight loss treatments for children, certain factors need to be considered. For example, the language and the interface must be adapted for children in order to ensure good usability of the system; additionally, a reinforcement system must be used. The objective of this paper is to describe a PDA application of an electronic diet and physical activity register. This electronic dietary assistant is one component of a larger e-health platform called ETIOBE that was developed as a weight loss treatment for children. The ETIOBE platform is an intelligent e-therapy system (eTI) for the treatment of obesity; its objective is to improve treatment adherence and promote the mechanisms of self-control in patients, to obtain the maintenance of achievements (reduced body weight) and to prevent relapses through establishing healthy habits.

The "intelligent" aspect of ETIOBE includes sensors that allow the clinician to obtain relevant information about the patient (contextual, physiological and psychological.) The system also includes various communication and information applications for transferring, managing, and storing such information and for interpreting and reacting to it. Furthermore, the applications can be personalized and adapted in accordance with the patient's answers and characteristics. Technically, ETIOBE comprises three different applications. Clinical support system (CSS) is an Internet tool that allows the clinician to design an adapted guidelines intervention, with the ability to adapt it according to the patient's progress. This platform is connected to the other platforms, which allows the clinician to be aware of the patient's progress in real time. Home support system (HSS) is a website where the child finds the tasks the clinician has selected (including self-reports, dietary registers, and physical activity registers.) The website also features a nutritional and healthy lifestyle knowledge component, with the support of several "serious games" which help the children absorb the information. Mobile support system (MSS) is comprised of a dietary and physical activity self-register based on PDA technology, sensorization and physiological information recruitment that is connected in real time to the CSS. The objective of this paper is to describe this electronic self-monitoring application.

ETIOBE Personal Digital Assistant System for Registering Dietary and Physical Activity Information

Because the application will run on PDAs using the Windows Mobile operating system, it was developed using .net technology based on Compact Framework 3.5 for mobile devices. The Microsoft .NET Compact Framework (.NET CF) is a version of the .NET Framework that is designed to run on Windows CE-based mobile/embedded devices such as PDAs, mobile phones, factory controllers, set-top boxes, etc. The .NET Compact Framework uses some of the same class libraries as the full .NET Framework as well as a few libraries designed specifically for mobile devices such as Windows CE InputPanel. However, the libraries are not exact copies of the .NET Framework. The ones in the .NET Compact Framework are scaled down to use less memory. The Microsoft .NET Compact Framework 3.5 Redistributable contains the common language runtime and class libraries built for the .NET Compact Framework. In addition to version 3.5 support, it also supports applications developed for version 1.0 and 2.0.

The .NET Compact Framework supports various programming languages such as C#, visual Basic.NET, and C++. Our application was written in C#.

Figure 1. Main screen.

Figure 2. Login screen.

This application allows the patient to enter personal information into the system. In this version the patient can create two types of registers, for diet and activity.

The application starts automatically when the PDA is turned on; this increases ease of use for children. First, the main screen appears, which includes the logo of the ETIOBE system and a button with the tag "self-records" (Figure 1.) The application always remains open; therefore, if the PDA is set to "standby/energy saver" mode, the main screen with the ETIOBE logo automatically appears when the active mode is resumed.

When users want to fill in a record, they must press the "self-records" button. The login screen then appears, and after completing login the user presses the exit button and returns to the main screen of the application (Figure 2.)

Dietary Register (see Figure 3)

- **Screen A:** The date and the time when food was ingested is entered in this screen. By default, the current time is entered, but can be modified.
- **Screen B:** Food eaten by the user is entered in this screen. For each type of food eaten, the amount (a piece, a glass, a dish, etc.) and order should be entered. All of this information is stored in a table, in which each row shows the type of food ingested (with the amount and order.) Thus, in the same self-record entry, patients can enter more than one food eaten; for example, the first row could be a dish of pasta and second row could be an apple. It is possible to add and delete rows as needed.
- **Screen C:** The social situation at the time of ingestion is selected in this screen. The different possibilities are presented as images accompanied by a short title. There are three possible situations: alone, with friends, and with parents.
- **Screen D:** In this screen The place where the user ate the meal is selected in this screen. As in the previous screen, the choices are presented as images with a short title identifying each. In this case there are five possibilities: home, kiosk, bakery, bar, and school.
- **Screen E:** The event preceding the meal or snack, and the user's thoughts prior to ingestion are entered in this screen. These two elements are entered as text.
- **Screen F:** The emotion experienced by the user prior to eating is selected in this screen. The different choices are presented as images accompanied by a short title. The five choices are: happy, angry, greedy, sad, and calm.

After entering the data, a message indicating that everything has been stored correctly is shown; if there is any problem, a message indicating the mistake appears. Next, a screen with a virtual agent or avatar appears with a message of encouragement. (The avatar is configured by the user using a different application, called Home Support System.) Finally the login screen again appears so that the user can fill out a new self-record or close the application.

Figure 3. Food dietary screens.

Physical Activity Register (see Figure 4)
- Screen A: This screen is the same as in the case of the dietary self-record. It contains the date and time when the activity occurred. By default, the current time is entered, but can be modified.
- Screen B: The activity completed and its duration are entered in this screen. The activity is entered as text and the time can be increased in increments of five minutes.

As in the dietary self-record, after entering the data a message indicating that everything has been stored correctly is shown; if there is any problem, a message indicating the mistake appears. Next, a screen with a virtual agent or avatar appears with a message of encouragement. Finally the login screen again appears so that the user can fill out a new self-record or close the application.

Screen A Screen B

Figure 4. Physical activity.

Discussion

This paper describes a PDA system designed for registering Dietary and Physical Activity information for the treatment of childhood obesity; it is an important component of the ETIOBE system. The use of self-records is fundamental in evaluating and treating obesity. However, traditional self-recording systems have significant limitations. Situational constraints, lapses of motivation and memory can result in missing reports in diary protocols (Piasecki, Hufford, Solhan & Trull, 2007.) The use of electronic PDA diaries offer important advantages and may enhance weigh loss treatments and assessment of nutrition and physical activity habits in children. They are portable and can be easily carried by participants, allowing for immediate entry of food intake; this aspect is critical for children who need to have higher levels of activity. Furthermore, the system is flexible and can be adapted to the specific conditions of each particular user. Additionally, such programs enable direct communication between therapists and patients through the internet, which facilitates real time monitoring. Moreover, the date and time of the self-record is accessible at all times, which offers therapists current information on the nutritional or lifestyle habits and progress of patients.

Another important benefit of the PDA system is that researchers can set an alarm within the PDA to remind participants that they should record their food intake. Alarms could reduce measurement errors that could occur when recording food intake at the end of a day. This alarm system can also alert the clinician if patients drastically reduce the number of their registers. It can be added an encouragement message system when the registering is correctly done. The software can give feedback to the patient if daily objectives have been met or not met.

Another advantage is that child participants may enjoy using a PDA to record dietary information, and may thus be more likely to keep accurate dietary records. Although the use of new technologies can be a barrier for older populations, the opposite is true for children and adolescents; the use of new technologies helps motivate them. Another advantage is that the digital information entered into the PDA system is easier for clinicians and researchers to share between different databases than information written manually. Furthermore, since participants enter their responses directly into the electronic diaries, there are fewer transcription errors and less missing data.

Like other methods, electronic diaries have both strengths and weaknesses. Bolger, Davis, and Rafaeli (2003) have pointed out several limitations. One is the high development cost of such programs. Furthermore, electronic devices require maintenance and may break or need replacement. Other minor but relevant problems are related to the mobile device design: usually the font sizes are small, visual contrast is not very sharp, and the battery power of the devices does not always suffice. Furthermore, these devices are best suited for simple responses, as entering open-ended responses is difficult. However, these technical limitations are expected to lessen greatly in coming years. Fortunately, as mobile devices increase in their capabilities, their size and cost decrease (Goodwin Velicer, & Intille, 2008.)

Further studies on the feasibility of using electronic diary in a broader range of specific populations are needed. However, as mobile technologies become ubiquitous, more robust, and less expensive, new software programs to meet the needs of the clinicians will be developed (Piasecki et al., 2007.) Electronic diaries using PDAs are likely to become routine tools in clinical psychology. As Bolger et al. (2003), pointed out, technological innovations are rapidly occurring, and in the near future we might have mobile devices able to "conduct ecologically valid research that would be minimally intrusive and maximally reflective of individuals' ongoing feelings, thoughts, goals, behaviors, and circumstances."

The next phase is to study such programs' usability, analyzing problems that can emerge in the use of the diary application by children without health problems. Researchers must identify problems and suggestions for improvement for electronic redesigned registers; this will require a controlled study comparing the efficiency of an electronic diary with the classical pen-and-paper version. This will necessitate an intra-subject design, wherein the group of children with weight problems will use both systems. Once the efficacy and efficiency compared to traditional modes has been analyzed, this component will be incorporated into childhood weight loss treatment programs, and the efficacy of two groups (using electronic and traditional systems) can be compared.

It is expected that electronic PDA diaries will improve the efficacy of self-recording techniques, improving their reliability and validity, as the users will register more data with greater accuracy and consistency. Furthermore the mobile electronic version will improve adherence to these tasks, rather than allowing users' motivation to deteriorate over time. Advantages of PDA recording systems are also anticipated to increase therapeutic efficiency in childhood weight loss programs.

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