Impact of the abandonment of assistive technologies for mobility on the incidence of serious falls in older adults living at home: Results of the ECOCAT study

Abdoul Razak Sawadogo[1,2,3,4] , Jean-François Nys[1], Estelle Tran[2], Caroline Gayot[1,2,3], Sophie Boyer[1,2,3], Noëlle Cardinaud[1,2,3], Clémence Thebaut[5] and Achille Tchalla[1,2,3]

Abstract

Purpose: To examine the impact of discontinuing the use of assistive technology for mobility (ATM) devices on the 6-months incidence of falls in older adults (OA) living at home.

Materials and methods: A medico-socioeconomic survey was performed to collect information on the quality of life and well-being of older adults, before and 6 months after being loaned an ATM device. Personal data (medical, social, and economic) were collected via a geriatric survey.

Results: In all, 102 OA participated in the study. Over the 6-months observation period, 17 (n = 81) serious falls were recorded among participants who were using their ATM device optimally; in those who discontinued device use, 12 falls (n = 21) were recorded (57.1%; p = 0.001). Factors significantly associated with falls at home were living in an urban area (odds ratio [OR]: 11.46; 95% confidence interval [CI]: 1.48; 88.98; p = 0.020), an Instrumental Activities of Daily Living Scale score > 4 (OR: 34.04; 95% CI: 1.59; 727.86; p = 0.024), and discontinuation of ATM device use (OR: 17.41; 95% CI: 2.59; 117.02; p = 0.003).

Conclusion: Discontinuation of ATM device use was associated with an increased risk for serious falls.

Keywords

Assistive Technologies, mobility, devices, older adults, serious falls, occupational therapists

Introduction

Several definitions of assistive technology (AT) are provided in the literature. According to the International Classification of Functioning, Disability and Health (ICF), ATs include any product, instrument, equipment, or technology adapted or specially designed to improve the functioning of a person with a disability.[1] The most recent definition of assistive products was provided by the Global Cooperation on Assistive Technology (GATE), as follows: "an assistive product is any product (including devices, equipment, instruments, and software), either specially designed and produced or generally available, whose

[1]Laboratoire VIESANTE - UR 24134 (Vieillissement, Fragilité, Prévention, e-Santé), IFR OMEGA HEALTH, Université de Limoges, Limoges, France
[2]Unité de Prévention, de Suivi et d'Analyse du Vieillissement (UPSAV), Pôle HU Gérontologie Clinique, CHU de Limoges, France
[3]Unité de Recherche Clinique et d'Innovation (URCI) de Gérontologie, CHU de Limoges, Pôle HU Gérontologie Clinique, Limoges, France
[4]Gerontopôle Nouvelle-Aquitaine, Limoges
[5]UMR 1094 Neuroépidémiologie Tropicale (NET), Université Paris Dauphine, PSL, LEDA-Legos, Université de Limoges, France

Corresponding author:
Achille Tchalla, University Hospital Centre, Department of Clinical Geriatric, 2 Avenue Martin Luther King, Limoges 87042, France.
Email: achille.tchalla@unilim.fr

primary purpose is to maintain or improve an individual's functioning and independence and thereby promote their well-being".[2] All definitions agree that AT devices modify the physical environment to improve or fully restore the user's capacity to perform personal care, work or leisure activities. They also prolong autonomy, reduce the risk for accidents in everyday life, and are likely to reduce the number of hours of human assistance required in the home by older adults.

However, these benefits are only realised if the person uses the AT device correctly. Therefore, third-party support is of paramount importance for frail older adults because of the learning difficulties that they frequently experience. In a study published in 1988,[3] the importance of a follow-up plan was emphasised for older adults using AT devices. This support begins with a diagnosis of the user's expectations and needs, since behind one need lies another. Identifying or diagnosing all these needs is an essential step in ensuring the proper use of the recommended AT and the follow -up plan to be put in place.

In France, networks and groups of health professionals advocate for coordinated care of frail older adults. First, an occupational therapist assesses the patient's needs in the home and recommends an AT device based on consultations with other health professionals. Then the occupational therapist makes several follow-up visits to the home to ensure that the device has been fully integrated into the patient's living environment.[4] The older adult's occupational roles, physical and cognitive abilities, and preferences and intentions with respect to AT device use are also ascertained. Through a multidisciplinary process, the occupational therapist can consult with other experts. An attending physician can recommend an AT device to a frail older adult in the absence of a multidisciplinary team environment; however, this has been criticised because the competence of attending physicians with respect to prescribing AT devices may be limited by the nature of their professional training.[4]

According to the World Health Organization (WHO) (2018), at least one reimbursement list is available for the National Health Insurance programs of most European countries.[5] In France, Article L165-1 of the Social Security Code lists reimbursable products and services. The application form for inclusion on this list consists of three parts[6]: summary of the application, a medico-technical report, and an economic report. However, manufacturers encounter several difficulties when conducting clinical and economic studies, including high financial costs, long lead times, challenges in recruiting and enrolling participants to studies, a lack of personnel dedicated to clinical and economic research, regulatory and administrative complexity, and clinical and financial barriers to global application. Thus, some manufacturers opt out of National Health Insurance programs, thereby passing costs on to the users of AT devices.

The geriatric mobile team (GMT) of the University Hospital Centre (UHC, Limoges, France) launched the ECOCAT project, in which older adults were loaned AT devices after an occupational therapy evaluation in the home. The loaned devices (the worn parts of which were professionally cleaned before being given to the older adults) were donated as part of a larger program conducted in Nouvelle-Aquitaine. The UHC received financial support from project partners, including "*Caisse Nationale de Solidarité Autonomie*" (CNSA), to build up an initial stock of AT devices. The beneficiaries of the AT devices also received multidisciplinary support from the project team, which consists of occupational therapists, social workers, geriatricians, nurses, clinical research assistants and health economists. Follow-up visits aimed to reduce the rate of discontinuation of AT. Empirical studies have reported dropout rates of 20–50%.[7–10] Discontinuation of AT use may have direct health and social welfare costs, and increases the demand on family caregivers.[11] The project team used several organizational models from the literature, including the Matching Person and Technology (MPT) model[12] and a model introduced by Phillips et al.[13] Regaining or prolonging mobility through AT is a critical issue in fall prevention.[14] For Chase et al.[15] (2012), ATM and home modifications accompanied by multidisciplinary interventions prevent falls in older adults.

According to the WHO, approximately 28–35% of older adults (aged ≥ 65 years) suffer a fall each year; the proportion increases to 32–42% for those aged > 70 years.[16] In total, 80% of the accidents in daily life experienced by those aged ≥ 65 years are falls. Moreover, more than half of all fallers (51.3%) fall more than twice a year,[17] and seven out of every 10 falls occur in the home Injuries caused by falls account for 85% of emergency department visits by adults aged ≥ 65 years. In extreme cases, falls can lead to premature death[18]; in 2016, >10,000 older adults died following falls.[19] Therefore, falls impose a burden on healthcare and social services. The healthcare costs of a fall depend on its severity; estimates range from €2316.74 (95% confidence interval [CI]: 1395.00; 3456.87) to €9285.71 (95% CI: 6768.88; 12,073.14).[20] According to the Medical Information Department and the Medico-economic Evaluation Unit of Toulouse University Hospital, the financial cost of hospitalizations for falls was €600 million in 2019 (€534 million for public institutions and €67.5 million for private institutions, excluding medical fees).[21]

This study examines the impact of discontinuing the use of ATM devices (bed rails, toilet risers, swivel bath seats, bath boards, grab bars with suction cups, 4-wheel rollators, walking frames, canes, booster stools, bathtub access bars, bedposts, and support bars) on the incidence of serious falls

among older adults living at home. The ATM devices were classified using the United Nations Children's Emergency Fund (UNICEF) classification system.[1]

Materials and methods

Eligibility Criteria

Inclusion criteria. The GMT of the UHC of Limoges conducted this prospective, single-centre study. The participants were men and women aged ≥ 65 years living in Haute-Vienne, France, with a life expectancy of ≥ 1 year. All participants completed the Comprehensive Geriatric Assessment (CGA) at home, followed by occupational therapy evaluations. They were provided with at least one ATM device, free of charge for ≥ 6 months, and gave informed consent after reading the information sheet. A family member or guardian could support the older adult during the consent process if necessary. The study protocol was reviewed and approved by the hospital's senior scientific board.

Exclusion criteria

We excluded older adults from the study based on the following criteria:
- Died before the end of follow-up (6 months after being loaned an ATM device);
- Did not undergo an occupational therapy evaluation after the CGA;
- Was not loaned an ATM device after occupational therapy evaluation due to unsuitability;
- Had an obsolete AT device and was institutionalised within 6 months;
- Discontinued use of their ATM device due to improvement or deterioration of functional status (as determined by an occupational therapist).
- Who were loaned multiple ATM devices but did not use them all consistently.
- Dropouts (People who wished to leave the study), participants lost to follow-up, and those who used an AT device intended to prevent adverse events other than serious falls (such as spoons).

Data collection

All participants underwent the same assessment process; the investigators evaluated them at the time of loaning the AT device and 6 months thereafter. All data were anonymised and entered into a database. We collected data via a medico-socioeconomic survey and the Comprehensive Geriatric Assessment (CGA); only the latter of these two surveys is regularly used by the GMT.

Medico-socio-economic survey

The medico-socioeconomic survey included three separate questionnaires: a medico-socioeconomic questionnaire developed by the project team, the EuroQol five Dimensions three Levels (EQ-5D-3 L)[22] questionnaire and the Icepop Capability Measure for Older People (ICECAP-O) questionnaire.[23–25] We tested the questionnaires in five older adults prior to the study.

The medico-socioeconomic questionnaire, which was completed only at the 6-months timepoint, includes the following domains: age, sex, place of residence, marital status, employment status before retirement, previous socio-professional status, monthly income, presence of family caregivers, history of falls/serious falls, and number of ATM devices used.

The EQ-5D-3 L and ICECAP-O questionnaires were administered at baseline and the 6-months timepoint.

The EQ-5D-3 L is a generic instrument for assessing mobility, self-care, usual activities, pain/discomfort and anxiety/depression. For each item, the patient must choose from among three levels of severity: no problems, some problems, or severe problems. The EQ-5D-3 L includes items pertaining to 243 health states. A weighting (utility) function is associated with each state. The quality-adjusted life year (QALY) is a measure of both the quantity (duration) and quality of survival. A utility score is assigned for a given health state depending on the time spent therein. Researchers quantify QALY using a simple scale, on which 1 corresponds to perfect health and 0 to death. Some health states are considered worse than death, and thus have negative QALY values.[22]

The ICECAP-O provides a measure of ability-related well-being; it quantifies a person's ability to perform specific actions and achieve certain outcomes. The ICECAP-O assesses five dimensions of capability: attachment (love and friendship), security (thinking about the future without concern), role (doing things that make you feel valued), enjoyment (enjoyment and pleasure), and control (independence).[25] There are four response options for each dimension: no capacity, little capacity, high capacity and full capacity; therefore, there are 1024 potential "capacity states" for the entire instrument. ICECAP-O scores take a numerical value between 0 (no capacity) and 1 (full capacity).[23]

Comprehensive Geriatric Assessment

The CGA is a multidimensional interdisciplinary health assessment designed to facilitate the management of older adults in a coordinated manner. This structured assessment is used to identify the medical, psychological, functional, and social problems experienced by older adults, to predict the risk of loss of autonomy. Based on the results,

preventive actions can be recommended. The CGA is intended for people aged > 75 years, as well as for those aged ≥ 65 years with multiple diseases. A geriatrician, accompanied by a nurse, performs the CGA in the home at the request of the secretariat of the GMT from an older adult (or their family). We used the CGA because it covers multiple factors that can lead to serious falls in the home.[26]

The socio-environmental component of the CGA solicits the following patient information: age, sex, date of birth, previous occupation, level of education, family situation, housing status and type, ATM equipment available in the home, monthly household income, financial aid, social security status and other benefits, availability of human assistance, and occupational activities. Functional autonomy is assessed using the following scales: the Activities of Daily Living (ADL) Scale,[27] Instrumental Activities of Daily Living (IADL) Scale,[28] Functional Autonomy Measurement System (SMAF)[29] and Iso-Resource Group (IRG) scale.[30] The ADL Scale assesses six basic ADLs: personal hygiene, dressing, toileting, transferring, continence and eating (autonomy, one point; partial dependence, 0.5 points; total dependence, 0 points). The scores for each domain are summed, ranging from 0 (most dependent) to 6 (most independent). The IADL Scale assesses IADLs, which are more complex than ADLs and include making phone calls, running errands, cooking, performing household chores, washing clothes, using transportation, and managing treatment and finances. Each item is scored as 0 or 1. Total scores are obtained by summing those for each domain and range from 0 (least autonomous) to 8 (most autonomous).

The SMAF uses an assessment grid of 29 functions grouped into five domains: ADL (7 items), mobility (6 items), communication (3 items), mental functions (5 items) and household tasks (8 items). For each item, disability is scored on the following 5-point scale: 0, independent; −0.5, with difficulty; −1, needs supervision; −2, needs help; −3, dependent. Total scores thus range from 0 to −87. A score ≤ −16 is indicative of a loss of independence. We included absolute values for the SMAF in our analysis, in accordance with international recommendations.

The "*Autonomie Gérontologique et Groupes Iso-Ressources*" (AGGIR) instrument is used for evaluating the dependence of older adults in France. It is a 17-item questionnaire that assesses complex physical activities, cognitive functions and social activities (walking, dressing, toileting, cleaning, cooking, taking medication, housework, and so forth). Scores of 1–2, 3–4 and 5–6 reflect high, moderate and low dependency, respectively.

The Mini-Mental State Examination (MMSE)[31] (30 items; total score range: 0–30) assesses neurological functions (spatial and temporal orientation, ability to perform calculations, praxis, learning, short-term memory, and

language). A score of 0 reflects the maximum possible level of cognitive impairment and a score of 30 indicates no cognitive impairment. A score < 24 indicates cognitive dysfunction.

The 30-item Geriatric Depression Scale (GDS)[32] assesses the level of depression of older adults in the past week using "yes" or "no" questions. Scores of 0–5 indicate normal mood, while scores of 5–9 indicate a risk for depressive symptoms, and scores > 9 reflect severe depressive symptoms. The highest possible total score is 30.

Fried et al.[33] used five criteria to define frailty/weakness, as follows: low grip strength (dominant hand < 20% of normal), slowness (walking speed < 20% of normal), low physical activity level in the past 2 weeks (< 20% of normal energy expenditure based on a physical activity questionnaire), low energy or self-reported exhaustion, and unintentional weight loss (4–5 kg since the previous year). An older adult is classified as "frail," "pre-frail" or "robust" when ≥3, ≥1, and no criteria are met, respectively.

The unipedal stance test[34] is used to screen for the risk of falling; if the stand time is <5 s, there is a risk of falling.

Some assessment tools from the medico-socioeconomic survey are also included in the GGA, such as the EQ-5D-3 L quality of life questionnaire. These data were standardised before the analysis. In the CGA, polypathology is defined as the presence of at least two comorbidities, while polymedication is defined as taking at least four medications per day.

Variables

Predictor variable: discontinuation of ATM. Two questions were used to categorise the older adults according to the extent of ATM device use: How many times per week do you perform activities related to your ATM device? How many times per week do you actually use your ATM device when performing this activity?

The "UPSAV-ECOCAT" group included older adults who used their ATM devices optimally during the 6-months observation period, i.e. on 50–100% of occasions on which the related activity was performed. Participants with an ATM device use rate of 0–49% were classified into the "HABITUAL" group. The mobility issues of the older adults in this group persisted, as judged by occupational therapists. These device use thresholds were decided upon during multidisciplinary project team meetings.

Outcome variables: future serious falls

A fall occurs when a person unintentionally drops to the ground or another surface below which they were standing.[35] Only serious falls, i.e. those resulting in full or partial hospitalization (>24 and ≤24 h, respectively), were included in our analysis. Participants who had at least one serious fall

during the 6-months study period were classified as "fallers"; all other participants were "non-fallers." The project team recorded the number of serious falls each week during the study period, as reported during telephone calls with the older adults and/or their family members. This information was cross-referenced with the data on serious falls recorded during the GGA.

Other covariates

The explanatory variables for severe falls were as follows: age (<80 vs. ≥80 years), sex (male vs female), place of residence (rural vs urban), diploma (yes vs no), monthly income (≤€1008 vs. >€1008), presence of family caregiver (no vs yes), polypharmacy (yes vs no), polypathology (yes vs no), history of falls (yes vs no), depression (yes vs no), and the MMSE (< 24 vs. ≥ 24), ADL (≤ 3 vs. > 3), IADL (≤ 4 vs. > 4), SMAF (≥ 16 vs. < 16), IRG scale (3–4 vs. 5–6) and frailty scores (pre-frail [score of 1–2] vs. frail [score of ≥ 3]).

Statistical analysis

Descriptive statistics were generated for the medico-socioeconomic variables (frequencies and percentages for qualitative variables, medians with 25% and 75% percentiles for quantitative variables). We compared the UPSAV-ECOCAT and HABITUAL groups using the Mann-Whitney U test for quantitative variables and chi-square test for qualitative variables.

In a univariate logistic regression model, associations between explanatory variables and the occurrence of serious falls at home were evaluated by odds ratios (ORs) with 95% CIs. All significant variables were included in the multivariate model, along with confounding variables. All statistical analyses were performed using SigmaStat 3.5 software (SigmaStat, San Jose, CA, USA). The significance level was set at $p < 0.05$.

Results

Participant demographics

After the assessments, 184 older adults received an ATM device, and 138 (75%) consented to participate in the study. The multidisciplinary project team reassessed 102 of the older adults (55.4%) 6 months after loaning the devices. In total, 36 older adults were excluded (19.6%) during this phase, for the following reasons: four died, two were institutionalised, six were using obsolete devices, three returned their devices for unspecified reasons, and 21 had a device for <6 months. Of the 102 older adults reassessed after 6 months, 81 (44.0%) used their ATM device optimally, while 21 (11.4%) discontinued device use (Figure 1).

The ATM devices that were abandoned by older adults were the following: bed rails, toilet risers, swivel bath boards, bath boards, grab bars with suction cup, rollators_ four wheels, walking frames, canes, shower stools, bathtub acces bars, bedposts, support bars (Figure 2).

Participant characteristics

Table 1 shows the baseline characteristics of the study population.

Age. In total, 84.3% of the total cohort was aged > 80 years; the UPSAV-ECOCAT and HABITUAL groups did not significantly differ in age (chi-square = 0.088).

Sex. The study population was predominantly female (67.6%). The sex ratio was not significantly different between the two groups (chi-square = 0.012).

Place of residence. In total, 72.5% of the older adults lived in urban areas and 27.5% lived in rural areas. The proportion of older adults living in urban areas did not significantly differ between the two groups (chi-square = 1.504).

Marital status. In total, 67.6% of the study population were widows; the proportion of widows did not significantly differ between the two groups (chi-square = 0.615).

Employment status before retirement and income. Most (75.5%) of the participants were graduates; the proportion of graduates was not significantly different between the two groups (chi-square = 2.638). Similarly, most (56%) of the participants were previously employed, and the proportion was not significantly different between the two groups (chi-square = 0.150). In total, 66% of the total population had an income exceeding €1008 per month, with no group difference seen in the proportion of older adults earning that amount (chi-square = 0.761).

Presence of family caregivers. Nearly 80.5% of older adults had a family caregiver who helped them carry out ADL. The proportion of older adults with a family caregiver did not significantly differ between the two groups (chi-square = 0.791).

4 medications)",1,1,3,0>4 medications)", "pdflink",1,1,0>Polypathology (≥2 comorbidities) and polymedication (>4 medications). In all, 85.3% of the total population satisfied the criterion for polypathology; there was no group difference in the rate of polypathology (chi-square = 0.351). The criterion for polymedication was met by 88.2% of the total population, and there was no significant group difference (chi-square = 0.002).
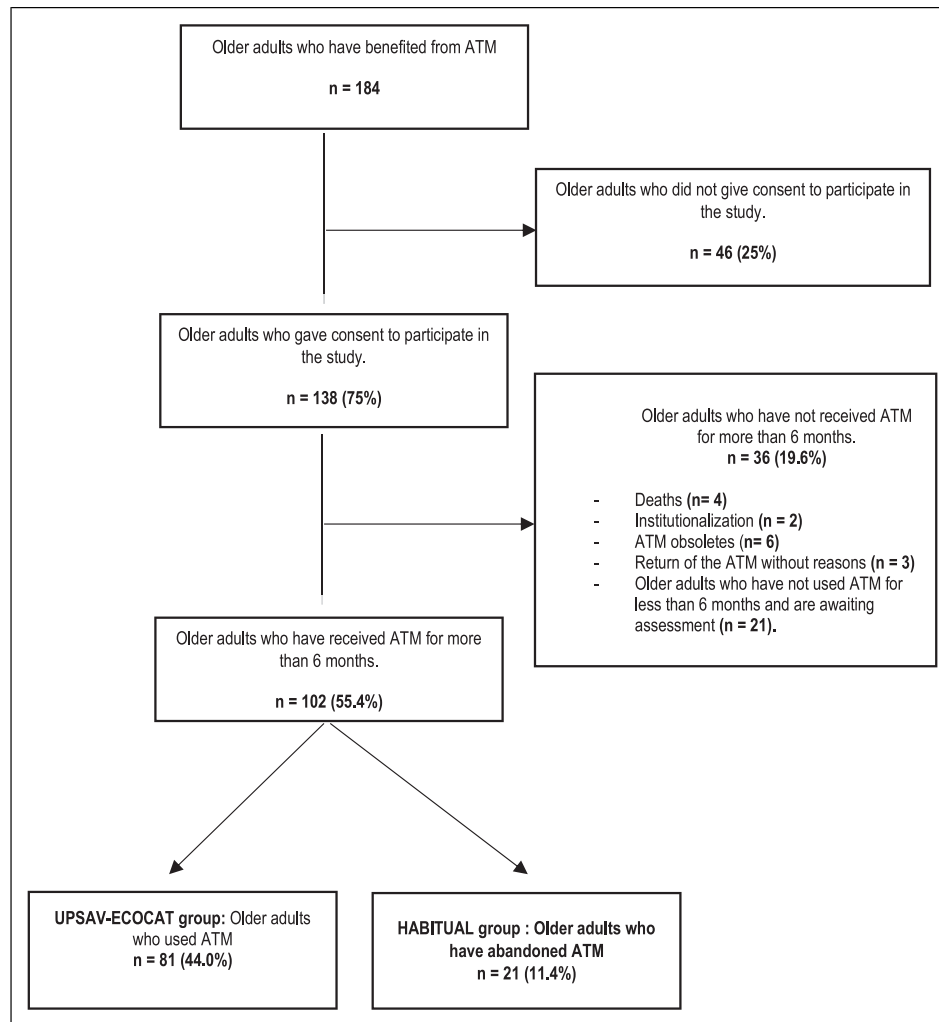
Figure 1. Flow chart of study participants, November 2016 to August 2019, Nouvelle-Aquitaine, France.

History of falls. Overall, 67.6% of the total population had a history of falls; there was no group difference in the history of falls (chi-square = 0.012).

Cognitive and psychological disorders. According to the MMSE and GDS, 61.8% of the entire cohort had cognitive impairment; the proportion was not significantly different between the groups (chi-square = 0.986). The overall proportion of older adults with depression was 60.8%, and was again not different between the groups (chi-square = 0.783).

Functional autonomy (ADL Scale, IADL Scale, IRG scale and SMAF scores). The proportion of older adults who were not functionally dependent was 17.6% according to the ADL Scale, and 15.7% according to the IADL Scale. In total, 55.9% of the total population IRG scale scores of 3–4. For all three of these metrics, there were no significant group differences (chi-square = 2.172, 3.056 and 0, 899,

respectively), which was also the case for the SMAF (chi-square = 0, 147).

Fried classification. According to Fried's five criteria, 55% of the total population was pre-fragile; there was no group difference in the proportion of such older adults (chi-square = 0.436).

Quality of life and well-being scores. There were no significant differences in quality of life scores between the two groups (Mann-Whitney U statistic = 867.500; $p = 0.891$), but a group difference was seen in well-being (Mann-Whitney U statistic = 8325.500; $p < 0.001$).

ATM. In total, 78% of the total population used at least one ATM device; the use rate was not significantly different between the groups (chi-square = 0.0424).

There were no significant group differences in any participant characteristic except well-being. Variables that
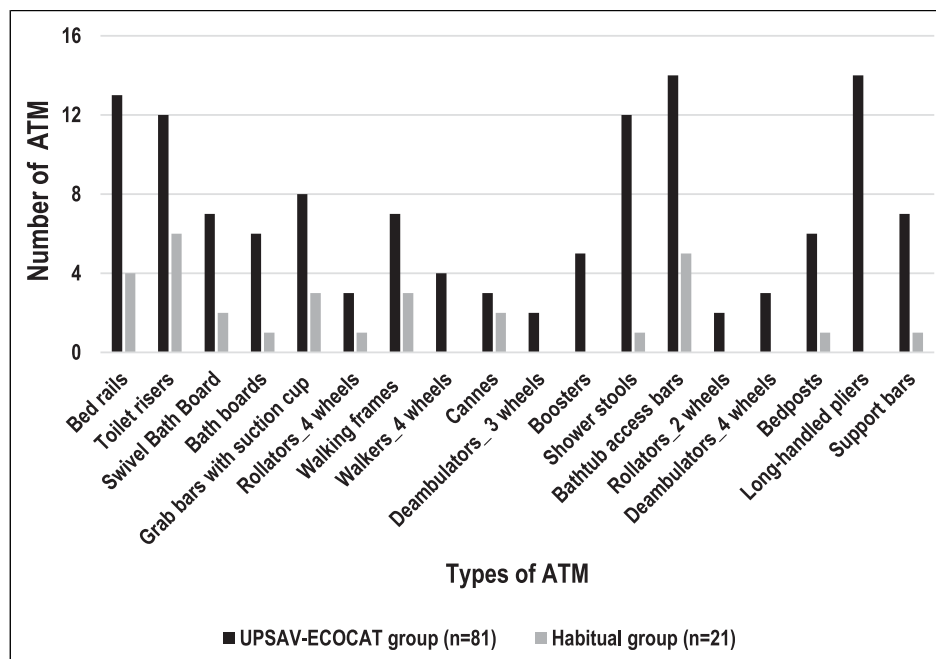
Figure 2. The distribution of ATM in the two groups.

we considered likely to explain serious falls in older adults were included in the univariate logistic regression model. Overall, however, we limited the number of risk factors in the model so that the true impact of discontinuing ATM device use on serious falls in the home could be determined.

Serious falls at home

In total, 17 (21.0%) serious falls were recorded in the UPSAV-ECOCAT group, compared to 12 (57.1%) in the HABITUAL group (chi-square = 10.71; *p* = 0.003) (Table 2).

Univariate and multivariate logistic regression models predicting serious falls during the 6-months follow-up period

The results of the univariate and multivariate regression models performed to identify risk factors for falls are presented in Tables 3 and 4. There were five significant variables in the univariate model: MMSE score ≥ 24 (OR: 4.19; 95% CI: 1.43; 12.17; *p* = 0.009), IADL Scale score > 4 (OR: 25.79; 95% CI: 3.33; 199.70; *p* = 0.002), SMAF score (OR: 25.79; 95% CI: 3.33; 199.70, *p* < 0.001), pre-frail status (OR: 2.85; 95% CI: 1.12; 7.26; *p* = 0.028), and ATM device discontinuation (OR: 5.02; 95% CI: 1.82; 13.87; *p* = 0.002).

Twelve variables with *p*-values ≤ 0.25 were included in the initial multivariate model. In the final model, the

variables significantly associated with the occurrence of serious falls at home were as follows: living in an urban area (OR: 11.46; 95% CI: 1.48; 88.98; *p* = 0.020), IADL Scale score > 4 (OR: 34.04; 95% CI: 1.59; 727.86; *p* = 0.024) and discontinuing ATM device use (OR: 17.41; 95% CI: 2.59; 117.02; *p* = 0.003).

Discussion

Various fall-prevention programs have been reported.[36] Approximately 50% of serious falls are preventable,[37] and these programs have shown the ability to significantly reduce the risk of falling.[38] However, older adults do not always adhere to these programs.[39,40] ATM device use discontinuation is a significant issue; the rate in this study was 21%, similar to previous studies (18–39%).[7] In Wielandt et al. ,[7] older adults (aged 69.2 ± 10.4 years) used ATM devices for bathing, grooming, and dressing after discharge from the hospital. The main difference from our study was that they did not employ a multidisciplinary team to follow up participants in their homes and encourage them to keep using their ATM devices.

The rate of non-adherence to fall-prevention programs among older adults with chronic diseases is high, at 40–60%.[41] There are several reasons for non-adherence, including perceived ineffectiveness and a lack of knowledge and understanding of the risks of falling.[42] Other relevant factors include the costs of prevention programs, lack of transportation and free time, and prohibitive travel distances.[43–45] These socioeconomic

Table 1. Characteristics of the study population.

Characteristics	Total (N = 102)	Older adults with optimal use of ATM, UPSAV-ECOCAT group (N = 81)	Older adults who have abandoned ATM, Habitual group (N = 21)	p-value or chi-square
Age				
>80, n (%)	86 (84.3)	69 (85.2)	17 (81.0)	Chi-square =
⩽ 80, n (%)	16 (15.7)	12 (14.8)	4 (19.0)	0.088
Sex				
Women, n (%) n (%)	69 (67.6)	55 (67.9)	14 (66.7)	Chi-square =
Men, n (%)	33 (32.4)	26 (32.1)	7 (33.3)	0.012
Place of residence				
Urban, n (%) n	74 (72.5)	61 (75.3)	13 (61.9)	Chi-square =
Rural, n (%)	28 (27.5)	20 (24.7)	8 (38.1)	1.504
Marital status				
Widowed, n (%)	69 (67.6)	56 (69.2)	13 (61.9)	Chi-square =
Married and living with spouse, n (%)	30 (29.4)	23 (28.4)	7 (33.3)	0.615
Married but separated from spouse, n (%)	1 (1.0)	1 (1.2)	0 (0.0)	
Divorced, n (%)	2 (2.0)	1 (1.2)	1 (4.8)	
Diploma				
Yes, n (%)	77 (75.5)	64 (79,0)	13 (61.9)	Chi-square =
No, n (%)	25 (24.5)	17 (21,0)	8 (38.1)	2.638
Employment status before retirement				
Managers, n (%)	3 (2.9)	2 (2.5)	1 (4.7)	Chi-square =
Employees, n (%)	57 (55.9)	46 (56.8)	11 (52.4)	0.150
Craftsmen/Shopkeepers, n (%)	15 (14.7)	12 (14.8)	3 (14.3)	
Farmers, n (%)	11 (10.8)	8 (9.9)	3 (14.3)	
No professional activity, n (%)	16 (15.7)	13 (16.0)	3 (14.3)	
Monthly income				
<803	23 (22.5)	19 (23.4)	4 (19.0)	Chi-square =
Between 803 and 1008€, n (%)	12 (11.8)	11 (13.6)	1 (4.8)	0.761
>1 008 €, n (%)	67 (65.7)	51 (63.0)	16 (76.2)	
Presence of family caregivers				
Yes, n (%)	82 (80.4)	65 (80.2)	17 (81.0)	Chi-square =
No, n (%)	20 (19.6)	16 (19.8)	4 (19.0)	0.791
Number of daily medications >4				
Yes, n (%)	90 (88.2)	72 (88.9)	18 (85.7)	Chi-square =
No, n (%)	12 (11.8)	9 (11.1)	3 (14.3)	0.002
Commorbidities ⩾2				
Yes, n (%)	87 (85.3)	70 (86.4)	17 (81.0)	Chi-square =
No n (%)	15 (14.7)	11 (13.6)	4 (19.0)	0.351
Level of dependence				
IRG 1–2, n (%)	11 (10.8)	8 (9.9)	3 (14.3)	Chi-square =
IRG 3–4, n (%)	57 (55.9)	46 (56.8)	11 (52.4)	0.899
IGR 5–6, n (%)	34 (33.3)	27 (33.3)	7 (33.3)	
Depressive Syndrome (GDS >9)				
Yes, n (%)	62 (60.8)	51 (63.0)	11 (52.4)	Chi-square =
No, n (%)	40 (39.2)	30 (37.0)	10 (47.6)	0.783
MMSE				

Table 1. (continued)

Characteristics	Total (N = 102)	Older adults with optimal use of ATM, UPSAV-ECOCAT group (N = 81)	Older adults who have abandoned ATM, Habitual group (N = 21)	p-value or chi-square
≥24, n (%)	63 (61.8)	52 (64.2)	11 (52.4)	Chi-square = 0.986
<24, n (%)	39 (38.2)	29 (35.8)	10 (47.6)	
ADL				
>3, n (%)	84 (82.4)	69 (85.2)	15 (71.4)	Chi-square = 2.172
≤ 3, n (%)	18 (17.6)	12 (14.8)	6 (28.6)	
IADL				
>4, n (%)	86 (84.3)	49 (60.5)	17 (81.0)	Chi-square = 3.056
≤ 4, n (%)	16 (15.7)	32 (39.5)	4 (19.0)	
SMAF				
≥ 16, n (%)	62 (60.8)	50 (61.7)	12 (57.1)	Chi-square = 0.147
<16, n (%)	40 (39.2)	31 (383)	9 (42.9)	
Critère de Fried				
Robust (1 critère), n (%)	10 (9.8)	8 (9.9)	2 (9.5)	Chi-square = 0.436
Pre-frail (1–2 criteria), n (%)	56 (54.9)	46 (56.8)	10 (47.6)	
Frail (3 or more criteria), n (%)	36 (35.3)	27 (33.3)	9 (42.9)	
Utility score				
me (Q1; Q3)	-	0.275 (0.202; 0.430)	0.275 (−0.021; 0.593)	p = 0.891
Well-being score				
me (Q1; Q3)	-	0.332 (0.284; 0.355)	0.243 (0.204; 0.307)	p < 0.001
Number of AT for mobility				
1 AT, n (%)	80 (78.4)	63 (77.8)	17 (80.9)	Chi-square = 0.424
Between 2 and 3 AT, n (%)	17 (16.7)	14 (17.3)	3 (14.3)	
4 AT and more, n (%)	5 (4.9)	4 (4.9)	1 (4.8)	

IRG, Iso-Resource Group; GDS, Geriatric Depression Scale; MMSE, Mini-Mental State Examination; ADL, Activities of Daily Living; IADL, Instrumental Activities of Daily Living; SMAF, Functional Autonomy Measurement System; ATM, assistive technology for mobility.

Table 2. Serious falls incidence rates.

	Total (N =102)	Older adults with optimal use of ATM, UPSAV-ECOCAT group (N = 81)	Older adults who have abandoned ATM, Habitual group (N = 21)	p-value
Falls, n (%)	29 (28.4%)	17 (21.0%)	12 (57.1%)	p = 0.001
Non-falls, n (%)	73 (71.6%)	64 (69%)	9 (42.9)	

and environmental factors were not applicable in our study because the ATM devices were loaned to the older adults for free.

Three main factors influence ATM device use compliance: the characteristics of the user, technology, and environment.[12] The factors promoting compliance are as follows:

- **User characteristics:** motivated, cooperative, optimistic, adaptable, disciplined, and aware of the generally positive impact of device use on quality of life; ability to use the device; acceptance of the difference between the ideal and actual situation; willingness to take on challenges.

- **ATM device characteristics:** useable with little or no pain, fatigue, discomfort or stress; compatible with other ATM devices; safe, reliable, easy to use and maintain, transportable, market-leading, aesthetically pleasing.
- **Environmental characteristics:** support from family, co-workers, and employer; realistic family and employer expectations of ATM device; encouragement from family, co-workers, and employer to use the device.

The risk factors for device noncompliance are as follows:

- **User characteristics:** fear of becoming dependent; embarrassed to use an ATM device; depressed,

Table 3. Results of univariate regression analysis of the impact of discontinuation of ATM device use on the incidence of falls in the home among older adults.

Variables	Odds Ratio (OR)	95% CI	*p*-value
Degree of use of ATM			
Optimal use	Ref	-	
Abandonment	5.02	[1.82; 13.87]	0.002*
Age			
>80, n (%)	Ref	-	
⩽ 80, n (%)	1.23	[0.36; 4.18]	0.741
Gender			
Female, n (%)	Ref	-	
Male, n (%)	1,14	[0,46; 2,85]	0.772
Place of residence			
Rural, n (%)	Ref	-	
Urban, n (%)	2.25	[0.81; 6.22]	0.118*
Diploma			
Yes, n (%)	Ref	-	
No, n (%)	1.60	[0.61; 4.20]	0.337
Monthly income			
≤1008 €	Ref	-	
>1008 €	2.53	[0.92; 6.96]	0.073*
Presence of family caregivers			
No	Ref	-	
Yes	1.24	[0.41; 3.80]	0.705
Number of daily medications >4			
Yes	Ref	-	
No	2.12	[0.66; 6.76]	0.205*
Commorbidities ⩾ 2			
Yes	Ref	-	
No	2.58	[0.84; 7.95]	0,098*
History of falls			
Yes	Ref	-	
No	1.53	[0.63; 3.73]	0,345
Depressive syndrome (GDS >9)			
Yes	Ref	-	
No	2,06	[0.86; 4.93]	0.106*
MMSE			
<24	Ref	-	
⩾24	4.19	[1.43; 12.17]	0.009*
ADL			
⩽ 3	Ref	-	
>3	3.50	[0.75; 16.36]	0.113*
IADL			
⩽ 4	Ref	-	
>4	25.79	[3.33; 199.70]	0.002*
SMAF			
⩾ 16	Ref	-	
<16	7.46	[2.84; 19.64]	<0.001*
Fried's criteria			
Robust (1 criterion)	Ref	-	
Pre-fragile (1–2 criteria)	2.85	[1.12; 7.26]	0.028*
IRG			
IRG 3–4	Ref	-	
IRG 5–6	7.34	[2.83; 19.06]	<0.001*

*: Eligible variables in the multivariate model.

Table 4. Results of multivariate regression analysis of the impact of discontinuation of ATM device use on the incidence of falls in the home among older adults.

Variables	Odds Ratio (OR)	95% CI	p-value
Degree of use of ATM			
Optimal use	Ref	-	
Abandonment	17.41	[2.59; 117.02]	0.003
Place of residence			
Rural, n (%)	Ref	Ref	
Urban, n (%)	11.46	[1.48; 88.98]	0.020
IADL			
⩽ 4	Ref	Ref	
>4	34.04	[1.59; 727.86]	0.024

CI, confidence interval; ATM, assistive technology for mobility; IADL, Instrumental Activities of Daily Living.

unmotivated, uncooperative, resistant, hostile, or angry; intimidated by AT and overwhelmed by the lifestyle changes required for use thereof; unskilled in the use of ATM devices; poor socialization and coping skills; health condition that limits use of AT.

- **ATM device characteristics:** does not achieve its intended purpose, or is demanding or uncomfortable to use; requires considerable organization or installation; incompatible with other devices; expensive; not market-leading/obsolete; repairs or services unavailable or expensive.

- **Environmental characteristics:** lack of support from family, co-workers, or employer; unrealistic expectations of others; environment preventing or discouraging ATM device use; requires assistance that is not available.

Compliance or non-compliance with ATM device use largely depends on the presence/absence of the factors listed above.[46] A 30% use rate threshold has been used to distinguish low- and high-compliance groups after 1 year.[47] The dropout rate (21%) after 6 months in this study was relatively high, thus calling into question the impact of multidisciplinary support on technology acceptance by older adults.

The goal of occupational therapy interventions is to improve older adults' functional capacity and independence. To this end, a person-centred approach is needed when recommending and providing assistive technologies. The emergence of a social model of rehabilitation, which conceptualizes disability as a social construction, underlies this person-centred approach (i.e. taking the patient's views and expectations regarding the outcome of the intervention into account).[7] At the national or international level, multidisciplinary teams can share knowledge and experience pertaining to the issue of non-adherence of older adults with fall-prevention programs and more specifically, the discontinuation of ATM device use. Researchers can draw on the MPT model, which represents a holistic approach to assigning ATM devices to patients based on their characteristics, preferences and needs. It is also essential to distinguish between older adults and people with disabilities, given the difference in incidence of cognitive problems between these two populations.[48]

In this study, there was a significant difference in well-being (as assessed by the ICECAP-O) between the UPSAV-ECOCAT and HABITAT groups ($p < 0.001$). Well-being assessment is important, because focusing solely on health functioning is likely to provide only a partial understanding of the benefits of multidisciplinary interventions.[23] In this study, older adults with high well-being were less likely to discontinue ATM device use. Frailty can be difficult for older adults to accept, as it may radically alter perceived social status. This "denial of frailty" can lead to refusal or discontinuation of mobility aid use.[49]

In addition to residing in an urban area and having an IADL Scale score > 4, discontinuation of ATM device use was a significant risk factor for serious falls in the home in this study. The incidence of serious falls in the HABITUAL group (57%) was higher than in the UPSAV-ECOCAT group. Our results are similar to those of a German randomised controlled trial of older adults (aged ≥ 65 years) returning home from hospital. The rate of serious falls in that study was 44.4% (22.2% within 6 months) in an intervention group but 55.6% in a control group. Patients in the intervention group were diagnosed during a home visit; an environmental risk assessment was also performed. Moreover, advice on potential environmental adaptations and facilities for home modifications were provided, along with training in ATM device use.[50] However, unlike our study, follow-up visits were not conducted to encourage use of the devices. Independence in the performance of instrumental ADL significantly increases the risk for falls among older adults, because such activities are more physically and cognitively demanding than ADL. This also underscores the importance of multidimensional screening to ascertain fall risk.

Study limitations and strengths

This study had several limitations. First, as the outcome variable was serious falls in the home, we only recorded those that resulted in hospitalizations. However, falls not resulting in hospitalization may nevertheless have serious consequences, such as post-fall syndrome, which can in turn lead to hospitalization. In addition, the number of falls was self-reported by the older adults and/or their families, and thus may have been subject to recall bias (particularly given that older adults are often affected by dementia). Therefore, fall incidence might have been underestimated. In addition,

we were unable to control for the availability of ATM devices in the older adults' homes from sources other than the ECOCAT project, and it may be difficult to extrapolate the results to other populations (e.g. older adults not followed by a GMT). Furthermore, we were unable to randomise the older adults to study groups. Finally, we did not analyse the pathologies responsible for the falls.

This study also had a number of strengths. For example, it was the first French study to use the ICECAP-O and EQ5D-3L to evaluate the effectiveness of an ATM device loan program for improving the mobility of older adults. Moreover, the questionnaires were administered in a face-to-face setting, and the staff were trained in data collection methods to ensure that complete and high-quality information was obtained. In accordance with current guidelines, all of the older adults were provided with a tailored fall-prevention program following a thorough initial home assessment. Furthermore, to avoid dropouts, we scheduled follow-up visits according to the literature. Finally, this was one of the first French studies to analyse the association between discontinuation of ATM device use and the incidence of serious falls in the home among older adults.

Conclusion

The discontinuation of ATM device use has been studied for many years, in both older adults and people with disabilities. Several studies have proposed reasons for discontinuation. In this study, the discontinuation rate was relatively high, at 21%. National or regional multidisciplinary team meetings may be useful for formulating follow-up schedules that are compatible with the French healthcare system, which could then be disseminated to rehabilitation professionals to help reduce study dropout rates. It would also be instructive to randomise older adults to ATM device and control groups in future studies. Health authorities must improve the accessibility of ATM devices for vulnerable older adults, where such devices can reduce the likelihood of serious falls in the home.

ORCID iD

Abdoul Razak Sawadogo [ORCID] https://orcid.org/0000-0001-7068-8945

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