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ARTICLE

The impact of therapeutic patient education and physical activity programs on the fall risk of elderly people

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Abstract – Objective: The objective of this study is to evaluate the effectiveness of a combined therapeutic education/physical activity program on risk factors for falls in elderly fall patients hospitalized in a rehabilitation healthcare service. This combined program is compared to a control program, which offers physical activity only. **Method:** Thirty fall patients are evaluated on the TUG, Tinetti, and FES-I tests and randomly assigned either to the group consisting of 24 sessions of physical activity alone, with endurance, stretching, balance and muscle strengthening exercises, or to the physical activity group combined with four therapeutic fall prevention education sessions. **Results:** For both programs, results reveal significant differences between the pre-tests and post-tests on each balance score and equally on fear of falling. An interaction effect (group × time) is observed on the FES only, which means that fear of falling decreases significantly more in the Physical Activity and Patient Education group than in the Physical Activity alone group. **Conclusion:** Therapeutic patient education seems to reduce fear of falling. This highlights the potential impact that such programs could have on elderly people who have had a previous fall/falls in terms of regaining self-confidence when going about their daily activities.

Key words: fear of falling, balance deficits, aging

Résumé – Impact de l'Éducation Thérapeutique du Patient associé à un programme d'activité physique sur le risque de chute des personnes âgées. Objectif : Cette étude a pour objectif d'évaluer, chez des personnes âgées chuteuses hospitalisées en Soins de Suite et Réhabilitation, l'efficacité d'un programme d'éducation thérapeutique couplé à un programme d'activité physique sur les facteurs de risque de chute. Ce programme est comparé à un programme contrôle proposant uniquement de l'activité physique. **Méthode :** Trente patients chuteurs sont évalués sur les tests TUG, Tinetti, et FES-I et assignés, aléatoirement, soit au groupe pratiquant l'activité physique seule, basée sur des exercices d'endurance, de souplesse, d'équilibre et de renforcement musculaire, pendant 24 séances, soit au groupe pratiquant les séances d'activité physique couplées à quatre séances d'éducation thérapeutique sur la prévention des chutes. **Résultats :** Pour les deux programmes, les résultats révèlent des différences significatives entre le pré-test et le post-test sur chaque score d'équilibre et sur la peur de chuter. Un seul effet d'interaction (groupe × temps) est observé, sur le FES, ce qui signifie que la peur de chuter a davantage diminué dans le groupe « activité physique et éducation thérapeutique » que dans le groupe « activité physique ». **Conclusion :** Les résultats de cette étude montrent que l'éducation thérapeutique favorise une diminution de la peur de chuter. Ce résultat est intéressant puisque retrouver confiance en ses déplacements dans les activités du quotidien est déterminant dans le maintien de l'autonomie et dans la prévention des chutes.

Mots clés : peur de chuter, troubles de l'équilibre, vieillissement

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1 Introduction

Falls are a major cause of serious injuries in older adults, leading to hospitalization, nursing home admission, and death. One third of adults aged over 65 fall each year (Inserm, 2015). Thus, in order to prevent falls (primary prevention) or recurrence (secondary prevention), it is important to assess fall risk. Risk factors for falls are classically grouped into two distinct categories: intrinsic and extrinsic (Dargent-Molina & Bréart, 1995). Extrinsic risk factors correspond to the characteristics of the fall site. Obstacles at crossing points, slippery floors or inadequate lighting are all factors to consider in the mechanism of fall. Intrinsic risk factors are those, which depend directly on the individual's state of health; the main risk factors for the elderly person's fall. This intrinsic risk could be assessed by motor or physical risk factors, such as balance deficits (Muir, Berg, Chesworthe, Klar & Speechley, 2010). Fear of falling must also be considered (Burker *et al.*, 1995; Inserm, 2015). Indeed, more than 50% of people aged 65 and over report fear of falling, and 38% report avoiding activity due to fear of falling (*e.g.*, Gillespie *et al.*, 2009; Zijlstra *et al.*, 2007). Balance preservation and the reduction of fear of falling in the elderly are fundamental to maintaining functional independence such as standing while doing manual tasks, rising from a chair, and walking around safely during daily life (Nick, Petramfar, Ghodsbin, Keshavarzi & Jahanbin, 2016). Fall prevention programs are an important public health strategy for the frail elderly population. Consequently, there is a general necessity to develop effective and practical programs to prevent falls in people who have not fallen, and to prevent further falls in those who have already fallen in the past.

Many preventive intervention programs based on reported risk factors have been established and evaluated (for a review, Gillespie *et al.*, 2012). A substantial number of studies have shown that physical exercise interventions have proved to be effective in reducing the fall risk, including Tai Chi (*e.g.*, Wong, Lin, Chou, Tang, & Wong, 2001), aerobic and resistance exercise (Sousa, Mendes, Silva & Oliveira, 2017), dancing (Franco *et al.*, 2016), endurance, muscle strengthening, stretching, and balance training (*e.g.*, Buchner *et al.*, 1997; Gardner, Robertson, & Campbell, 2000), or combinations of these activities (Shumway-Cook, Grubner, Baldwin, & Liao, 1997; Skelton & Dinan, 1999). These studies have shown an improvement in lower limb strength, balance, and functional abilities in addition to reduced fall risk as well as fear of falling (Howe, Rochester, Jackson, Banks, & Blair, 2007; Sherrington *et al.*, 2008). Large scale fall prevention programs based on physical exercise have also been developed, such as the Ossebo and PIED programs. Ossebo is an on-going multicenter randomized controlled trial, which aims to assess the effect of a two-year community-based group physical exercise program on the prevention of falls among older women (El-Khoury, Cassou, Charles, & Dargent-Molina, 2013; El-Khoury, Cassou, Latouche, Aegerter, Charles, & Dargent-Molina, 2015). This program has been effective in reducing injurious falls and in improving measured and perceived physical function. The PIED program is a large multifaceted community-based fall prevention program based on balance-related psychological factors (Filiatrault *et al.*, 2007, 2008). The PIED program has been successful in improving balance performance among community-dwelling seniors and has also had a positive impact on perceived balance. Interestingly, in addition to physical exercise, the PIED program is based on fall risk education classes. This approach resembles therapeutic patient education. Therapeutic patient education programs have been developed in order to provide health information and instructions to help patients learn about specific or general medical topics (Pariel, Boissières, Delamare, & Belmin, 2013). Topics include the need for preventive services, the adoption of healthy lifestyles, the correct use of medications, and how to deal with diseases or injuries at home (HAS, 2007). Therapeutic patient education is effective in the context of various chronic diseases, including diabetes and asthma (Golay, Lagger, Chambouleyron, Carrard, & Lasserre-Moutet, 2008; Lagger, Pataky, & Golay, 2009; Magar *et al.*, 2005). Therapeutic education for fall prevention is not fundamentally different from that proposed within the context of chronic diseases because, falling must be considered as a chronic disease and not as an isolated accident (Puisieux, Lagardère, Beghin & Pardessus, 2014). As yet, there are but few therapeutic education programs for fall patients in elderly care facilities in France. In 2013, approximately 30 French therapeutic patient education programs targeted the elderly, four of which concerned fall prevention (Pariel *et al.*, 2013).

Gillespie *et al.* (2012) have shown that in educational interventions designed to reduce falls by increasing knowledge about fall prevention, there is no evidence of a reduction in the rate of falls or risk of falling. Educating patients shows no significant efficiency in its exclusive form but remains necessary in a multifactorial approach (Gillespie *et al.*, 2012).

Several studies have investigated multifactorial programs including physical activity and therapeutic patient education on fall risk. Shumway-cook, Silver, LeMier, Cummings and Koepsell (2007) evaluated the effectiveness of a 12-month multifaceted intervention (physical exercise and therapeutic patient education) on falls and risk factors (balance, lower extremity strength, and mobility) in community-living older adults. Patients of the multifactorial program received six hours of therapeutic patient education and three sessions of physical activity per week for a year. In the control group, patients received two fall-prevention brochures developed by the Centers for Disease Control and Prevention. The multifactorial program produced small but significant improvements in fall risk factors (strength, balance, and mobility), but did not reduce the incidence rate of falls in older adults over the 12-month period. The 25% overall reduction in falls, although statistically insignificant, was similar to that reported in several meta-analyses of randomized controlled trials that have assessed a variety of exercise

Table 1. Pretest participant characteristics.

	PA ($n=12$)		PAPE ($n=13$)	
Variables	M	SD	M	SD
Age (years)	78.92	8.01	80.23	8.09
Operation following the fall (nb)	6	–	8	–
Hip surgery	*3*	–	*6*	–
Arm surgery	*3*	–	*1*	–
Ankle surgery	*0*	–	*1*	–

Note: M: mean; SD: standard deviation; Nb: number.

interventions, including endurance, stretching, balance, and strength training (*e.g.*, Chang *et al.*, 2004; Gillespie *et al.*, 2003; Province *et al.*, 1995). Logan *et al.* (2010) also evaluated a 6-week multifactorial intervention program to prevent falls in older adults, compared to a no-intervention control group. The program included six sessions of strength and balance exercise and six sessions of therapeutic patient education (home adaptations, getting up from the floor, footwear, and food hygiene). Results showed that the multifactorial program was associated with a sizeable reduction in the rate of falls (55%, $p < 0.001$) over the subsequent year.

To date, no study has investigated the respective contribution of therapeutic patient education programs and global physical activity programs to risk factors. Thus, the aim of the present study is to assess the efficiency of a physical activity program associated with therapeutic patient education on risk factors in the institutionalized elderly, compared to a control group with a physical activity program only. We hypothesized that while both intervention programs would induce benefits on risk factors for falls, the therapeutic patient education program would additionally strengthen these benefits.

2 Materials and methods

2.1 Participants

Thirty hospitalized patients in a rehabilitation healthcare service following a fall (18 women and 12 men, aged between 65 and 93, M = 79.60, SD = 7.91) volunteered to take part in this study. Fourteen of these thirty patients had undergone surgery following their fall (hip, arm or ankle) (Tab. 1). Each participant was included in a standard post-fall rehabilitation protocol with regular physiotherapy sessions (manual lymphatic drainage massage and electrotherapy). They provided their informed consent, and were not compensated for their participation. The inclusion criteria were as follows:

– to be over the age of 65;
– to have fallen at least once in the previous year;
– to be authorized to practice physical activity by the head of department;
– to have no mental disorder (determined by the department geriatrician).

Exclusion criteria were:

– a time under 14 seconds at the Timed Up and Go test (meaning normal mobility);
– a score over 24 at the Tinetti test (meaning low risk of falling);
– and a 16 FES-I score (meaning no concern about falling).

Participants were randomly assigned either to the physical activity (PA) group (15 patients) or to the physical activity and patient education (PAPE) group (15 patients).

Over the course of the study, five participants were not able to attend the post-test session (four participants left the study voluntarily and one participant left following an aggravation of his pathology, unrelated to the program). The analyses finally considered the 12 remaining participants in the PA group and the 13 remaining participants in the PAPE group.

2.2 Measures

All participants completed two tests and one scale. The Timed Up and Go Test (TUG; Podsiadlo & Richardson, 1991) is a simple test used to assess mobility and requires both static and dynamic balance. It uses the time that a person takes to rise from a chair, walk three meters, turn around, walk back to the chair, and sit down. A time longer than 30 seconds indicates a significant limitation of mobility. A time between 20 and 30 seconds, a slight limitation and a time less than 14 seconds, no limitation. The Tinetti test is an easily administered task-oriented test that measures gait and balance abilities. The Tinetti test (score/28) rates the ability to maintain balance while performing Activities of Daily Living related tasks (Tinetti, 1986). A score below 20 points indicates a very high risk of falling, a score between 20 and 23, a high risk of falling and a score between 24 and 27, a low risk of falling (Tinetti, 1986). The Falls Efficacy Scale International (FES-I) FES is a 16-item rating scale used to assess confidence in performing daily activities without falling (Kempen *et al.*, 2007). Scores range from a minimum of 16 (no concern about falling) to a maximum of 64 (severe concern about falling).

2.3 Procedure

The entire study lasted 10 weeks including the pre and post-test sessions as well as program sessions. During the first session, participants independently completed the

Table 2. Frequency, Time, Type and Intensity of the physical activity program.

Frequency	Time/Type	Intensity (for aerobic and strength exercises)
3 times per week	20 min Aerobic conditioning	Very mild shortness of breath (sessions 1 to 6)
8 weeks	20 min Strength training	Mild shortness of breath (sessions 7 to 12)
	20 min stretching and balance exercises	Moderate shortness of breath (sessions 13 to 18)
		Almost severe shortness of breath (sessions 19 to 24)

Table 3. Description of the four one-hour health prevention sessions.

Knowledge of a fall and its risk factors
Gather information about the patient's history of falls
Transmit various information about falls to the patients; the definition of a fall, its risk factors and its immediate and long-term consequences (physical, psychological, social, behavioral) as well as the prevention strategy
Importance of footwear and food hygiene
Understand foot importance in balance: understand the risks of falling due to footwear in poor condition or badly worn, acceptance of foot care, adapted footwear
Apply the principles of appropriate food hygiene: identify personal general food needs, consider specificities and eating habits in order to adopt a diversified and balanced diet, monitor weight
Strategies for exercise adherence
Communicate the importance and benefits of physical activity to the patient
Promote body knowledge, how to avoid suffering and injuries, and lifestyle advice (alcohol, tobacco, sedentary lifestyle)
Environment and affordances
Identify the dangers of domestic falls, formulate the actions to be taken, reorganize the environment and adopt safety strategies
Become aware of these physical abilities

battery of balance, gait and fall efficacy tests in the presence of an Ms.C. sport science student (in adapted physical activity) and a psychologist. Participants then engaged in one of the programs (PA or PAPE) chosen by a random draw. The PA program, led by the Ms.C. student in adapted physical activity, applied the FITT components (Frequency, Intensity, Time and Type) (Tab. 2). It consisted of a one-hour collective physical activity, three times per week, over a period of two months, for a total training time of 24 hours. Each exercise session consisted of a standardized format with a gradually increasing intensity level, which included 20 minutes of moderate-intensity aerobic conditioning (bike or treadmill), 20 minutes of progressive strength training (upper and lower body members), and 20 minutes of stretching and balance exercises known to impact fall risk, such as the proprioception board and the trampoline, (*e.g.*, Buchner *et al.*, 1997; Gardner *et al.*, 2000) (Tab. 2).

For the PAPE group, participants completed the same physical activity program and equally attended four one-hour health prevention sessions (one session every two weeks, led by the Ms.C. student in adapted physical activity, trained in therapeutic patient education). The main purpose of these collective sessions was to acquire basic knowledge about falling and its risk factors, and to prevent the physical and psychological consequences of falling in the elderly. The four themes were: knowledge of falling and the risk factors, the importance of footwear and food hygiene, strategies for exercise adherence and the environment and affordances (Tab. 3). During a final post-test session, participants completed the battery of balance, gait and falls efficacy tests only, under the same conditions as in the pretests.

2.4 Statistical procedure

The normal distribution of data was verified with the Shapiro-Wilk test. An Analysis of Variance (ANOVA) was conducted on each measure (time) as a within variable, with the intervention group (PA *versus* PAPE) as the between-subject variable.

3 Results

The scores of each pre-test and post-test are presented in Table 4. Scores on the TUG and Tinetti pretests, compared to age-matched norms, revealed that both groups had issues with balance and a very high fall risk (TUG > 20 seconds, Tinetti < 20 points). The FES-I pre-test revealed that patients averaged between "somewhat concerned" and "fairly concerned" by fear of falling (mean score between 2 and 3 on a 1–4 scale).

Taking the 4 participants who left the program voluntarily into account, overall adherences of both intervention programs were 83.33% for the PA program, with 280 out of a possible 336 sessions (14 participants for 24 sessions), and

Table 4. Pre and post-test scores of each measure for the PA and PAPE groups.

	PA ($n=12$)				PAPE ($n=13$)			
	Pre-test		Post-test		Pre-test		Post-test	
Variables	M	SD	M	SD	M	SD	M	SD
TUG (sec)	26.83	4.91	21.42	5.05	26.00	3.96	21.54	2.99
Tinetti (score/28)	17.33	2.10	20.67	2.15	17.85	2.15	21.08	2.14
BBS (score/56)	29.42	4.64	37.58	6.52	33.77	3.24	40.23	3.47
FES-I	39.83	3.24	37.83	3.43	38.31	2.14	34.69	2.10

Note: M: Mean; SD: Standard Deviation; n.s: non significant. Nb: Number; TUG: Timed Up and Go test, BBS: Berg Balance Scale, FES-I Falls Efficacy Scale-International.

Table 5. ANOVA results.

	F	$p<$	η^2
TUG			
Group	0.47	n.s	0.02
Time	112.81	0.0001	0.831
Group × time	1.05	n.s	0.044
Tinetti			
Group	0.31	n.s	0.013
Time	213.43	0.0001	0.903
Group × time	0.052	n.s	0.002
FES-I			
Group	4.69	0.0001	0.811
Time	115.81	0.0001	0.747
Group × time	9.58	0.01	0.294

TUG: Timed Up and Go, FES-I: Fall Efficacy Scale-International.

73.80% for the PAPE program, with 310 out of a possible 420 sessions (15 participants for 24 physical sessions and 4 therapeutic patient education sessions).

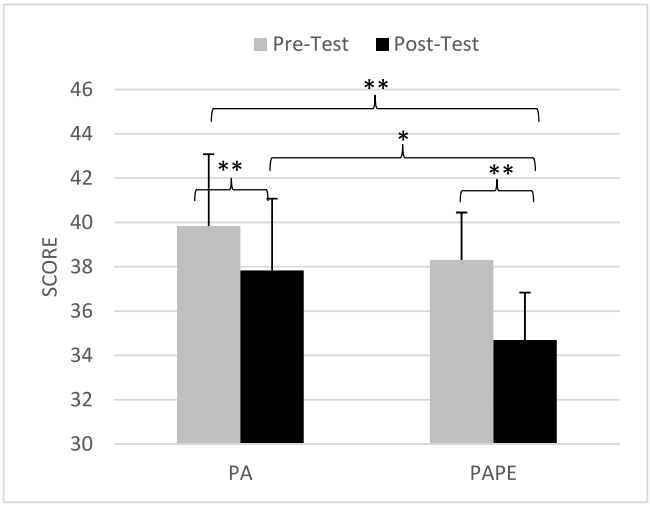
To question the benefit of each program, an Analysis of Variance (ANOVA) was conducted on each measure (time) as a within-subject variable, with the intervention group (PA *versus* PAPE) as the between-subject variable. Three main time effects (pre *versus* post-test) were found on: TUG, $F(1, 23)=112.81$, $p<0.0001$, $\eta^2=0.831$; Tinetti, $F(1, 23)=213.43$, $p<0.0001$, $\eta^2=0.903$; FES-I, $F(1, 23)=115{,}81$, $p<0.0001$, $\eta^2=0.811$. One main group effect was found on FES-I, $F(1, 23)=4.69$, $p<0.05$, $\eta^2=0.747$. Only one interaction effect was significant on the intervention group × time condition for the FES-I, $F(1, 23)=9.58$, $p<0.01$, $\eta^2=0.294$ (Tab. 5). Post hoc Newman-Keuls tests indicated a significant decrease in FES-I between the pretest and post-test for the PA group ($p<0.001$), and for the PAPE group ($p<0.0001$). Post hoc also revealed that there was no significant difference between the PA and the PAPE pre-tests ($p=n.s.$), although a significant difference can be observed between the PA and the PAPE post-tests. ($p<0.05$) (Fig. 1).

4 Discussion

The purpose of this study was to determine whether an intervention program, combining physical activity and therapeutic patient education, offers falling elderly participants a wider range of benefits on risk factors for falls compared with a simple program of physical activity.

The results, when considered before and after training, demonstrated significant benefits of both programs on each of the balance scores (TUG and Tinetti) and fear of falling (FES-I).

The beneficial effects this training has on both the balance score and the fear of falling are in line with findings of many empirical studies on physical activity (*e.g.*, Buchner *et al.*, 1997; Chang *et al.*, 2004; Franco *et al.*, 2016; Gillespie *et al.*, 2012; Sousa *et al.*, 2017) and combined programs (El-Khoury *et al.*, 2013; 2015; Gillespie *et al.*, 2012; Shumway-cook *et al.*, 2007). These results confirm that elderly people who have had a previous fall/falls may benefit –in terms of balance and fear of falling– from training programs based on therapeutic patient education and/or on physical activities. These significant benefits in terms of scores are less



*: post hoc $p < .05$; **: post hoc $p < .001$

Fig. 1. Results of FES-I pre-tests and post-tests for PA and PAPE groups.

obvious in terms of age-matched norms and clinical categorizations. Scores on the TUG post-test revealed that both groups still had issues with balance and a very high fall risk (TUG > 20 seconds). The FES-I post-test revealed that, participants still averaged between "somewhat concerned" and "fairly concerned" by fear of falling (mean score between 2 and 3 on a 1–4 scale) even if the PAPE group scores were approaching "somewhat concerned". The Tinetti post-test was the only test showing a category change after the programs. Participants went from a very high risk of falling (score < 20) to a high risk (score between 20 and 23).

The high adherence level (up to 73%) seems to report that participants on both programs were assiduous. However, there is a main difference in the effects on fall risk factors between the PA and PAPE programs. It seems that the added value of the therapeutic patient education is revealed in the fear of falling, given that FES-I was the only test in which the PAPE group benefits differed from the PA group benefits. This study suggests that PAPE training, combining physical activity and therapeutic patient education might be an effective way to reduce fear of falling among older adults who have had a previous fall/falls. Fear of falling is an important factor to consider. Indeed, literature reports that 40 to 70% of elderly, people who have fallen in the past, currently have a fear of falling (Jung, 2008). Fear of falling is associated with a decrease in daily activity, lower perceived physical health status, self-efficacy and confidence, a lower quality of life, and increased institutionalization (Brouwer, Musselman, & Culham, 2004; Cumming, Salkeld, Thomas, & Szonyi, 2000). It is also interesting to highlight that therapeutic patient education has a singular effect on the only subjective measure of the protocol. This highlights the potential impact that such programs could have on the elderly who have had a previous fall/falls in terms of regaining self-confidence while going about their daily activities, such as cleaning the house, going up or down stairs, visiting a friend. The recommendations will be more effective if the messages are positive and emphasize the benefits that the elderly can derive from improving their balance, if they are aware that falling is not inevitable, recognize their own risk factors, and feel able to act, alone or with the help of their professional and natural caregivers (Puisieux *et al.*, 2014).

This study remains exploratory and preliminary and opens the way for future interrogations. It would be interesting to consider the specific role of several variables, such as participant characteristics and the program set up. This study is part of a clinical routine, therefore the PA and PAPE programs were carried out in parallel with a physiotherapy rehabilitation program. Hence, concerning the possible sources of improvement, we cannot conclusively distinguish between the training programs based on therapeutic patient education and/or on physical activities and the hospital care. Furthermore, the participants did not all have the same pathological profile. Some were recovering from surgery, others were not. Among those who had had surgery, some had been operated on upper limbs, others on lower limbs. The mechanical and psychological consequences on walking and the risk of falling are not the same. Even though the geriatrician considered that the participants did not suffer from cognitive impairment, no assessment of cognitive skills was performed (*e.g.*, the Mini Mental State Examination). Thus, the participant selection may be biased due to the lack of cognitive function standardized assessment.

Future studies should explore the FITT components (Frequency, Intensity, Time and Type) in more detail in order to enable the optimal consideration of training components. The training threshold, which represents the minimum amount of activity required to produce effects is not clearly defined, particularly for this specific audience.

The most important perspective of this work lies in the conversion of these advances in terms of fall prevention, providing information about the participant's long-term evolution. Indeed, we are proposing results on data related to well identified fall risk factors but no data in this study directly concerns the fall. Most of all, this study does not address the effect of fear of falling on the risk of falling, or even on falls. Therefore, several questions remain unanswered and future work with the same participants should be planned in order to gather important information on the fall rate and the retention of the observed effects on the indicators of the participant's fall risk several months after the program. We could also see if the benefits have lasted longer for the group that followed the therapeutic education sessions, since therapeutic education aims to change lifestyle habits which increase the risk of falling. One of the main objectives of therapeutic education is to bring about long-term change (Ferrières *et al.*, 2006). It is an ongoing process, adapted to the evolution of the disease and the patient's lifestyle, with long-term management (HAS, 2007). Consequently, the setting up of maintenance phases, as advised in the Pegase project (Ferrières *et al.*, 2006) with a strengthening of all acquired skills could be relevant.

Given that this study suggests an added value of therapeutic education, it would be relevant to continue this work in relation to the cognitive level of the participants. Indeed, the work of Haines *et al.* (2011) has shown a beneficial effect of therapeutic education with reduced falls among patients with intact cognitive functions. This work suggests the importance of sufficient retention of cognitive abilities in order to integrate the benefits of therapeutic education. Future work will help to identify from which cognitive level therapeutic patient education remains relevant, especially since dementia and falls are strongly associated (Puisieux, Pardessus & Bombois, 2005). Another perspective for future research would be to assess in more detail the specific contribution of each intervention (hospital care, physical activity and therapeutic patient education) on fall prevention. Clearly, this important direction might allow a more accurate understanding of the clinical potential of therapeutic patient education on fall prevention.

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