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Acceptance of ICTs for health and/or Physical Activity Monitoring in Patients with Chronic Diseases

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Abstract

Physical activity (PA) is a cornerstone of medical treatment in chronic patients but difficult to maintain over the long term. The Information and Communication Technologies (ICTs) offer new possibilities to provide support for patients and to monitor PA. The aim of this study was to assess the knowledge about, the use of and the interest in ICTs for health and PA monitoring, and to evaluate the influence of gender, age and socio-professional category on ICT acceptance. A survey on ICT's knowledge, use and acceptance was specifically elaborated for this study. Patients participating in a supervised PA training program completed this survey during a face-to-face visit. Seventy-eight patients between 45 and 79 years old were surveyed. Most of them had access to the Internet (92%) and owned a smartphone (69%). Age was the major factor influencing access to and technical knowledge about ICTs. Half of the patients were in favor of using ICTs for health and PA monitoring. The factors that conditioned this acceptance were to be young, highly educated, and to have already used ICTs. The other half of the patients were opposed to ICTs because of the complexity and constraints of these technologies, and because they worried about the lack of data security. These results emphasize the need to know more about the profile of the patients in order to propose the relevant personalized PA support.

Keywords: Physical activity training, Monitoring, Information and Communication Technologies, Acceptance, Patients, Non-communicable disease.

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INTRODUCTION

Over thousands of years, the evolution of lifestyles in the Western world has led people to become increasingly physically inactive and sedentary. Physical inactivity is defined by less than 150 minutes of moderate intensity PA per week, the international recommendation for health. One adult out of three (31.1%) in the world today is physically inactive [1]. Globally, physical inactivity increases with age, and women (33.9%) are more inactive than men (27.9%) [1]. Sedentary behavior is defined as any waking behavior in a sitting, supine or reclining position, and with an energy expenditure of less than 1.5 metabolic equivalents (METs) [2]. In a cohort of French working adults time spent in sedentary behavior is close to 12 hours for workdays and 10 hours for non-workdays [3].

Physical inactivity and sedentary behavior are behavioral risk factors which are responsible for the steady increase in the prevalence of Non-Communicable Diseases (NCDs) [4, 5]. In 2018, these diseases were the first overall cause of mortality

worldwide, with 41 million deaths per year¹. Without behavioral changes, the number of annual deaths will increase to 52 million in 2030 [6]. Consequently, the prevention and the treatment of NCD involve the adoption of healthy behaviors, especially physical activity and the avoidance of sedentary behaviors.

The health benefits of PA have been widely demonstrated in healthy people as well as in patients with NCDs [7]. PA is a cornerstone for prevention of NCDs and was recognized as a non-pharmacological treatment with sometimes similar (i.e., reduction of blood pressure in hypertensive subjects) or greater effects (i.e., improvement of mortality outcomes in patients who had a stroke) than those obtained with drugs [8].

Numerous studies demonstrate the difficulties to maintain PA over a long period in subjects with NCDs, even if then know that PA is a cornerstone to

¹ <http://www.who.int/en/news-room/fact-sheets/detail/noncommunicable-diseases>

their treatment [9]. For example, Dorn *et al.*, (2001) [10] demonstrated in myocardial infarction patients that the compliance rate strongly decreased after the first two months, dropping from 79.6% to 55.1% between the second and sixth month. Thus, it is necessary to find other ways to support and motivate patients to maintain sufficient PA levels over time.

The Information and Communication Technologies (ICTs) have become increasingly powerful and useful in daily life, reflecting a high acceptance of the Internet and connected objects by the general population. In 2016, 52.3% of the world population had Internet access and 47% used it. In developed countries, more than 80% of the population used the Internet [11].

ICTs could be an interested option to support the behavioral change, especially in PA. Several studies demonstrated positive significant effects of ICTs on increasing PA in subjects with NCDs [12-14]. In contrast, other intervention studies using ICTs to promote PA in patients failed to find a significant change in PA [15, 16]. Nevertheless, none of these studies was focused on patient attitudes and acceptance of these ICTs. However these attitudes might strongly influence the use of the digital system.

The objective of supervised PA training is for physically inactive subjects with NCDs to acquire self-confidence, skills and abilities, and to increase their PA level during and after the supervised training. However, as reported, maintaining long-term PA over time requires support, and ICTs could be an interesting option. The primary aim of this study was to determine if PA support through ICTs should be offered to all patients or just to patients with specific profiles. To answer this question, the current knowledge about, use of and interest in ICTs applied to PA of subjects with NCDs who participated in a 3-month supervised PA program were studied. The second aim was to investigate the effect of age group, gender and socio-professional categories on ICT acceptance and use.

MATERIALS AND METHODS

Participants

The participants were women and men aged from 45 to 79 years with one or several NCDs. The patients were under the care of and received PA training from PA professionals at either the Gabriel Montpied or the Estaing University Hospital Centers (Clermont-Ferrand), the *Centre de Ressources, d'Expertise et de Performance Sportives* (Vichy) or the *Fédération d'Education Physique et de Gymnastique Volontaire de l'Allier* (Moulin). Recruitment was done by phone with the help of the PA professionals of each center. The aim of the study and the study design were explained during

the call, the age and the NCD were verified, and oral consent was given. Each participant then signed an informed consent form before participating in the survey.

Study Design

The survey was specifically created for this study. It was completed in one session by all of the patients during a 45-minute face-to-face interview. The survey consisted of 22 questions about the Internet (access, frequency and reasons for use), connected objects (knowledge and possession), smartphones (possession and use), mobile applications (knowledge and use), e-health knowledge, the use of the Internet to search for health information and to use it for health and PA monitoring. The questions were either in closed (n=10), open (n=4) or in multiple-choice (n=8) form. They were progressively ordered, beginning with daily ICT usage and ending with health/PA monitoring applications. For the closed questions, the answers were expressed in the binary mode (Yes/No). The answer, "don't know", was only added in order to highlight uncertainty for three closed questions (e-health knowledge, ICT use for health or physical activity). Open questions were used to confirm a previous answer and give an example (name of the connected object and of a mobile application). The multiple-choice questions were used to express different reasons for using the Internet, the smartphone and the mobile applications. These questions were also asked to understand why participants were ready or not to adopt ICT for health and PA monitoring.

This survey was registered with the French National Commission for Data Protection and Liberties (CNIL) under the number 0169. The survey was also approved by the French Committee for the Protection of Human Subjects (Sud Est VI) and registered under the reference 2016/CE40.

Statistical Analyses

Chi-square tests were used to assess the independence of variables by comparing the observed and theoretical sample sizes. When the p-value was lower than or equal to 0.05, the independence of variables was rejected and the variables were considered to be dependent. The variables studied were age group, gender and socio-professional categories. For age, three groups were defined: 45–54, 55–64, and 65 years or over.

RESULTS

Sample Characteristics

The sample consists of 78 adults with chronic disease. The socio-professional categories and medical characteristics of patients are summarized in Table-1

Table-1: Patient characteristics

Variables	Category	Sample size (n)	Frequency (%)	χ^2	p
Gender	Women	50	64	6.2	0.02*
	Men	28	36		
Age group (year)	45-54	24	31	0.9	0.75
	55-64	30	38		
	> 65	24	31		
Professional activity	Without	57	73	16.6	< 0.0001***
	With	21	27		
Situation	Actively employed	21	27	23.0	0.005**
	Unemployed	8	10		
	On sick leave	13	17		
	Retired	36	46		
Socio-professional category	Employee	52	67	142.9	< 0.0001***
	Artisan	6	8		
	Manager	9	12		
	Intermediate profession	5	6		
	Worker	5	6		
	Farmer	1	1		
Long-term disease	Yes	55	70.5	13.1	0.0003***
	No	23	29.5		
Chronic disease	Obesity	37	47.4	24.7	0.005**
	T2D	20	25.6		
	COPD	13	16.7		
	Cancer	8	10.3		

* p<0.05; ** p<0.01; *** p<0.001

More women than men were surveyed (64%), 59.5 ± 8.4 years old, with a homogeneous distribution in age group, and mainly obese (BMI: $34.4 \pm 7.5 \text{ kg.m}^{-2}$). Regardless of gender, most of them were professionally inactive, and specially retired. Regarding the professional categories, they were largely employees, regardless of gender and age group. Approximately 70% of the patients suffered from a long-term disease (i.e., one of the 30 NCDs whose costs are totally covered by French Public Health Insurance), especially since they were older ($\chi^2 = 14.2$; $p = 0.008$) and male ($\chi^2 = 2.8$; $p = 0.092$). Twenty-nine percent of the patients had been suffering from a long-term disease for less than 5 years, 18% for between 5 and 10 years, and 53% for more than 10 years. The mean time was 11.3 ± 9.2 years. Almost one patient out of two suffered from obesity, one patient out of four suffered from type 2 diabetes (T2D), and the others suffered from chronic obstructive pulmonary disease (COPD) or cancer. Moreover, statistically, there were more patients suffering from obesity than patients suffering from T2D, COPD or cancer ($\chi^2 = 24.7$; $p = 0.005$).

Knowledge and use of ICT

More patients had access to the Internet than no access (92% vs. 8%; $\chi^2 = 55.84$; $p < 0.0001$). Among patients with access to the Internet, 72% accessed it several times a day. The main reasons were “to look for information” and “to communicate”. The third reason mentioned was “to browse the Internet”. More than nine out of ten patients used the Internet for at least two reasons.

Sixty-four percent of the patients claimed to know what connected objects are. More patients were familiar with connected objects than were not ($\chi^2 = 6.20$; $p = 0.013$). Among the known connected objects, the smartwatch and the smartphone were the most frequently cited, regardless of gender and age group.

While more than half of the patients knew the connected objects, only 43% reported having one. As many patients had a connected object as did not have one. The smartphone was the most frequently connected object owned by the patients (69%). The main reasons it was used was “to phone and to send text messages” “to take pictures and watch movies”, and “to read/send emails”. The use of mobile applications in daily life concerned less than half of the patients who had a smartphone.

As many patients knew and did not know what a mobile application was. Among the patients who had a smartphone, 72% knew what a mobile application was and 85% had already downloaded one. The most frequently used mobile applications dealt with everyday information (GPS, weather, bank, news), followed by leisure activities (games, music, movies) and the social networks (Facebook) (Figure-1). Note that only 14% of the mobile applications used by patients concerned PA (Visorando, for example) and only 4% concerned health (Samsung Health).

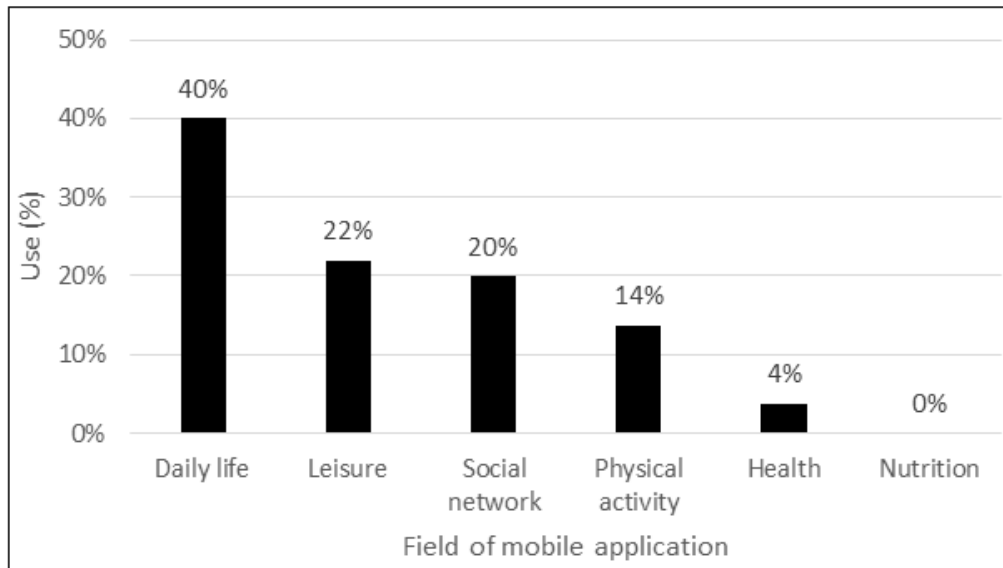


Fig-1: Mobile applications used by the patients

Gender had no effect on the knowledge about, possession of, or use of ICTs, except for Internet access (Table-2). In fact, 100% of men and 88% of women had access to the Internet ($\chi^2 = 3.64$; $p = 0.05$). The socio-professional category moderately influenced Internet knowledge and use. It statistically influenced Internet access, e-health knowledge and the use of the Internet to look for health information. Workers/laborers had a more limited Internet access than the other socio-professional categories ($\chi^2 = 21.5$; $p < 0.0001$). Consequently, workers used the Internet less frequently to look for health information ($\chi^2 = 11.6$; $p = 0.04$). Although artisans had access to the Internet, they

looked for health information less often than managers, intermediate professionals and employees. Workers, artisans and farmers were less familiar with how e-health works than managers, intermediate professionals and employees ($\chi^2 = 21.7$; $p = 0.02$).

Age group mainly influenced the knowledge, possession and use of ICT (Table-2). In fact, older patients (over 65) had more limited technological knowledge and experience than the younger. However, the age group had no effect on e-health knowledge or the use and interest in ICTs applied to health and PA (Table-2).

Table-2: Influence of gender, age group and socio-professional category on ICT knowledge, and agreement to use them to monitor health and PA

	Gender		χ^2	p	Age group			χ^2	p	Socio-professional category						χ^2	p
	Men	Women			45 – 54	55 – 64	> 65			Employee	Artisan	Manager	Intermediate prof.	Worker	Farmer		
Has access to the Internet (%)	100	88	3.64	0.05*	96	100	79	8.76	0.01*	96	100	89	100	40	100	21.5	0.0007***
Is familiar with connected objects (%)	54	70	2.10	0.15	63	80	46	6.80	0.03*	65	33	78	60	60	100	3.9	0.57
Owns a connected object (%)	43	44	0.01	0.92	42	60	25	6.69	0.03*	46	50	44	20	20	100	3.8	0.58
Owns a smartphone (%)	71	68	0.1	0.75	83	73	50	6.64	0.04*	73	83	67	60	20	100	7.3	0.2
Knows about mobile app (%)	39	56	2.0	0.16	71	60	17	16.03	0.0003***	52	50	56	60	0	100	6.4	0.27
Has downloaded mobile applications (%)	36	46	0.78	0.38	63	47	17	10.7	0.005**	42	67	44	40	0	100	6.5	0.26
Knows about e-health (%)	43	44	0.26	0.88	33	53	42	2.68	0.61	44	17	56	100	0	0	21.7	0.02*
Uses the Internet to look for health information (%)	82	80	0.05	0.82	83	87	71	2.30	0.32	87	50	78	100	40	100	11.6	0.04*
Agrees with ICT use for health monitoring (%)	43	56	1.46	0.48	54	60	38	3.90	0.42	52	33	67	60	20	100	11.8	0.29
Agrees with ICT use for PA monitoring (%)	39	48	0.64	0.72	50	53	29	4.27	0.37	42	50	67	40	20	100	10.1	0.43

* p<0.05; ** p<0.01; *** p<0.001

Interest in ICTs to monitor health and/or PA

A total of 44% of the patients were able to define e-health, 16% had a doubt and only 40% were unable to define what e-health is ($\chi^2 = 9.92$; $p = 0.007$). Nevertheless, 81% of the patients had already used an e-health service such as a search for information about a health issue ($\chi^2 = 29.54$; $p < 0.0001$). Concerning the definition of e-health cited by the patients, Internet-based health information was the most frequently mentioned. Patients talked about health information, consultation and medical monitoring via the Internet. The second most cited notion was telemedicine and telesurgery, with the notion of the "medical desert". Medical monitoring with a mobile phone and mobile applications were also mentioned to explain the e-health concept, but to a lesser extent.

Regarding the use of ICTs for health monitoring, 51% of the patients were in favor of, 19% were against and 30% of the patients had a doubt and answered, "I don't know" (Table-3). More patients were in favor of the use of ICTs for health than against or without an

opinion ($\chi^2 = 12.5$; $p = 0.002$). The factors in favor of ICT use for health were to be familiar with them and to own a connected object, to own a smartphone, to know about and to download a mobile application (Table-3). Among the patients in favor of ICT use for health monitoring, the most frequent reasons cited was "to assist with medical monitoring" and the possibility "to have personalized support". More than 75% of the patients thought that e-health was "the future" of healthcare. For the patients who were against it, the main reason was the complicated use of ICTs. Patients were also against sharing health data on the Internet. Moreover, patients felt like they were under constant surveillance. Two patients also explained that they were against these tools because the human relationship is central to the healthcare system. The uncertain patients were not firmly opposed to ICT use. Nevertheless, some patients underlined a lack of interest and of motivation towards these tools. They expected these devices to be easy to use and demanded information about the benefits of using a digital system.

Table-3: The factors in favor of, in doubt of or against the use of ICTs for health and PA monitoring

		Use of ICTs for health					Use of ICTs for physical activity				
		In favor of (%)	Doubtful (%)	Against (%)	χ^2	p	In favor of (%)	Doubtful (%)	Against (%)	χ^2	p
Total		51	30	19	12.5	0.002**	45	31	24	5.15	0.07 [†]
Gender	Women (%)	70.0	60.9	53.3	1.5	0.48	68.6	62.5	57.9	0.6	0.72
	Men (%)	30.0	39.1	46.7			31.4	37.5	42.1		
Age group	45 – 54 (%)	32.5	34.8	20.0	3.9	0.42	34.3	33.3	21.1	4.3	0.37
	55 – 64 (%)	45.0	30.4	33.3			45.7	29.2	36.8		
	> 65 (%)	22.5	34.8	46.7			20.0	37.5	42.1		
Socio-professional category	Employee	67.5	65.2	66.7	11.8	0.29	62.9	62.5	78.9	10.1	0.43
	Artisan	5.0	17.4	0.0			8.6	12.5	0.0		
	Manager	15.0	8.7	6.7			17.1	4.2	10.5		
	Intermediate prof.	7.5	4.3	6.7			5.7	12.5	0.0		
	Worker/laborer	2.5	4.3	20.0			2.9	8.3	10.5		
	Farmer	2.5	0.0	0.0			2.9	0.0	0.0		
Has access to the Internet	Yes (%)	97.5	91.3	80.0	4.8	0.09	94.3	91.7	89.5	0.4	0.81
	No (%)	2.5	8.7	20.0			5.7	8.3	10.5		
Is familiar with connected objects (%)	Yes (%)	80.0	52.2	40.0	9.6	0.008**	77.1	54.2	52.6	4.7	0.09
	No (%)	20.0	47.8	60.0			22.9	45.8	47.4		
Has a connected object (%)	Yes (%)	57.5	34.8	20.0	7.3	0.03 [†]	57.1	33.3	31.6	4.8	0.09
	No (%)	42.5	65.2	80.0			42.9	66.7	68.4		
Has a smartphone (%)	Yes (%)	85.0	56.5	46.7	10.0	0.007**	82.9	54.2	63.2	5.9	0.05*
	No (%)	15.0	43.5	53.3			17.1	45.8	36.8		
Knows about mobile applications (%)	Yes (%)	70.0	34.8	20.0	13.9	0.009**	71.4	41.7	21.1	13.5	0.001***
	No (%)	30.0	65.2	80.0			28.6	58.3	78.9		
Has downloaded mobile applications (%)	Yes (%)	60.0	30.4	13.3	11.6	0.003**	62.9	33.3	15.8	12.3	0.002**
	No (%)	40.0	69.6	86.7			37.1	66.7	84.2		
Knows about e-health (%)	Yes (%)	50.0	30.4	46.7	4.0	0.41	45.7	45.8	36.8	5.1	0.28
	No (%)	35.0	43.5	46.7			37.1	29.2	57.9		
	Don't know (%)	15.0	26.1	6.6			17.1	25.0	5.3		
Uses the Internet to look for health information	Yes (%)	82.5	78.3	80.0	0.2	0.92	82.9	79.2	79.0	0.2	0.91
	No (%)	17.5	21.7	20.0			17.1	20.8	21.0		

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

As regards PA monitoring, 45% of the patients were in favor of using ICTs, 31% were uncertain and 24% were against ICTs (Table 3; $\chi^2 = 5.15$; $p = 0.07$). The factors in favor of using ICTs for PA monitoring were knowing about them and having downloaded a mobile application (Table-3). The other factors had no

effects. The two most cited positive reasons were "to receive advice about how to perform PA" and "to have examples of PA". Moreover, 77% of the favorable patients thought that ICT was the future of healthcare (Figure-2).

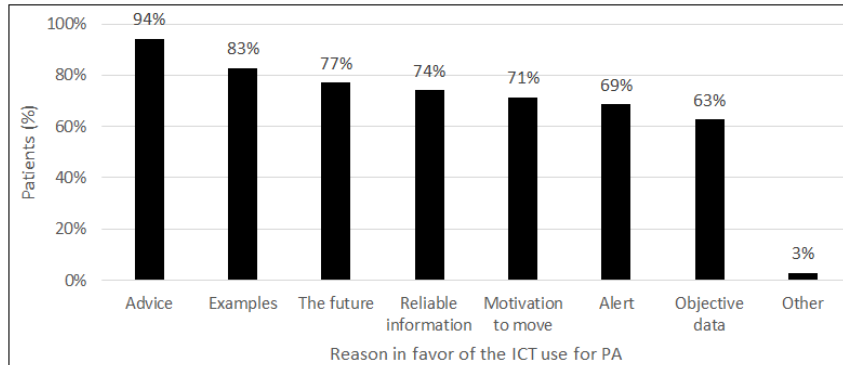


Fig-2: Reasons in favor of using ICTs for PA

The reasons for questioning ICTs were more variable. They were of the same nature as those concerning health monitoring: lack of usefulness,

secured systems and human contact and, conversely, increased surveillance (Figure-3).

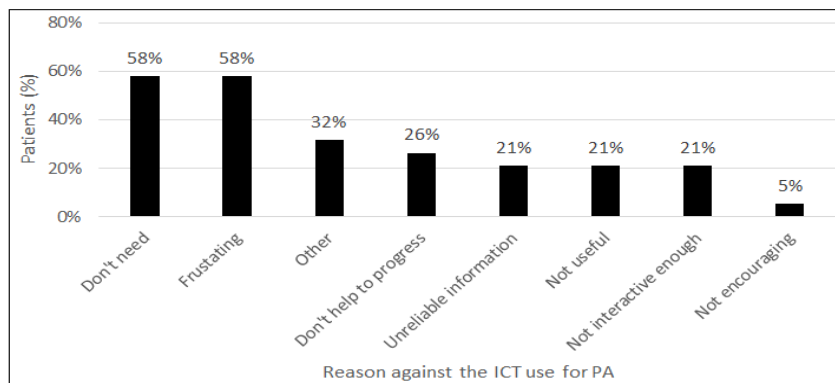


Fig-3: Reasons against ICT use for PA

The uncertain patients had questions about the added-value and the utility of these tools for PA monitoring. The importance of human contact and support were also underlined to improve the motivation to perform PA.

DISCUSSION AND CONCLUSION

The aim of this study was to determine if patients after a 3-month supervised PA training program would be ready to use ICTs to maintain their level of physical activity. Our results showed that ICTs might be relevant for maintaining long-term PA in less than half of the participants with new PA skills, especially those who know about and have already downloaded a mobile application.

The reasons in favor of using ICTs for health and for PA mentioned by the patients in our study were to be connected, young, and to require digital medical monitoring and personalized PA support. Iftikhar *et al.*, highlighted that Internet access and possession of a

mobile phone were associated with willingness to use e-mail, send SMS or to watch video conferences about chronic disease management [16]. Bughin *et al.*, observed that the key arguments for adopting mobile therapeutic care were the program personalization, the comforting aspect, the advice received in real time and the link with health professionals [17]. In Ammenwerth *et al.*, patients were interested in the self-control, the health consciousness, the motivation for PA, the monitoring goals and the individual feedback provided by the telemonitoring system [18].

On the other hand, there were many reasons for not using e-health. The main obstacle was related to the difficulty of using digital health systems and the lack of training in our study, like in others [16]. Solutions to improve the acceptance of ICTs by the patients could include encouraging access, simplifying the use of these tools and instructing patients about how to use them [19]. Technical know-how was considered

as a form of self-efficiency that influenced the attitude towards these tools and the perceived ease with which they could be used.

Another obstacle mentioned in our study was the lack of confidence in the ability of these tools to accurately measure behavior and to accompany behavioral changes. This was in agreement with the findings of Mercer *et al.*, [19]. If the feedback is accurate, it is a strong incentive to change behavior. The necessity to have a goal and to quantify the gap between the goal and the behavior is essential for success.

Moreover, the lack of human relationships in digital systems was a critical point because of the social need in health care to promote the healthy behaviors in our study, like in the study of Iftikhar *et al.*, [16]. However, if the digital system does not replace but is instead integrated into the regular medical care, it reinforces/fosters synergy [19]. Interestingly, Loeckx *et al.*,’s smartphone-based PA study pointed out that the difficulty with pathology management induced patients to ask for more human than technological support [20].

In our study and that of Bughin *et al.*, the regular use of connected objects and the feeling of being under surveillance were negatively perceived [17]. Finally, the fear concerning the lack of trust and data privacy was also cited by the patients in the study of Rasche *et al.*, [21].

Age was a major factor that influenced knowledge about the use of ICTs. Older people (over 65) were less equipped and had limited knowledge regarding ICTs. Gender only influenced access to the Internet. Women were slightly less equipped than men. These results were consistent with those of Diaz-Prieto and Garcia-Sanchez [22]. They found that computer and Internet knowledge decreased with increasing age and men used the Internet more often than women. There was also a social gradient in ICT use according to social category. Thus, working class patients, unlike managers and intermediate professionals, were less equipped and consequently used e-health to a lesser extent. Another study confirmed this gradient according to social-professional category. Buysse *et al.*, examined whether or not T2D patients were interested in a telemonitoring platform to manage their health [23]. The poorly educated patients used the computer and the Internet significantly less and, consequently, looked for less information on diabetes than the middle or highly educated patients. Educated patients were also more interested in the use of the telemonitoring platform, especially to send glycemic data in order to adapt their medical treatment and to ask questions. Nevertheless, e-health platforms could not replace one-on-one visits. These results suggested that the first step to accept e-health was regular access and use of the Internet in a non-medical context.

Following are some of the strengths and limitations of our study. Among the strengths, our study made it possible to examine patients’ reasons for using or rejecting ICTs for PA after having tested PA benefits during a supervised training program and then being faced with the problem of maintaining PA on their own. The results of the present study provided potential solutions for optimizing e-health systems according to patients’ requirements. Obviously, ICTs should be able to accompany healthy behaviors, but they also have to live up to patients’ expectations, to be clearly explained, easy to use, friendly and interactive. However they cannot replace human relationships. The limitation of this study is the low number of patients and the unbalanced distribution of patients according to disease and socio-professional category.

In conclusion, our survey demonstrated that in patients with NCDs who participated in a supervised PA training program, the Internet was widely and personally used to obtain health information. Half of them were ready to use ICTs for PA follow-up because they know about and are able to download mobile applications. Future studies will be necessary to confirm if the use of a digital system will help them to maintain long-term PA. The other half did not plan to use ICTs to monitor PA. These patients will have to be assisted and monitored by health practitioners or PA professionals until they can acquire strong skills in using these tools and are reassured about data accuracy and privacy. Future generations of patients will be more familiar with ICT use applied to administrative e-procedures and, soon, to e-health.

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DECLARATION OF INTEREST STATEMENT

The authors declare to have no conflict of interests.

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