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Assisting Support Groups of Patients with Chronic Diseases through Persuasive Computing

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Abstract: Obesity has become a serious health problem affecting millions of people around the world. Obese people have a higher risk to attain chronic diseases, a reduced quality of life, and higher risk of premature death. Persuasive technology and virtual communities can help address these problems by motivating patients to follow a healthier life style. This paper presents the Persuasive Health Network (pHealthNet), a pervasive virtual community designed to promote a healthy lifestyle in patients with chronic degenerative diseases that participated in a national program for the prevention of diseases, education and self-care. The development and deployment of the system supports the program's goal of persuading patients to change their eating habits and to increase their physical activity. The system was incorporated in the program of two self-support groups whose participants are monitored for a period of three months. The results of an *in situ* evaluation showed that participants increased their trust in themselves, adopted healthier eating and exercising habits and where more satisfied with the program that those who followed the traditional approach.

Keywords: Pervasive ecosystem, virtual community, persuasive tools, chronic diseases, SODHis, self-support groups
Categories: J.3, H.5.3

1 Introduction

The increased consumption of energy-dense foods high in saturated fats and sugars, and reduced physical activity are some of the main causes of increased obesity and malnutrition around the world [World 2009]. Mexico ranks 2nd as the country with more obese citizens [OECD 2005], where approximately half of the adult population is obese [Salud and INSP 2006]. To cope with this, the Instituto Mexicano del Seguro Social (IMSS) recently implemented PREVENIMSS, a national program for education and prevention of diseases caused by malnutrition and obesity. IMSS is the main public health organization in Mexico attending more than 50 million affiliates. PREVENIMSS aims at preventing chronic diseases by educating people about healthy lifestyle habits. The success of the program, however, has been constrained by the lack of continuous support once the patients complete the four-week basic program.

Virtual communities allow many individuals to collaborate and share experiences with people who are geographically distributed [Joon 2007]. In the medical area,

virtual communities have been successfully used in the care of patients [Jadad *et al.* 2006]. Their benefits include stress reduction, opportunistic access to information relevant to their disease, and increased communication between patients and physicians [Shelly *et al.* 2002].

Similarly, interactive systems have been designed to change users' attitudes and/or behaviors. This type of applications are called *Persuasive technologies [Fogg 1998]*. Persuasive computing seeks to influence a person to do things they didn't think they could do or simply didn't have the habit of doing. Its main objective is the design, investigation, and analysis of the interactive products that produce the change of attitudes or behaviours of people [Fogg 2008]. For instance, the UbiFit Garden system was designed to encourage regular physical activity. The system uses wearable sensors to detect and track people's physical activities and display them through an aesthetic image [Choudhury *et al.* 2008]. This image is presented to the user in the form of a flower garden. When the sensors detect a new physical activity, the appearance of the plants in the garden are improved by adding new elements, such as butterflies. If no physical activity from a user is detected the flowers in the garden might perish. Indeed, several persuasive prototypes have been developed to improve people quality of life by successfully motivating them to make positive decisions about their health [Consolvo *et al.* 2006; Consolvo *et al.* 2007; Consolvo *et al.* 2008].

Consequently, users while interacting with such systems operate within an ecology of people, physical artifacts and electronic systems [Odum 1996] –an ecology that has been enhanced with wearable computers, mobile and pervasive technologies that invade our everyday lives. This will facilitate a timely dialogue between data, tools, users and their social networks. In this paper by binding the ideas of persuasive technologies and virtual communities we propose the development of a persuasive virtual community. We define a *persuasive virtual community* as set of heterogeneous devices through which several stakeholders, including both users and software agents, communicate and collaborate through persuasive services. A persuasive virtual community aims at creating a harmonic environment between tools, technologies and people to ensure that the objective of persuasion is met with improved efficiency.

This idea is materialized in a virtual persuasive community called Persuasive Health Network (pHealthNet). Such solution was created to support the interaction and communication between specialists and patients as proposed by the PREVENIMSS program while persuading them to maintain good nutrition and physical activity habits. We argue that patients that use this solution would feel more motivated to keep working on their programs, since they get a feeling of being personally attended while benefiting from the support of a group.

The rest of the paper is organized as follows: In Section 2 we present the results of a field study conducted in a hospital to understand the PREVENIMSS program and its impact on patients' lifestyle. Section 3 presents the persuasive virtual community designed to support the PREVENIMSS program. In Section 4 we discuss the results of an evaluation conducted to assess the system's core characteristics and users' intention to use it. Section 5 presents how our work compares to that of others. Finally, in Section 6 we present our conclusions and directions for future work.

2 Understanding how the PREVENIMSS program promotes a healthy lifestyle

For three months, we conducted a field study at a public hospital in the city of Ensenada, Mexico. The study was conducted to understand how the PREVENIMSS program helps patients who have problems of obesity or chronic diseases to improve their eating and exercising habits. We identified the Control SODHi as the main area of opportunity for the deployment of persuasive technology. The Control SODHi attends patients with obesity problems to promote healthier habits. The SODHis work by organizing self-support sessions (one per week) where a group of specialist encourage patients to do physical activity and balance the consumption of food –the group of specialists include a physician, a physical trainer, a psychologist, a nutritionist and a social worker. After a fourth and final session, patients are encouraged to keep with their exercise and nutrition plans while assisting to a weekly appointment with specialists.

The study was conducted in three phases. In the first phase we studied how patients are canalized to the Control SODHi program and how it works. We conducted eight semi-structured interviews with the people involved in such process – two social workers, two nurses and four physicians. We also shadowed them for two complete work shifts. The second phase of our study included a set of passive observations of a couple of Control SODHis –including a total of eight sessions. Our observation helped us become involved with the groups and to identify our target informants. In addition, we conducted eight semi-structured interviews: three with the Control SODHi staff (including the nutritionist, psychologist and exercise trainer) and five with patients. For the final phase we evaluated patients' perception of the program. Additionally, we conducted thirty-two phone interviews with patients that had recently participated in the program. The patients interviewed were eight men and twenty four women with an average age of 44 years old. All patients interviewed have problems associated to being overweight and expressed interest in improving their lifestyle habits. The interviews were analyzed using a comparative verification of evidence resulted on the identification of major themes for each topic of inquiry.

2.1 Issues and opportunities for the deployment of persuasive technology and virtual communities

To exemplify the Control SODHi process here we present a scenario of a patient attending to the program.

> *Maria[1] is a 50 years old woman with diabetes and overweight problems. To help Maria improve her health, Dr. Perez (a physician) recommends her to join the self-support group: control SODHi. Maria decides to attend the group. In her first session she meets a group of specialists and a group of people with problems similar to hers. Maria meets with the group weekly and soon gets attached to Rita –a 48 years old woman with high level of cholesterol. During the sessions Maria and Rita support each other improving their dietary and exercise habits. They exchange tips, recipes*

[1] All names have been changed to protect the privacy of our informants.

and goals. After a couple of weeks Maria losses weight and her level of cholesterol improves. When the group sessions finish she is unable to maintain contact with Rita or others in the group. Gradually Maria stops exercising and her dietary habits deteriorate resulting in an increase of her weight and cholesterol level. Maria ends up in Dr. Perez office again.

Maria's case and others helped us to discover issues faced by patients and specialists in SODHi. We found three major issues that impact patients' motivation and their healthy habits after or during their participation in SODHi.

2.1.1 SODHi support groups disintegrate soon after the sessions end.

Attending four sessions is not sufficient to connect with a community hence the relational ties established among the staff of SODHi and patients falls apart soon after the sessions have finished. This lack of communication among patients and specialists once the group meetings have finished does not help to create a long-lasting support group among staff and patients. A patient made this clear during an interview: *"Four sessions is a short period of time … and now that I'm motivated the sessions are over"*. As a consequence, patients might loose motivation and eventually they may abandon their diet and exercise plans. In addition, the limited amount of time that patients spend in the program, constrain their ability to seamlessly integrate the newly acquired habits into their routines; as a result, those patients who during the sessions were motivated lost interest a few months afterwards.

2.1.2 SODHi demands physical presence

SODHi meetings are held at the hospital and most of the patients found it difficult to attend to the weekly support session. An informant made the following comment during an interview: "*Sometimes I can't keep my appointments because I live far from the hospital and when I miss them I usually gain weight"*. Furthermore, missing one session impacts the social ties established with other members of the SODHi and limits the access to relevant information required to keep track of a patient's progress.

2.1.3 SODHi provides limited access to relevant information

During the sessions, patients watch informative videos, listen to talks given by specialists and receive informative leaflets. They, also, may exchange their personal experiences when following the diet and exercise plan throughout the week and share information such as tasty and healthy recipes or effective exercise plans. When the sessions are completed or patients miss a session this information exchanges stops. When the program finishes patients no longer have access to information and also miss the opportunity to learn new ways to maintain a healthy lifestyle.

2.2 SODHi impact on patients' healthy habits

We asked 32 SODHi patients about their dietary and exercise habits during the group sessions and to what extent they still followed the recommendations. Figure 1 shows the results of this comparison. As shown, the number of patients that exercised and kept a diet was higher during the SODHi sessions than a few months afterwards. For instance, while 75% of the patients exercised during the period when the SODHi

sessions were conducted, only 41% continued to do so –resulting in a decrease of 34%. Additionally, 46% of patients stopped dieting after SODHI. This could be partially explained by the fact that patients lost communication with specialists and other members of the group. For instance, during an interview a patient explained: "*I would like to attend again the group sessions or persuade my team members to meet again because it is [impossible] to continue just by myself*". Indeed, we found that the most relevant aspect motivating users is maintaining communication with specialists and others members of the group. We found that 87.5% of patients lost all contact with the specialists and 91% with other members of their group once they completed the four-week program.

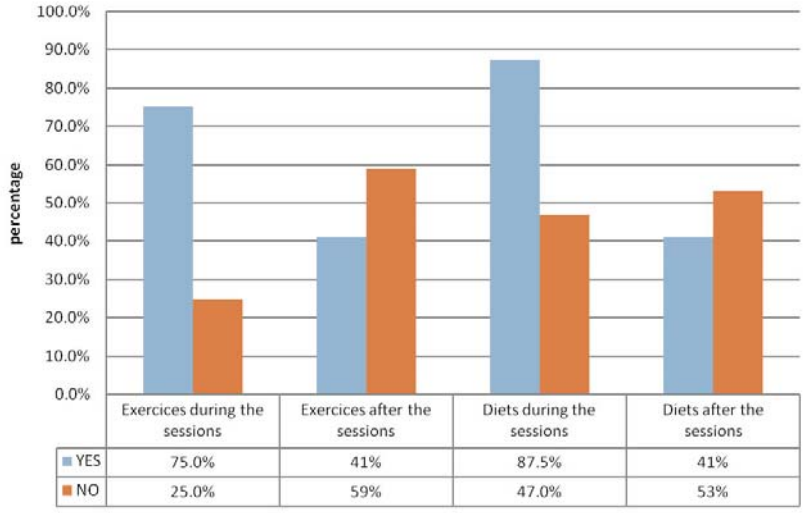

Figure 1: Percentage of patients exercising and dieting during and after Control SODHi sessions

Despite of this, we also found that patients agree that Control SODHi persuaded them to improve their health and their quality of life. 87.5% of the patients stated that they had achieved their goals by participating in the program, 91% of them considered that their quality of life had improved as a result of the program, and 94% of the patients interviewed considered the program to be effective in motivating them. It is interesting to note that the amount of people that evaluated Control SODHi as effective (94%) arguing that it allows them to achieve their goals (91%) and improve their quality of life (91%) also considered the time when they were attending to SODHi. In contrast with those who only considered the time they remained exercising (59%) and dieting (53%) after SODHi ended. In addition, we found out that after SODHi ended several patients acquired healthier eating habits. An informant made the following comment related to this: "*I do not longer 'do diet' because I learn how to eat healthy and now is how I eat*". Additionally, most of the patients, who sign up to control SODHi, do not complete the four-week program due to factors such as lack of time or the absence of specific goals for them to achieve.

These results highlight the need of mechanisms to help patients follow up on their program and keep in touch with group members and specialists without the need of having formal meetings for months, for which neither patients, nor the specialists have time. This motivated our design of a persuasive virtual community aimed at providing this support while continuously motivating the patients to maintain healthier habits.

3 pHealthNet: A pervasive virtual community for SODHi

We envision a persuasive virtual community to help SODHi staff and patients maintain their diet and exercise programs beyond the four-week sessions [Gasca *et al.* 2008]. The persuasive Health Network system (pHealthNet) uses two devices (i.e, a pedometer and a mobile phone) and a virtual persuasive web portal (Figure 2).

Figure 2: The Control SODHi (a) Maria receive a challenge notification in her mobile phone (b) Rita reviews Maria's goals through a timeline

The pHealthNet site allows users to maintain community attachment by adding friends, setting challenges between participants, helping users keep track of their nutritional and physical habits through a timeline, and giving users proper credit when performing healthy activities. The mobileHealthNet client allows users to maintain a connection with relevant events in the site through SMS messages, as well as, easily and quickly upload the amount of steps walked during the day. Altogether the services of the site and both devices form a persuasive virtual community helping users to monitor their lifestyle habits while keeping a record of them. To better explain our systems' functionality we present a scenario of a patient currently attending the program and using the system –this scenario revisits the one described in section 2.

> *Mr. Diaz, the social worker recommends Maria to use the pHealthNet site. She registers herself to the site and adds Rita as a friend. Rita adds an exercise goal to Maria, challenging her to complete 10000 steps a day for a*

week. While Maria is at work she receives in her mobile phone a message notifying her of the challenge. Maria logs in and accepts the challenge. When Maria arrives home she grabs her pedometer and walks off to the nearest park to exercise. At the park, she walks for an hour approximately completing 15000 steps. When she finishes her exercise she uses her mobile phone to upload the amount of steps just completed. After a couple of hours, Maria receives a message from the physical trainer congratulating her for the progress. When Rita is introducing her steps she consults Maria's timeline to assess her progress. She realizes that Maria has just crashed her record and creates herself a new goal of completing 20000 steps for the next day.

To provide this functionality the system uses a client-server architecture as a basis for its implementation. Connectivity between the server and the mobile phone is achieved through SOAP 1.1, WSDL 1.1 and HTTP 1.0/1.1. The mobile phone has a component that works in pair with its counterpart in the server to send and receive messages. The site is implemented on top of a web server with MySql, Apache and PHP. The system includes three main services as described next.

3.1 Supporting community attachment

The idea of this service is to provide users a set of tools that allow maintaining a social network and a connection with other members with similar problems and that have attended to SODHi. For instance, a patient commented: *"Having the support of somebody keeps me motivated and helps me to not feel [like I am the only one]…"*. Our system allows users to manage friends and specialists, as well as, send/receive email and SMS messages. Also, users may participate in collaborative games to persuade others to keep a healthy lifestyle, received encouraging messages, upload recipes, challenge friends and ask questions to specialists. For example, as shown in the scenario, the physical trainer sends Rita a message to congratulate her, with the aim of boosting her self-confidence.

3.2 Providing activity awareness

We identified three important types of activity awareness to provide: a patient's history of past behavior, his current status, and his level of activity performance. During an interview a patient commented: *"I would like to keep in touch with the people in my group, see them again and talk with them about our experiences or even evaluate their progress"*. Users can use control SODHi's timeline to consult the physical activities executed by them or others (see Figure 3). In addition, a meter activity in the form of a traffic light shows the level of physical activity users conducted and the level of participation on the site –red being worst and green being best. Moreover, depending on the traffic light color a persuasive message is shown to the user. This type of awareness might help users to improve their lifestyle habits. For instance, as shown in the scenario, when Rita challenges Maria resulting in an increase of the amount of steps walked by both.

3.3 Persuading a healthy commitment

The idea of this service is to allow patients to challenge friends about their dietary and exercise habits. A patient explained: *"By committing with myself and with my partners, being close to them and being consistent … our habits could improve"*. Our system allows users to challenge others by introducing goals such as the amount of steps to be taken for a period of time, a level of glucose or the amount of weight lost. For instance, as shown in the scenario, Rita challenged Maria to complete 10000 steps a day for a week. In addition, our system gives patients' proper credit for their activities. To maintain users motivated, pHealthNet recognizes patients' efforts by giving prizes to them in the form of electronic money called "SaluPesos". Patients can win money every time they introduce a healthy activity to the system. For instance, if they increase their amount of steps or complete a goal. These challenges are complemented with persuasive messages about eating or exercising habits. The system provides a set of tools that act as a social actor to persuade users' behavior. These tools include a set of predefined SMS messages that are sent to the mobile phone of the user to keep him motivated, to promote his commitment with the community, or to congratulate him. For instance, as shown in the scenario, when Maria received a message notifying her about the new challenge imposed by a member of her network.

4 Evaluation of pNetHealth

We evaluated pHealthNet core characteristics, participant's intention to use the system, their motivation, their lifestyle habits, as well as the impact of the system in the program.

4.1 Methodology

We deployed the system for a period of three months, with twelve participants of two SODHis as users –eight sessions in total (Figure 3). In the first group (Group A) a total of six participants used pHealthNet from June to August 2008, attending to SODHi the entire month of June but maintaining contact with the community through pHeatlhNet for the following months. In contrast, the second group (Group B) used pHealthNet from July to August 2008, attending SODHi during July and maintaining contact through pHealthNet for the following months.

The dynamics of each SODHi session was changed to incorporate pHealthNet. In each session an amount of time was set aside to allow patients to use the system and learn new features. The tools of pHealthNet were introduced in SODHi based on the type of commitment each promotes:

- *Individual commitment,* allowing a participant to interact with the site in an individual manner, by uploading recipes, steps, diet plans, comments and testimonies.
- *Community attachment*, allowing a participant to interact with his community by inviting friends, asking questions to specialists and sending or receiving messages to and from them –including SMS.

- *Lifestyle changes through persuasion*, persuading a participant to change their lifestyle habits by challenging each other, creating goals and using persuasive games.

Figure 3: Participants in a SODHi session using pHealthNet

For both groups in the first session, pHealthNet was introduced to each patient and they were given internet access and their userID to log into the system. All the participants of the SODHi were included in their social network. Though, it is interesting to note that the rest of the activities were introduced differently from one group to another. For Group A, individual tools were introduced in the first session, following from community ones (second session) and finally, those that promote persuasion (third session). In contrast for Group B, community tools were introduced in the first session, following from those tools that promote persuasion (second session) and finally, individual ones (third session). The session when the pedometer was given to participants also differs from one group to another. While the pedometer for Group A was given in the second session, for group B it was given in the first one. We made these changes since we noticed with Group A that the pedometer had an important motivating factor while giving participants a reason to log into the system everyday to register the number of steps they have walked. For both groups, in the fourth and final session, we conducted a focus group and a brainstorming session to gather feedback and capture their experiences with pHealthNet. We logged some of the user events specifying which features were used and at what time, throughout both evaluations.

4.2 Results

The results of our evaluation show an increased engagement of the patients with the program due to the use of the system while helping them to abide to their plans. In addition, patients viewed the application as useful, efficient, and generally appealing. pHealthNet was qualified by patients as the main motivator of the program. We also found that patients were persuaded by stages in accordance with the system's features that were revealed during the group sessions. For instance, at the beginning the use of the pedometer engaged the patients while at the end it was the shared challenges that motivated them. Here we present the results in detail.

4.2.1 Logs of computer behaviour and self-reported measures.

The use of the system has been rather heterogeneous due to patients' computing skills and computer access. All patients had a mobile phone; however, some of them didn't have internet access or even knew how to use a computer. For instance, in four weeks Maria published nine diets, twenty three recipes, two comments and one testimony. She registered nineteen times her footsteps and updated her weigh seven times. On the other hand, Carmen only published three recipes, one goal and registered fourteen times her footsteps during the same period. In contrast with Maria, Carmen didn't have access to a computer at home. However, she kept a paper-based journal of their activities and brought it along with recipes to the session to be assisted in recording the data. In total, patients recorded their footsteps seventy four times, added four comments, nine diets, twenty-seven recipes, ten goals, one question to the specialist, one testimony and updated their weight twelve times.

Table 1 shows the total of activities completed by participants using pHelathNet during and after SODHi. It is interesting to note that the amount of activities that involve collaboration decreased after SODHi while the individual activities increased –the amount of activities that involve collaboration decrease from 39.3 to 33 and the individual ones increased from 63.5 to 231. From this, one can infer that despite the fact that participants engaged with the site, a long lasting relationship among the team members of the SODHi wasn't created.

Activities	**Group A**		**Group B**		**Average**	
	During SODHi	***After SODHi***	***During SODHi***	***After SODHi***	***During SODHi***	***After SODHi***
Activities that involve collaboration	***34***	***30***	***45***	***36***	***39.5***	***33***
Friends	21	8	23	9	22	8.5
Steps goals	3	2	8	6	5.5	4
Other goals	2	2	6	8	4	5
Messages	7	14	6	10	6.5	12
Q&A to the specialist	0	4	0	3	0	3.5
Games challenges	1	0	2	0	1.5	0
Individual ctivities	***115***	***824***	***114***	***276***	***114.5***	***550***
Steps	44	147	67	240	55.5	193.5
Weight	7	20	0	0	3.5	10
Diets	9	55	0	0	4.5	27.5
Recipes	20	572	0	0	10	286
Comments	1	0	2	0	1.5	0
Testimonies	34	30	45	36	39.5	33

Table 1: total number of activities completed by participants using pHealthNet during and after SODHi

However, half of the individual activities that increase in their total amount after SODHi aimed at promoting collaboration –including recipes, comments and testimonies (this activities increased from 51 to 319). In relation to this, during a final interview, a patient commented: *"When I exercise at home I'm alone and eventually I stop doing it, here I learned that I'm not alone and looking at the steps of others keep you motivated"*. Indeed, some of the patients mentioned that having the virtual community and being aware of their friends' exercise and diet habits improved their

own dietary and exercise habits. In addition, most of the patients that used pHealthNet during SODHi established relationships with their team members beyond the SODHis –these team members also included specialists.

Analyzing the information per activity, it is interesting to note that still after SODHis finished other friends were invited to register in the system. These friends include relatives and members of other SODHis. To this aim a patient made the following comment during an interview: *"My children help me, they call me from Tijuana (a ninety-minute drive from Ensenada) to ask me the amount of steps I took and dietary habits"*. Also, we found that there were no questions made to the specialists through the system during the SODHi sessions, but afterwards a few questions were made. During SODHis patients meet specialists at least once per week while after SODHi these meetings were rare. However, pHealthNet provides patients with another medium to maintain this relationship with specialists. Finally, it is interesting to note that the amount of times patients updated their weight and the amount of steps conducted also increased. Therefore, the site positively impacted on patients' lifestyle habits. In general, it is clear that the patients frequently used the site, it helped them maintain community attachment, and helped them increase their physical activity.

4.2.2 Individual patient commitment with the persuasive virtual community

To analyze in more detail how the system impacts patients' lifestyle habits we individually analyzed the physical activity performed by some of the patients. Figure 4 shows the timeline of the physical activities, during and after SODHi, recorded by two patients that participated in Group A–patient G (Maria) and patient J (Carmen).

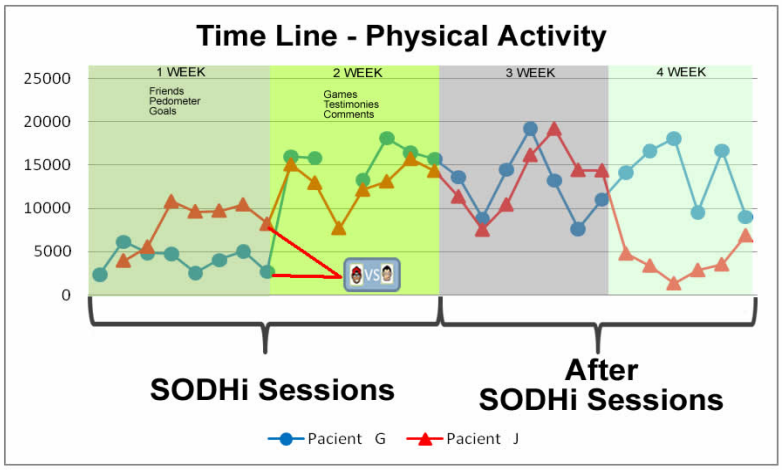

Figure 4: Patients' timeline of physical activities

During the first week *patient G* registered 7 times her physical activity with a daily average of 4254 steps. On the other hand, *patient J* registered 6 entries of physical activity with a daily average of 8377 steps. In the second week, we can observe that patients G and J increased the number of steps after being challenged. As a result of

such challenge, patient G registers 6 records of physical activity with an average of 13,744 steps per day –an increase of 354% when compared to the previous week. For patient J, the increase in the amount of steps was from 8,377 to 12,141.

In the following weeks (after the SODHi finished), patients G and J continued their physical activities. Patient G recorded for two weeks an average of 13,443 steps (per day) –a similar amount of steps that the one registered during SODHi. Patient G continues registering steps in the following 3 months after completing the SODHi program, with an average of 13,146 steps (Max 3020 and Min 38,749).

It is interesting to note that participants' exercise habits were diverse. For instance, patient G performed physical activities from Monday through Wednesday, while patient F performed his exercise mostly on weekends. Despite of this, we observed that the amount of steps conducted by patients was higher the first day of the week they used to exercise –for patient G, Mondays and for patient F, Saturdays. This could be partially explained because they want to achieve their week goal by increasing their activity from day one. Therefore, challenges became an essential motivating tool to increase their physical habits.

Figure 5 shows the timeline of the physical activities conducted by four patients of Group B –patients who are on the upper section of the figure are women and the ones at the bottom are men. In contrast with Group A, in Group B we gave the pedometer to each member of the SODHi in the first session and the following week they were on vacation –during this period participants didn't update the amount of steps they walked.

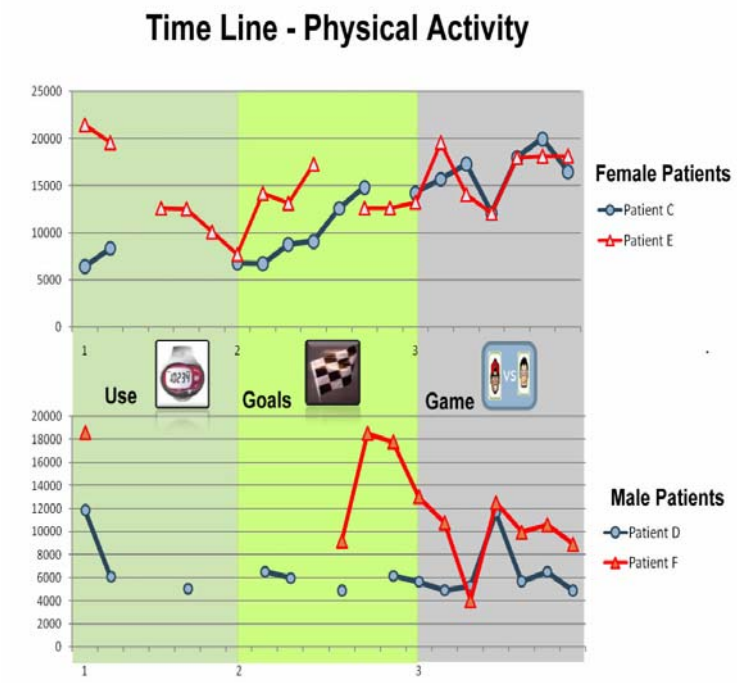

Figure 5: Patients' Time line of physical activities

As the figure 5 shows, it is interesting to note that the amount of steps registered is not as steady as the ones registered by Group A. However, similarly to Group A, when the goal was created patients of Group B increased their amount of steps and then decrease after a week. Nevertheless, when the games were introduced (in the last week) patients experienced a noticeable increment in number of steps recorded –even surpassing the steps taken when the goals were introduced.

Analyzing the information by genre it is interesting to note that the amount of steps registered by women is more stable than the ones registered by men. Also, the amount of steps registered by women is always increasing. In general, patients acquired new physical habits and behaviours. In this regard, a patient made the following comment: *"before I walked very little, I was a [coach potato] but now I walk more and I am very happy with the results"*.

4.2.3 Assessment of patient's motivation and their perception of system usage

We used the motivation achievement survey to measure patients' level of motivation during SODHi. Table II shows the results of comparing a group that used pHealthNet (Group B) during SODHi and another which was formed in the same period and did not use the system. As the table shows, the level of motivation in general is higher for the group that used pHealthNet by an average of 34%. It is interesting to note that the patients' perception of the importance of SODHi sessions and their perceived specialists' skills reached 100% for those using pHealthNet. This could be partially explained because the ecology of the system highlights the essential elements of a self-support group: (1) increase the level of communication among team members (including specialists), (2) promptly promote healthier habits and (3) increase patients' level of self-trust.

Description	SODHi patients that used pHealthNet	SODHi patients that did not use pHealthNet	Difference
General satisfaction	83%	63%	+20%
Importance of SODHi sessions	100%	50 %	+50%
Specialist skills	100%	67%	+33%
Self-trust and physical actitivity	83%	50%	+33%

Table 2: Patients' level of motivation

A second analysis was conducted to evaluate the patients' perceived usefulness of the system and ease of use based on the Technology Acceptance Model (TAM) [Davis 1989]. 85% of the patients completely agreed that the use of the system increases the amount of physical activity they performed, while 71% completely agreed that the system helps them maintain their dietary plan. 100% of the patients agreed that the system promotes a healthier lifestyle by allowing them to better control their dietary and exercise habits. In addition, 71% of the patients completely agreed that the system was flexible and understandable and 57% completely agreed that the system was easy to use.

4.3 Discussion

In general, we observed that pHealthNet promoted an individual commitment. Lack of internet access was the main obstacle in using pHealthNet. Despite of this, patients discovered new ways to interact with the system and participate in the community. For instance, while some participants (such as Carmen) participated "offline" others asked family members to upload their information for them. These "assistants" ended up registering themselves to the system and participating in it as well. We also found that patients where persuaded by stages in accordance with the system's features that were revealed during the group sessions. For instance, at the beginning the use of the pedometer engaged the patients while at the end it was the shared challenges that motivated them. Revisiting Maria's case we observed that for the first week she focused on uploading her personal information such as diets or recipes while at the end she only registered her footsteps.

We also found out that collaboration among users was used to persuade. We observed that collaboration and social support was an important instrument to engage users to achieve goals. Going back to Maria's case, while for the first week she scored at most 6167 steps per day, once Rita challenged her she increased her footsteps by 300% -up to 18150 steps (Figure 6). By doing so she completed a 10,000 step challenge which helped her lose 5 kilos. Patients repeatedly expressed that the system would keep them motivated by connecting their goals and problems with those of others. For instance, a patient mentioned during an interview: *"you are used to skip exercise at home, but with the [site] you know that you aren't alone and that motivates you"*. Another patient stated that: *"A [rivalry] in a good way exists because you could see the amount of exercise others have been doing but that cheers you up because you don't want to be left behind"*. As a result of the use of our system, three of the participants decided to continue with the program to become part of a larger community with the group that started the following month. This explains why most activities recorded by participants once SODHi sessions ended were non-collaborative. Apparently the participants were already motivated and did not need additional encouragement form collaborative activities. They continued recording their physical activities and uploading recipes that they found useful.

It is interesting to note that the type of collaboration exhibited among patients and stakeholders, including the staff of Control SODHi and specialists, was not as intense as the one exhibited between patients. For instance, as shown in Table 1, while only 1.75 comments, on average, were exchanged between patients and specialists (0 in Group A and 3.5 in Group B), 11.75 comments, messages, challenges and testimonies were exchanged among patients (12.25 in Group A and 11.25 in Group B). Also we found that the content and purpose of such collaboration was different. While the collaboration exchanged between patients and friends in their social network was based on positive reinforcement to help patients maintain their activities outside the program, the collaboration exchanged between stakeholders and patients was based on educational purposes aim at helping patients choose adequate mechanisms for dieting and exercising or explain educational materials such as the available videos in the site. For instance, patient P used pHealthNet to talk with the nutritionist N about his diet. This interaction took place as following:

P: "Tomorrow, I have to eat tuna and I don't like it very much. May I mix it with bacon?"

N: "No. You may change the tuna for ham but you can't use bacon because it is is high in cholesterol and fat. You may only add to your food natural species such as pepper or lemon"

Indeed, community support played a central role in helping pHealthNet users increase their trust in themselves and adopt healthier habits. Table 3 summarizes the system's functionalities and capabilities and their impact on pHealthNet users.

Persuasive virtual community tools	**System's functionalities/capabilities description**	**Impact on pHealthNet users**
Collaboration tools	*Connect with Friends.* Used to add family members or group peers to the user's social network.	Collaboration tools: ▪ Persuade users through personal and group experiences ▪ Show the cause and effect of having an unhealthy lifestyle ▪ Establish social and participation rules for the community
	Send SMS Messages. Used to send SMS messages to a member of the user's community.	
	Ask to your specialist. Allows pHealthNet users and specialists to exchange SMS messages or comments through the site.	
	Diets and recipes. Used to share healthy diets and recipes with friends who could make comments on them.	
Persuasive and monitoring tools	*Challenge a friend.* A pHealthNet user creates goals to challenge friends. Goals might include weight loss, number of steps achieved over a period of time, a predefined level of pressure and glucose.	Persuasive and monitoring tools: ▪ Increase users' physical activities ▪ Promote continuity with the program ▪ Motivate computer usage
	Playing games. A pHelahtNet user plays games to earn salupesos (health money) to buy SMS messages.	
	Traffic light. A pHealthNet user consults his level of physical activity and his nutrition habits through a traffic light.	
	Exercise Timeline. A pHealthNet user uploads the amount of steps achieved over a period of time and consults such information through a timeline.	
	The nutrition diary. A pHealthNet user may keep a diary of her food intake.	
Educational tools	*SODHI blackboard.* The control SODHi staff may use this tool to update the board on the main page of the site. Each pHealthNet user consults the messages associated to the board whenever they log in into the site.	Educational tools: ▪ Provide unlimited access to relevant information
	Educational videos. A pHealthNet user may consult educational videos uploaded by the Control SODHi staff or specialists for educational purposes.	

Table 3: pHealthNet functionalities and impact on pHealthNet users

Finally, the motivation achievement survey revealed that patients that used pHealthNet were significantly more motivated than those who did not use the system to support the program. In general, the application was perceive as useful and easy to use although many of the patients have never used a computer before.

5 Related work

The existing work in the domain of wellness technologies is already quite extensive. Available wellness technologies range from technological devices designed to act as powerful persuader [O'Brien and Mueller 2007; Consolvo *et al.* 2008; Ståhl *et al.* 2009] to applications that use such devices to make a positive impact on a user wellness, e.g. increase the level of physical activity [Anderson *et al.* 2007; Consolvo *et al.* 2008].

Two of the most widely commercial devices for wellness management are FoodPhone and Polar Watches. Food Phone is a mobile application that helps users to keep track of the food that he/she ingests every day by taking pictures of food ingested and getting reviews from the nutritionist [FoodPhone 2009]. Polar Watches enable users to keep track of their exercise routines, allowing them to monitor their heart rate and get a report of the number of calories burned [Polar]. In a similar direction, the Wellness Diary (WD) is a mobile journaling tool for a wide variety of wellness-related self-observation parameters (altogether 17 parameters), such as weight, exercise, steps, eating, stress level, sleep duration and quality, and tobacco and alcohol consumption. From these parameters the user can select the most suitable ones for her and personalize the application main view accordingly. However, the perceived value of the applications has been relatively low in short-term use because the feedback graphs are not considered motivating due to the lack of history data [Ahtinen *et al.* 2009]. In contrast, pHealthNet incorporates a set of tools that allow a user to consult history data coping with this issue.

Similarly, the Neat-O-Games offer a set of games for mobile devices which, through continuous monitoring and rewarding systems aim at becoming part of people's everyday routines and attack the behavioural aspect of the sedentary lifestyle. To facilitate analysis and the user's interaction with the system, the authors use configurable avatars that participate in virtual races with the users, promoting physical activities throughout their day to-day life [Kazakos *et al.* 2008]. TripleBeat is another system with close resemblances to this work. Overall, despite the different domain, the authors utilize a social motivation scheme, based on competition between several users with pre-defined individual goals. This way of persuasion plays an important role in enhancing the exercise experience and in encouraging users towards more active lifestyles [Oliveira and Oliver 2008]. The problem of these applications is that they do not provide mechanisms that allow patients to communicate with specialists or viceversa. This lack of communication might decrease patients' satisfaction [Wilson 2003]. In contrast, pHealhtNet bridges the gap between healthcare providers and patients by allowing the creation of virtual communities.

Virtual communities that incorporate persuasive features to promote a healthy lifestyle have been developed in recent years. *Houston* is a software application that promotes healthy lifestyles in social groups, allowing users to register physical activities and send instant messages [Sunny *et al.* 2006]. As in our system, *Houston*

uses a pedometer to measure the physical activity and mobile phones for members of the social group to communicate. It offers services to record physical activity, set goals, exchange messages with friends and visualize activity for a period of time. In contrast, pHealthNet virtual community, by supporting groups created in the healthcare facility, includes not only friends, but also healthcare specialists, and allows participants to share information such as receipts and exercises.

UP Health is a persuasive system which runs on desktop computers and mobile phones to share information to promote physical activity and smoking cessation in social groups [Misook and Jeunwoo 2007]. The application uses persuasive tools to accomplish these objectives. However, *Up Health* offers limited social support because it only shares records and goals among their members, but there are no collaborative activities such as the games included in pHealthNet. An additional difference between these systems is that pHealthNet was created to support a social program established in a hospital to assist patients with a chronic disease.

Several virtual communities for healthcare have been created. A good example is *HutchWorld* [Shelly *et al.* 2002], to assist cancer patients through social interaction tools, information, and entertainment activities. Although these systems have proved to be very successful in improving patients' quality of life, their focus is only on community support, and not on persuading patients to change their living habits. In contrast, pHealhNet incorporates not only a series of persuasive tools, but aims at creating a pervasive virtual community to surround the patient with persuasive services. In a similar direction, Sá & Carriço proposed a tool where patients undergoing psychological treatment are able to register and visualize different types of data such as thoughts, exercises, images and sounds. Such information helps patients to improve their adherence to the post-consultation activities increasing continuity, as we found out. Also, the tool includes mechanisms that allow therapists to introduce persuasive comments or triggers, helping patients maintain their activities outside consultation settings [Sá *et al.* 2007]. It is interesting to note that in our evaluation we found that this type of communication was exhibited among patients and not between patients and specialists. This could be partially explained because in our work patients used a device that allow them to easily calculate their exercise progress without the need specialists' intervention.

6 Conclusions

We presented pHealthNet: a persuasive virtual community aimed at promoting healthy lifestyle supporting a national program of self-support groups.

pHealthNet emerged from an exploratory study that detected several barriers which made it difficult for patients to adopt healthier habits through a hospital program in which groups of patients and specialists met for weekly sessions. The system was created to facilitate group members to keep in touch, provide easy access to reference material and motivate a change in behavior through persuasive tools.

The design of pHealthNet avoided the use of costly or complex technologies to make it accessible to the patients to which the SODHi program is directed. In fact, several of the participants in the evaluation have never used a computer before, nor have one at home, however, all patients used mobile phones. The design process of the system involved the selection of the appropriate medium through which the

persuasive message will be conveyed as well as the timing and nature of the message itself. Several themes emerged from our work, which we present as five key design requirements that we argue a community system to support self-support groups in health-related issues should incorporate:

- Persuade users through personal and group tools for motivational reinforcement and the exchange of their experiences
- Empower a social network community with asynchronous and synchronous communication channels on a diversity of devices
- Enable users to self-measure their progress
- Promote friendship competition
- Provide customizable educational cues for behaviour improvement

The results of an evaluation showed that patients increased their confidence in themselves and their diets and physical activity. In general, information on the use of the persuasive virtual community was positive and we found that the persuasive tools and the virtual community can help motivate people to maintain a higher level of physical activity and dietary habits for either a short or long term.

Despite of this, our evaluation is limited by the relatively low number of subjects that used pHealthNet and the period of time we observed them. One group was followed during two months and the other during one month. Thus we can't make inferences about long time behavior. However, we want to clarify that our efforts centred on acquiring a vast and detailed understanding of the way a persuasive virtual community impact few individuals across a varied set of circumstances.

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