Discover Psychology

Discover

Research

The association between falls and autonomy in older adults is mediated by self-efficacy

Hadis Imani[1] · **Ben Godde**[1]

Received: 21 August 2021 / Accepted: 11 October 2021
Published online: 08 December 2021

Abstract
Objective Falling has various physical and psychological consequences in older adults. We aimed at replicating previous findings that reported autonomy is associated with a history of falls and that this association is moderated by self-efficacy. We further assumed that cognitive function would moderate this relationship.
Method We analyzed data from the German Ageing Survey ("Deutscher Alterssurvey," DEAS, year 2017, n = 6626), a longitudinal cohort-based survey of individuals living in private households aged 40 and over in Germany.
Results Linear regression confirmed that perceived autonomy was negatively associated with a history of falls. With higher self-efficacy, the association between falls and autonomy was less substantial. Further, we extend previous findings in that self-efficacy also mediated the effect of falls on perceived autonomy. Against our assumptions, cognition as measured with the digit-symbol substitution test predicted perceived autonomy but did not moderator this association.
Discussion We conclude that interventions facilitating self-efficacy might ameliorate negative effects of falling on autonomy of older adults.

Keywords Falls · Autonomy · Self-efficacy · Cognitive function · Older adult

1 Introduction

In older adults, gait and balance deficits are substantial causes for falls which are correlated with a reduction of functionality and serious health problems. Fear of falling, falls, and impairments in daily activities can have a negative influence on the wellbeing of older adults [1]. Further consequences may be reduced self-confidence and self-efficacy [2], psychosomatic symptoms, lower quality of life, loss of independence, followed by inabilities to leave their homes, and finally social isolation [3]. Healthy aging is formed on decreasing dependency, boosting quality of life, practical capability and engagement in substantial duties [4].

Prevalence of falls in older adults varies between 21 to 85% in different studies [5]. In addition to advanced age, low objective and subjective health status, and visual and auditory impairment, several further risk factors for falls have been identified in previous studies. These include limited activities of daily living (ADL), poor nutrition, urban environment, neighborhood conditions, and perceived accessibility [1, 6, 7]

Experiencing a fall can further influence and limit activities. However, being more physically active promotes functional skills such as the capability of performing ADL [8] and functional capacity is a major predictor of autonomy in ADL. A salient correlation was reported between having a lower risk of falls and autonomy in the performance of both, ADL and instrumental (I)ADL [9].

✉ Hadis Imani, h.imani@jacobs-university.de | [1]Jacobs University Bremen, Bremen, Germany.

Autonomy may be defined as 'freedom, independence, self-government and self-determination' [10]. Further according to Ryan and Deci [11] being autonomous as a fundamental need, is defined by having "choice of action" and goes beyond the pure execution of daily activities. Research from Iwatsuki et al. [12] revealed that being able to make their own choices is correlated with better motor learning and performance, confirming autonomy as a key factor in goals and action achievement. Loss of autonomy as a multidimensional process is common among older adults, which happens gradually and their individual perception throughout the different aspects of mental, social, physical and spiritual elements are correlated with quality of life and well-being [13].

Self-efficacy plays a fundamental role in learning processes and acts as a motivator in decisions and achievements [14]. Lower fall-related self-efficacy is associated with a higher number of falls in the past [15]. Also, impairments in sensorimotor functioning may lead to fear of falls [5] and thus reduction in self-efficacy. Older adults with a higher self-efficacy are at a lower risk of falling and fallers with a lower self-efficacy might be less active in comparison to fallers with greater self-efficacy [16]. This fits with observations by Warner et al. [17] and Ryan and Deci [11] who revealed greater autonomy in people with higher self-efficacy. Further, older adults with lower general self -efficacy reported more limitations of ADL while those with higher level of self-efficacy were more eager for life adjustments, self-care behaviour charming and putting an attempt on finishing activities [18]. It is important to note that functional capability, independency and a feeling of self-efficacy can affect each other and therefore an individual's well-being because with getting older people are gradually less involved in activities.

Important to note, falls are twice as common among people with cognitive problems and dementia [19]. Lower cognitive status is strongly correlated with incidence of falls in comparison with cognitively healthy older adults [20, 21]. In addition, early cognitive decline has a measurable effect on postural control systems and puts patients at increased risk of balance failures and falls [22]. Further, cognitive function is an important factor in performing ADL [23] and thus facilitates autonomy. Several studies indicated that cognitive impairment is associated with the perception of low autonomy in older adults (for review, [24]).

Using data from the fifth wave of the DEAS (German Aging Survey) dataset from the year 2014, Hajek and König [25, 26] showed that experiencing a fall in the past 12 months was correlated with lower perceived autonomy and that self-efficacy moderated this relation such that older adults with higher self-efficacy were more autonomous. With our study we followed three aims to replicate and extend the analyses by Hajek and König [25]: First, we aimed at exactly replicating their findings with data from a more recent wave of the same data set (the sixth wave of the DEAS from 2017). Second, as self-efficacy is associated with both, falls and autonomy [2, 15–17, 24], we assumed that self-efficacy would not only moderate but also mediate the association between falls and autonomy and extended the analysis accordingly. Third, based on the revealed association between falls and cognitive status [21] and the importance of cognitive functioning for ADL [23] we further examined whether cognitive function instrumentalized as performance in the Digit Symbol Substitution Test (DSST) [27] would significantly moderate the association between a history of falls and autonomy. The DSST is one of the most used tests in neuropsychology and sensitive to both the presence of cognitive dysfunction and to impairments in processing speed, executive functioning, and working memory. Good performance on the DSST requires intact motor speed, attention, and visual perceptual functions, and correlates with real-world functional outcomes (e.g., the ability to accomplish everyday tasks) [27, 28].

2 Methods

2.1 Sample

A secondary data analysis was done with existing panel data from the scientific release of the German Ageing Survey ("Deutscher Alterssurvey," DEAS), as provided by the Research Data Centre of the "German Centre of Gerontology (DZA)". Data from the sixth wave (year 2017) were used in the current study (n = 6626). The DEAS study is a longitudinal cohort-based survey of individuals living in private households aged 40 and over (individuals in the second half of life) in Germany. Data are from the scientific release of the German Ageing Survey (DEAS), provided by the Research Data Centre of the German Centre of Gerontology (DZA). This data base combines a large cross-sectional sample with longitudinal samples. For example, information on the household composition, attitudes, family structure, social networks, as well as physical and mental health are provided [29]. The response rate of the sample reaches 65.4% of the adjusted gross sample [30]. It is comparable with the response rate of other longitudinal studies on similar age groups [31].

2.2 Dependent variable

Perceived autonomy, as included in the DEAS, was measured according to Schwarzer [32] with a 4-point Likert scale, where a higher score indicates higher perceived autonomy. The 4 items of the scale are: "In my daily life, I get along well on my own," "I make my own decisions and don't allow others to protect me," "I organize my life according to my own ideas," and "I cope with my daily life without outside help". The score was used as a dependent variable.

2.3 Independent variables

History of falls was measured as the experience of falling in the past 12 months (yes, no; cf. [33]).

Generalized self-efficacy was assessed using the scale proposed by Schwarzer, Jerusalem and Generalized [34]. The original scale consisted of 10 items. The scale comprises 10 statements, which are scored by the respondent as follows: 1—not true at all, 2—hardly true, 3—moderately true, 4—exactly true. The short scale was created by members of the DEAS in direct consultation with Ralf Schwarzer. It contains five items with four levels each. The individual scale value with a possible range of 1–4 is the mean value of the items. At least three items have to have valid values. The total score, representing a person's level of self-efficacy. Higher scores indicate stronger self-efficacy.

Cognitive function was assessed with the Digit Symbol Substitution Test [27, 28]. This test is easy to use and common in surveys. A table with codes of Arabic figures from 1 to 9 is matched to simple geometric signs. In the test, a table with four rows of figures should be filled out with the corresponding geometric sign within 90 s. The number of figures exceeds the number of possible entries in the given time. The interviewer notes problems while conducting the test. Ranging from 1 to 92, higher scores reflect better cognitive functioning. It measures perceptual motor speed and processing speed of visual perception and information [27, 28].

2.4 Further covariates

Sociodemographic details such as sex, age, civil status (single; divorced; widowed; married, living separated from spouse; married, living together with spouse) as well as individual monthly net equivalent income (OECD scale) were included as covariates in the regression model.

Frequency of sports activities, frequency of alcohol consumption (response items for both were: "never," "rarer than once a month," "one to three times a month," "once a week," "several times a week," and "daily") as well as smoking status ("daily smoker", "casual smoker", "former smoker", "non-smoker") were also added to the model.

Depression was measured with a short version of the German translation of the CES-D (Center for Epidemiologic Studies Depression) Scale (15 items, questions 504 of the interview) [35]. The sum over all 15 items (ranging from 0 to 45) was entered into the model. High values indicate higher depressive symptoms.

The SF-36 subscale [36] (ranging from 0 = worst score to 100 = best score) was used to measure physical functioning. The degree of physical impairment was measured using an evaluation of ten daily activities on a scale from 1 (yes, limited a lot) to 3 (no, not limited at all). The sum of the items is then transferred into the standard 0–100 range. Additionally, self-rated health (ranging from 1 = "very good" to 5 = "very bad") and the number of physical illnesses (cardiac and circulatory disorders; bad circulation; joint, bone, spinal, or back problems; respiratory problems, asthma, or shortness of breath; stomach and intestinal problems; cancer; diabetes; gallbladder, liver, or kidney problems; bladder problems; eye problems, vision impairment; ear problems, hearing problems; and other illnesses or health problems) were also included as covariates.

2.5 Data analysis and statistics

Data analysis was done with SPSS v.27. At first, distributions of the variables and Z scores were computed for perceived autonomy, self-efficacy, and cognition. Bivariate correlations and homogeneity of variance were analyzed. Then with covariates being adjusted, multiple linear regression was applied to evaluate the association between a history of falls in the past and perceived autonomy and weather self-efficacy and cognitive function moderate this association. Additionally, as results revealed that self-efficacy was associated with perceived autonomy and falls were associated with self-efficacy, we also tested whether self-efficacy mediated the effect of falls on autonomy using SPSS PROCESS version v3.5 (model 4; Hayes [37]). Statistical significance was deemed when the p-value was less than 0.05.

3 Results

3.1 Description of the sample and bivariate correlations

Table 1 provides sample characteristics and descriptive statistics for all variables. In sum, 1132 out of the total sample of 6626 participants (20.04%) experienced a fall in the past year. Perceived autonomy was 4.48 ± 0.5 (mean and SD) and mean self-efficacy was 3.1 ± 0.4. Mean performance in the DST was 45.83 ± 13.65.

Pairwise correlations (with Bonferroni-adjusted significance levels; Table 2) revealed that falls were negatively associated with perceived autonomy ($r = -0.14$, $p < 0.01$), self-efficacy ($r = -0.10$, $p < 0.01$) and cognitive function ($r = -0.10$, $p < 0.01$). Both, self-efficacy and cognitive function, were positively related to perceived autonomy ($r = 0.43$, $p < 0.01$ and $r = 0.14$, $p < 0.01$, for self-efficacy and cognition, respectively). Finally, self-efficacy was positively associated with cognition ($r = 0.11$, $p < 0.01$).

3.2 Regression analysis

Collinearity of all variables was assessed by collinearity diagnostics. The Variance Inflation Factor (VIF) and Tolerance were below 10 and 1, respectively, indicating that collinearity could be neglected. Five linear models were tested in the current study (Table 3): in the first model, the association between history of falls and perceived autonomy was tested, adjusted for all covariates. In the second model, self-efficacy was added and in model 3 the interaction of history of falls and self-efficacy. In model 4, the model was expanded by adding cognition, and finally, in model 5, the interaction term of fall and cognition was added to the model.

Model fit improved by adding predictors and it turned out that model 4 with self-efficacy, history of falls by self-efficacy interaction, and cognition added to the model best fit the data (see Table 4 for detailed fit parameters). Adding the history of falls by cognition interaction to the model did not further improve model fit and this interaction was also not significantly associated with perceived autonomy.

Finally, model 4 was accepted and revealed that perceived autonomy can be predicted by history of falls in the last year ($\beta = -0.058$, $p < 0.001$), by self-efficacy ($\beta = 0.34$, $p < 0.001$), and by performance in the digit-symbol test ($\beta = 0.47$, $p = 0.003$). Furthermore, the interaction term of history of falls and self-efficacy was significant ($\beta = 0.36$, $p = 0.015$) indicating that self-efficacy moderated the effect of history of falls on perceived autonomy. With higher self-efficacy, the association between history of falls and autonomy was less substantial (Fig. 1). From the other covariates, whereas being female was positively associated, depressive symptoms, increases in the number of physical illnesses, and not smoking any more or never having been a smoker were negatively associated with perceived autonomy (cf., Table 3 for detailed statistics).

3.3 Mediation analysis

Based on the finding that self-efficacy was significantly associated with both falls and perceived autonomy, we tested the hypothesis that self-efficacy acts as a mediator in the relationship between falls and perceived autonomy. As the regression revealed that cognition does not act as a moderator (no interaction effect with falls), cognition was added as covariate to this model with all other covariates. Detailed results are shown in Table 5.

A significant partial mediation effect of self-efficacy was revealed (Fig. 2). When adding self-efficacy as mediator to the model, the direct effect of fall on autonomy reduced from $\beta = -0.191$ (standardized regression coefficient, $t(4233) = -5.18$, $p < 0.001$) to $\beta = -0.157$ ($t(4232) = -4.55$, $p < 0.001$). The indirect effect of falls on autonomy through self-efficacy amounted to $\beta = -0.034$ (95% CI: −0.0606 to −0.0079) and was composed by an effect of fall on self-efficacy ($\beta = -0.96$, $t(4233) = -2.56$, $p = 0.010$ and of self-efficacy on autonomy ($\beta = -0.35$, $t(4232) = 25.22$, $p < 0.001$). Direct and indirect effects amounted to a total effect of falls on autonomy of ($\beta = -0.191$, $p < 0.001$). Furthermore, the history of falls by self-efficacy interaction was still significant confirming the moderation effect revealed before ($F(1, 4231) = 5.902$, $p < 0.01$).

Table 1 Demographic data (N = 6626)

	N/Mean	%/(SD)
Gender: female (Ref.: male)	3290	49.7
Age in years	67.3	10.95
Marital status: living together with spouse	4537	68.5
Married, living separated from spouse	94	1.4
Divorced	659	9.9
Widowed	897	13.5
Single	438	6.6
Monthly net equivalent income in Euro	2076.14	1318.177
Body mass index (BMI)	27.03	4.70
Smoking status: daily	644	11.6
Yes, sometimes	198	3.6
Not anymore	2086	37.6
Never been a smoker	2619	47.2
Consumption of alcohol: Daily	700	12.6
Several times a week	1391	25
Once a week	881	15.9
One to three times a month	668	12
Less frequently	1286	23.2
Never	629	11.3
Physical activity: Daily	834	15.2
Several times a week	2231	40.8
Once a week	687	12.6
One to three times a month	520	9.5
Less frequently	814	14.9
Never	384	7
Self-rated health (from 1 = "very good" to 5 = "very bad")	2.45	0.97
Number of physical illnesses (from 0 to 11)	2.67	2.01
Depressive symptoms (ranging from 0 = no depressive symptoms to 45 = severe depressive symptoms)	6.65	5.95
Physical functioning (from 0 = lowest score to 100 = best score)	80.82	23.8
Fall in the preceding 12 months	1132	2.24
Self-efficacy (from 1 = low self-efficacy to 4 = high self-efficacy)	3.1	0.43
Perceived autonomy	4.48	0.51
Digit symbol test	45.83	13.65

Mean (SD) and n (%) are reported

Table 2 Correlation matrix between variables

	1	2	3	4
1 Fall	1			
2 Autonomy	− 0.140**	1		
3 Self-efficacy	− 0.100**	0.431**	1	
4 Cognitive test	− 0.103**	0.147**	0.118**	1

**Correlations are all significant at the 0.01 level (2-tailed)

Table 3 Result of multiple linear regression

Independent variables	Perceived autonomy Model 1	Perceived autonomy Model 2	Perceived autonomy Model 3	Perceived autonomy Model 4	Perceived autonomy Model 5
Fall in the preceding 12 months (Ref.: no)	− 0.076*** (0.036)	− 0.062*** (0.034)	− 0.058*** (0.034)	− 0.058*** (0.034)	− 0.057*** (0.034)
Gender: female (Ref.: male)	0.108*** (0.030)	0.104*** (0.028)	0.103*** (0.028)	0.094*** (0.028)	0.094*** (0.028)
Age in years	0.014 (0.001)	0.027 (0.001)	0.027 (0.001)	0.048** (0.002)	0.047** (0.002)
Not married, (Ref.: married, living together)	0.166*** (0.031)	0.153*** (0.029)	0.153*** (0.029)	0.154*** (0.028)	0.154*** (0.028)
Monthly net equivalent income in Euro	0.048*** (0.000)	0.026 (0.000)	0.025 (0.000)	0.022 (0.000)	0.022 (0.000)
Body mass index (BMI)	0.013 (0.003)	− 0.011 (0.003)	− 0.012 (0.003)	− 0.010 (0.003)	− 0.011 (0.003)
Smoking status:—Yes, sometimes (Ref.: daily)	− 0.001 (0.080)	− 0.005 (0.074)	− 0.004 (0.074)	− 0.006 (0.074)	− 0.006 (0.074)
Not anymore	− 0.039 (0.046)	− 0.041 (0.043)	− 0.041 (0.043)	− 0.048* (0.043)	− 0.048* (0.043)
Never been a smoker	− 0.037 (0.046)	− 0.034 (0.042)	− 0.034 (0.042)	− 0.041* (0.043)	− 0.041 (0.043)
Consumption of alcohol: Several times a week (Ref.: daily)	0.050* (0.047)	0.049* (0.044)	0.048** (0.044)	0.046** (0.044)	0.047** (0.044)
Once a week	0.033 (0.052)	0.029 (0.049)	0.028 (0.049)	0.027 (0.049)	0.027 (0.049)
One to three times a month	0.051** (0.056)	0.039* (0.052)	0.039* (0.052)	0.039* (0.052)	0.039* (0.052)
Less frequently	0.062** (0.050)	0.045* (0.047)	0.043* (0.047)	0.044* (0.047)	0.044* (0.047)
Never	0.026 (0.058)	0.019 (0.054)	0.019 (0.054)	0.021 (0.054)	0.021 (0.054)
Physical activity: Several times a week (Ref.: daily)	− 0.016 (0.041)	0.010 (0.038)	0.010 (0.038)	0.007 (0.038)	0.008 (0.038)
Once a week	− 0.031 (0.051)	− 0.006 (0.048)	− 0.006 (0.048)	− 0.008 (0.048)	− 0.008 (0.048)
One to three times a month	− 0.034* (0.056)	− 0.004 (0.052)	− 0.004 (0.052)	− 0.007 (0.052)	0.006 (0.052)
Less frequently	− 0.036* (0.050)	− 0.005 (0.047)	− 0.006 (0.047)	− 0.008 (0.047)	− 0.008 (0.047)
Never	0.006 (0.068)	0.018 (0.063)	0.018 (0.063)	0.016 (0.063)	0.016 (0.063)
Self-rated health (from 1 "very good" to 5 "very bad")	− 0.059** (0.022)	− 0.021 (0.021)	− 0.021 (0.021)	− 0.020 (0.020)	− 0.021 (0.020)
Number of physical illnesses (from 0 to 11)	− 0.053** (0.008)	− 0.046** (0.008)	− 0.046** (0.008)	− 0.044** (0.008)	− 0.044** (0.008)
Depressive symptoms (ranging from 0 = no depressive symptoms to 45 = severe depressive symptoms)	− 0.163*** (0.003)	− 0.067*** (0.003)	− 0.066*** (0.003)	− 0.064*** (0.003)	− 0.063*** (0.003)
Physical functioning (from 0 = lowest score to 100 = best score)	0.188*** (0.001)	0.166*** (0.001)	0.165*** (0.001)	0.161*** (0.001)	− 0.179*** (0.001)
Self-efficacy (from 1 = low self-efficacy to 4 = high self-efficacy)		0.385*** (0.014)	0.342*** (0.015)	0.341*** (0.015)	0.342*** (0.015)
Interaction term: Fall × self-efficacy			0.036** (0.032)	0.036** (0.032)	0.034* (0.032)
Digit symbol test				0.047** (0.015)	0.040** (0.017)
Interaction term: Fall × Cognition					0.017 (0.033)
Constant	− 3.219** (0.197)	− 3.218*** (0.183)	− 3.924*** (0.183)	− 4.417*** (0.186)	− 4.338*** (0.187)

Beta Coefficients and Standard errors (in parenthesis) are reported. ***p < 0.001, **p < 0.01, *p < 0.05

Table 4 Model comparisons

Model	R	R2	Adjusted R2	F	df1	df2	P	Akaike information criterion
1	0.422	0.178	0.173	39.8	23	4234	0.000	– 1035.2
2	0.534	0.286	0.282	638.9	1	4233	0.000	– 1631.8
3	0.535	0.287	0.282	5.8	1	4232	0.016	– 1635.7
4	0.537	0.288	0.284	9.04	1	4231	0.003	– 1642.7
5	0.537	0.288	0.284	1.2	1	4230	0.259	– 1642.1

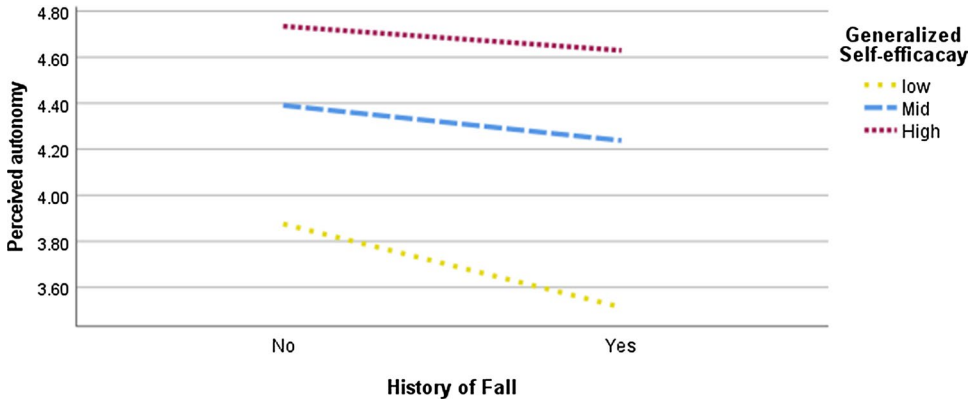

Fig. 1 The association between fall and autonomy depends on self-efficacy level

4 Discussion

Based on data from a more recent wave of the same longitudinal dataset drawn from a nationally representative sample of community-dwelling adults in the second half of life, the present study aimed at replicating earlier results from Hajek and König [25] that self-efficacy moderates the association between history of falls and perceived autonomy. We further extended their previous study by analyzing (1) a potential mediation effect of self-efficacy and (2) whether cognitive function would significantly moderate the association between history of falls and perceived autonomy. We confirmed that with higher self-efficacy, the association between history of falls and autonomy was less substantial. What is new, indeed, is that self-efficacy (partly) mediated the effect of history of falls on perceived autonomy. Finally, cognitive functioning predicted perceived autonomy but did not moderate the association between history of falls and perceived autonomy.

According to Ryan and Deci [11], being autonomous is defined by having "choice of action" and goes beyond the pure execution of daily activities. Herewith, it highlights the importance of individual perception rather than action itself. This links perception of being autonomous or not to one's belief of one's own capability which is known as self-efficacy. Self-efficacy is a key factor in successful aging, and can decrease by several factors like age, diseases, health condition, etc. In general, performing an activity can lead to higher satisfaction and can influence other aspects of life such as emotion, autonomy, and performing daily activities more independently [38]. Our results confirm that while a history of falls leads to diminished autonomy, higher self-efficacy would help people to leave home, walk and to maintain daily activities for a longer period of time, and thus attenuate the effects of experiencing falls in the past. However, over-confident older adults often insist on performing daily activities on their own [39] which might increase the risk of falling again.

Our analysis has further shown that self-efficacy partially mediates the effect of history of falls on perceived autonomy. It might be assumed that experiencing falls reduces self-efficacy and, consequently, perceived autonomy. This assumption is in line with Loft et al. [15] who indicated that lower fall-related self-efficacy is associated with a higher number of falls in the past [15] and with Warner et al. [17] and Ryan and Deci [11] who revealed greater autonomy in people with higher self-efficacy. A recent study by Yang and Pepper [16] confirmed that higher fall-related self-efficacy was significantly correlated with a lower number of falls [16]. Dadgari et al. [40] further reported a significant association between low fall-related self-efficacy and high levels of fear of falling and a significant role of self-efficacy as a mediator between falls and fear of falling.

Table 5 Mediation analysis

		Self-efficacy (M)					Autonomy (Y)			
		Coeff	se	t	P		Coeff	se	t	P
Fall in the preceding 12 months (Ref.: no)	a	− 0.096	0.0161	− 2.55	0.01	c	− 0.191	0.018	− 5.18	0.000
						c′	− 0.157	0.017	− 4.55	0.000
Self-efficacy (from 1 = low self-efficacy to 4 = high self-efficacy)		–	–	–		b	0.35	0.016	25.22	0.000
Constant		314	0.0973	32.26	0.000		4	0.12	35.6	0.000
Covariates										
Gender: female (Ref.: male)		0.006	0.0135	0.476	0.63		0.098	0.015	6.25	0.000
Age in years		− 0.001	0.0007	− 1.51	0.13		0.0018	0.000	2.15	0.03
Not married, (Ref.: married, living together)		0.035	0.0137	2.52	0.01		0.182	0.0158	11.53	0.001
Monthly net equivalent income in Euro		0.000	0.000	4.13	0.001		0.000	0.000	2.9	0.002
Body mass index (BMI)		0.006	0.0304	4.46	0.001		0.0015	0.001	0.96	0.33
Smoking status:—Yes, sometimes (Ref.: daily)		0.021	0.0356	0.607	0.54		− 0.007	0.042	− 0.018	0.85
Not anymore		0.001	0.0209	0.087	0.93		− 0.048	0.024	− 1.99	0.04
Never been a smoker		− 0.009	0.0205	− 0.465	0.64		− 0.045	0.023	− 1.92	0.055
Consumption of alcohol: Several times a week (Ref.: daily)		0.001	0.0211	0.077	0.93		0.054	0.024	2.24	0.02
Once a week		0.001	0.0211	0.077	0.938		0.044	0.027	1.64	0.10
One to three times a month		0.013	0.0234	0.567	0.57		0.077	0.029	2.68	0.07
Less frequently		0.05	0.0224	2.20	0.02		0.076	0.025	2.94	0.03
Never		0.029	0.0260	1.09	0.27		0.046	0.030	1.55	0.1
Physical activity: Several times a week (Ref.: daily)		− 0.065	0.018	− 3.56	0.001		− 0.19	0.021	− 0.91	0.36
Once a week		− 0.09	0.023	− 3.85	0.001		− 0.049	0.027	− 1.84	0.06
One to three times a month		− 0.124	0.025	− 4.98	0.001		− 0.063	0.029	− 2.18	0.02
Less frequently		− 0.107	0.022	− 4.83	0.001		− 0.055	0.025	− 2.13	0.03
Never		− 0.061	0.030	− 2.02	0.04		0.008	0.035	0.24	0.8

Table 5 (continued)

	Self-efficacy (M)				Autonomy (Y)			
	Coeff	se	t	P	Coeff	se	t	P
Self-rated health (from 1 "very good" to 5"very bad")	− 0.055	0.009	− 5.65	0.001	− 0.035	0.011	− 3.14	0.01
Number of physical illnesses (from 0 to 11)	− 0.004	0.0036	− 1.08	0.29	− 0.012	0.004	− 2.98	0.03
Depressive symptoms (ranging from 0 = no depressive symptoms to 45 = severe depressive symptoms)	− 0.02	0.0012	− 16.1	0.001	− 0.014	0.001	− 9.9	0.001
Physical functioning (from 0 = lowest score to 100 = best score)	0.001	0.0004	3.03	0.001	0.004	0.000	9.6	0.001
Cognition	0.000	0.0005	1.43	0.15	0.002	0.000	3.3	0.01

Coefficients and standard errors are reported.

a Path between fall and self-efficacy

b Path between Self-efficacy and autonomy

c Total effect which autonomy was predicted by fall through Self-efficacy

c' Path between fall and autonomy

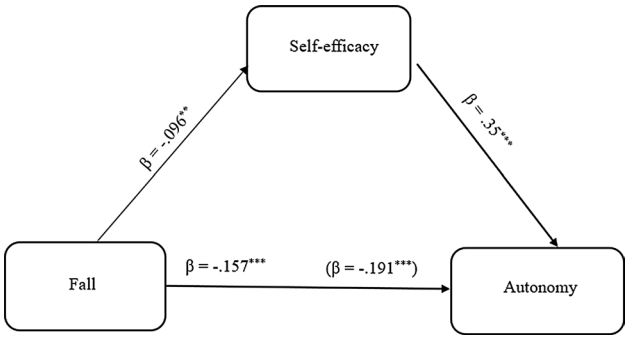

Fig. 2 Self-efficacy partly mediates the effect of history of falls on perceived autonomy. *p < 0.05, **p < 0.01, ***0.001

Being in a positive emotional state and at a higher level of self-efficacy are related to better daily activities management and dedication which affect real and perceived autonomy. Accordingly, dependency to others limits individual productivity, performance and well-being [2]. Langer [41] denoted that even the illusion of choice can improve an individual's confidence in their ability to make the desired outcome, even if the outcome is determined by chance. Comparably, participant's prediction of their performance was found to rise when they had a superficial choice concerning an upcoming task. As Langer argued, people's perception of their ability to control their environment fosters feelings of competence, and feeling competent and self-efficacious can result in improved learning and enhanced performance [41].

Altogether, with this study we emphasize that self-efficacy is differently involved in the associations between history of falls and perceived autonomy. As a general trait high self-efficacy may attenuate the negative effects of experiencing falls on autonomy. Thus, despite a history of falls, interventions for enhancing self-efficacy could also enhance perceived autonomy and in the following activities that facilitate mental and physical activities and abilities as well as self-care behavior, and to maintain that for a longer time. On the other hand, experiencing falls might also reduce self-efficacy and by that perceived autonomy with all negative consequences. Again, interventions to enhance self-efficacy might help in breaking this connection. However, social support networks play an important role in healthy aging [42] and according to Warner et al. [17], the importance of social support for older adults with higher self-efficacy should not be underestimated. Although in our study we did not study older adults' social life and it should be considered in the future studies as an important component.

In this study, we also highlight that cognitive function is negatively correlated with a history of falls and positively with self-efficacy and perceived autonomy. Our results therefore confirm previous findings indicating that cognitive impairment is associated with the perception of low autonomy in older adults [24]. High cognitive function, on the contrary, is related to higher self-efficacy and thus might facilitate the positive effects of self-efficacy as described above. Also, cognitive abilities might be related to motor control and thus be an important factor for preventing falls. In recent years evaluating the association between falls and cognitive decline reached attention in many studies but underlying mechanisms are still undefined and more experimental studies in this field are needed [20]. Kim [20] suggested that screening for cognitive decline issues in those with a history of falls may help delay the onset of fall-related cognitive and physical disability.

Perceived low autonomy is also associated with basic education (< 6 years), slightest or no social support, anxiety, cognitive deterioration, low educational level and limitations in ADL [24]. It is noteworthy that older adults' perceived autonomy can be affected by different factors some of which are unchangeable such as educational level or marital status while other factors like physical and mental health, mobility and skills as well as self-efficacy are components on which interventions could be focused on [43]. In addition, our study revealed some other interesting associations. Perceived autonomy was negatively correlated with depressive mood which is consistent with prior findings by Mazure and Maciejewski [44] and O'Riley and Fiske [45]. Older adults with lower scores in autonomy were at higher risk for depressive symptoms. We argue that experiencing falls increases the fear of falling again therefore reducing the level of physical activity and leading to social isolation. After a while, this isolation could provoke further mental disabilities, such as depression, and even boost cognitive decline [21] or limitations in performing daily activities [23]. As low autonomy is triggered by depression, improvement of mental health will positively impact the affected individual.

Further, being female is also associated with perceived autonomy. This is in line with Breton et al. [46] and Hajek and König [25] who in their studies showed an association between functional autonomy and physical abilities in older women. This gender effect might be explained by women being more involved with daily activities like housework. Also, women in comparison to men are more sensitive to others and relations [47]. Moreover, older individuals' worsening

self-rated health and physical functioning and number of physical illnesses were associated with a decrease in perceived autonomy which is consistent with Hajek and König [25, 26]. Functional capacity is a major predictive variable of autonomy in activities of daily living. Physical activity is known to improve physical condition and functional capacity coupled with alleviating the risk of suffering from health problems and various diseases which people are susceptible to. A salient correlation was discovered between having a lower risk of falls and autonomy and the performance of both ADL and IADL [9]. Also, previous cross-sectional research has found that autonomy and functional ability of older adults can be improved with higher amounts of physical activity [8]. Physical activity has direct and indirect effects on autonomy in outdoor activities and both together are associated with mobility [48]. These findings emphasize the role of physical activity for better physical functioning and being functionally independent.

5 Limitations and strengths

For this study we used an existing dataset for secondary data analysis. This limited our chance to explore other variables and to investigate the probability of associations of autonomy with other variables such as personality traits. Also, most data are based only on self-report from the participants. Furthermore, getting the exact number of falls during a year before would have been an advantage for correlating them with other measures.

Most of the studies until the submission of this paper, collected data from people residing in nursing homes, institutions or other residential care centers and we suggest further investigating autonomous decision-making among those healthy people who live in the community rather than collecting from institutionalized people, or, to compare both groups. Further investigation of healthy people living at home, would enable us to better promote policies, guidelines, rehabilitation packages including psychological wellbeing as well as daily activities to increase their quality of life and improve their mental health consequently.

As shown, self-efficacy acts as an important component in daily life and interventions should focus more on training. In addition, other factors such as depressive symptoms, physical health, family support and social participation also can moderate this relation which has not been studied in this paper and further studies are needed here. While this study is conducted on German data, replication of our work with data from other countries is suggested. In many cultures it is common that old people stay with their families and are happy with others caring for their daily needs and duties. As mentioned above [17, 19], such social support networks might also affect the association between physical inabilities and perceived autonomy.

Previous studies reported a correlation between cognition and history of falls and dependency to others in cognitively impaired older adults. For assessing cognitive function, the digit symbol test was used in this study, which measures predominantly perceptual motor speed and visual processing speed. Hence replicating this study with other measures of cognition is suggested to examine the hypothesis whether cognition moderates the relation between falls and autonomy.

Author's contributions Both authors contributed to the study conception and design. Data preparation and analysis was performed by Hadis Imani. The first draft of the manuscript was written by Hadis Imani. Both authors worked on revisions of the draft and read and approved the final manuscript.

Funding Open Access funding enabled and organized by Projekt DEAL. Not applicable.

Data availability The data used in this study are third-party data. The anonymized datasets of the DEAS (1996, 2002, 2008, 2011, and 2014) are available for secondary analysis. The data were made available to scientists at universities and research institutes for scientific purposes. The use of the data is subject to written data protection agreements. Microdata (referring to individuals) of all the completed waves of the German Ageing Survey (DEAS) is available free of charge to scientific researchers for non-profitable purposes. The Research Data Centre of the DZA (FDZ-DZA) provides access and support to scholars interested in using DEAS for their research. However, for reasons of data protection, signing a data distribution contract is required before data can be obtained. Please for further information see (data distribution contract) https://www.dza.de/en/fdz/german-ageing-survey/access-to-deasdata.html.

Code availability Not applicable.

Declarations

Ethics approval and consent to participate An ethical statement for the DEAS study was not necessary because only secondary analysis of existing and published data was performed and criteria for the need of an ethical statement were not met (risk for the respondents, lack of information about the aims of the study, examination of patients). This is in accordance with the German Research Foundation-guidelines (Deutsche Forschungsgemeinschaft, DFG) available at: http://dfg.de/foerderung/faq/geistes_sozialwissenschaften/ (only available in German language). The German Centre of Gerontology (DZA) also confirmed that an ethical statement was not necessary. It is worth noting that the DEAS study has a permanent advisory board. Prior to each wave of data collection, the permanent advisory board receives detailed information about the sampling method, the consent to participate and the instruments used in the DEAS study. The permanent advisory board concluded that the DEAS study did not need approval from an ethics committee. This procedure is in concordance with local guidelines. Please also see the RatSWD (Principles and Review Procedures of Research Ethics in the Social and Economic Sciences): https://www.ratswd.de/dl/RatSWD_Output9_Forschungsethik.pdf, page 28 (only available in German language).

Competing interests We have no conflict of interest to declare.

References

1. Curl A, Fitt H, Tomintz M. Experiences of the built environment, falls and fear of falling outdoors among older adults: an exploratory study and future directions. Int J Environ Res Public Health. 2020;17(4):1224. https://doi.org/10.3390/ijerph17041224.
2. Toledano-González A, Labajos-Manzanares T, Romero-Ayuso D. Well-being, self-efficacy and independence in older adults: a randomized trial of occupational therapy. Arch Gerontol Geriatr. 2019;83:277–84. https://doi.org/10.1016/j.archger.2019.05.002.
3. Petersen N, König HH, Hajek A. The link between falls, social isolation and loneliness: a systematic review. Arch Gerontol Geriatr. 2020;88:104020. https://doi.org/10.1016/j.archger.2020.104020.
4. Rechel B, Doyle Y, Grundy E, McKee M. How can health systems respond to population ageing? In: World Health Organization. Regional Office for Europe, Health Evidence Network, European Observatory on Health Systems and Policies. https://apps.who.int/iris/handle/10665/107941. 2009.
5. Jahn K, Freiberger E, Eskofier BM, Bollheimer C, Klucken J. Balance and mobility in geriatric patients. Z Gerontol Geriatr. 2019;52(4):316–23. https://doi.org/10.1007/s00391-019-01561-z.
6. Pirker W, Katzenschlager R. Gait disorders in adults and the elderly. Wien Klin Wochenschr. 2016;129(3–4):81–95. https://doi.org/10.1007/s00508-016-1096-4.
7. Kim J, Byun M, Kim M. Physical and psychological factors associated with poor self-reported health status in older adults with falls. Int J Environ Res Public Health. 2020;17(10):3548. https://doi.org/10.3390/ijerph17103548.
8. Parra-Rizo MA, Sanchis-Soler G. Satisfaction with life, subjective well-being and functional skills in active older adults based on their level of physical activity practice. Int J Environ Res Public Health. 2020;17(4):1299. https://doi.org/10.3390/ijerph17041299.
9. Tornero-Quiñones I, Sáez-Padilla J, Espina Díaz A, Abad Robles MT, Sierra Robles Á. Functional ability, frailty and risk of falls in the elderly: relations with autonomy in daily living. Int J Environ Res Public Health. 2020;17(3):1006. https://doi.org/10.3390/ijerph17031006.
10. Welford C, Murphy K, Rodgers V, Frauenlob T. Autonomy for older people in residential care: a selective literature review. Int J Older People Nurs. 2012;7(1):65–9. https://doi.org/10.1111/j.1748-3743.2012.00311.x.
11. Ryan RM, Deci EL. Self-regulation and the problem of human autonomy: does psychology need choice, self-determination, and will? J Pers. 2006;74(6):1557–86. https://doi.org/10.1111/j.1467-6494.2006.00420.x.
12. Iwatsuki T, Abdollahipour R, Psotta R, Lewthwaite R, Wulf G. Autonomy facilitates repeated maximum force productions. Hum Mov Sci. 2017;55:264–8. https://doi.org/10.1016/j.humov.2017.08.016.
13. Boyle G. Autonomy in long-term care: a need, a right or a luxury? Disabil Soc. 2008;23(4):299–310. https://doi.org/10.1080/09687590802038795.
14. Zimmerman BJ. Self-efficacy: an essential motive to learn. Contemp Educ Psychol. 2000;25(1):82–91. https://doi.org/10.1006/ceps.1999.1016.
15. Loft CC, Jones FW, Kneebone II. Falls self-efficacy and falls incidence in community-dwelling older people: the mediating role of coping. Int Psychogeriatr. 2018;30(5):727–33.
16. Yang R, Pepper GA. Is fall self-efficacy an independent predictor of recurrent fall events in older adults? Evidence from a 1-year prospective study. Res Nurs Health. 2020;43(6):602–9.
17. Warner LM, Ziegelmann JP, Schüz B, et al. Maintaining autonomy despite multimorbidity: self-efficacy and the two faces of social support. Eur J Ageing. 2011;8:3–12. https://doi.org/10.1007/s10433-011-0176-6.
18. Easom LR. Concepts in health promotion: perceived self-efficacy and barriers in older adults. J Gerontol Nurs. 2003;29(5):11–9. https://doi.org/10.3928/0098-9134-20030501-05.
19. Montero-Odasso M, Verghese J, Beauchet O, Hausdorff JM. Gait and cognition: a complementary approach to understanding brain function and the risk of falling. J Am Geriatr Soc. 2012;60(11):2127–36. https://doi.org/10.1111/j.1532-5415.2012.04209.x.

20. Kim J-H. Fall experience and cognitive function in middle aged and elderly population. Medicine. 2020;99(18): e19203. https://doi.org/10.1097/md.0000000000019203.
21. Kamińska M, Brodowski J, Karakiewicz B. Fall risk factors in community-dwelling elderly depending on their physical function, cognitive status and symptoms of depression. Int J Environ Res Public Health. 2015;12(4):3406–16. https://doi.org/10.3390/ijerph120403406.
22. Bahureksa L, Najafi B, Saleh A, Sabbagh M, Coon D, Mohler MJ, Schwenk M. The impact of mild cognitive impairment on gait and balance: a systematic review and meta-analysis of studies using instrumented assessment. Gerontology. 2016;63(1):67–83. https://doi.org/10.1159/000445831.
23. Jekel K, Damian M, Wattmo C, Hausner L, Bullock R, Connelly PJ, Dubois B, Eriksdotter M, Ewers M, Graessel E, Kramberger MG, Law E, Mecocci P, Molinuevo JL, Nygård L, Olde-Rikkert MGM, Orgogozo J-M, Pasquier F, Peres K, et al. Mild cognitive impairment and deficits in instrumental activities of daily living: a systematic review. Alzheimer's Res Ther. 2015;7(1):17. https://doi.org/10.1186/s13195-015-0099-0.
24. Sánchez-García S, García-Peña C, Ramírez-García E, Moreno-Tamayo K, Cantú-Quintanilla GR. Decreased autonomy in community-dwelling older adults. Clin Interv Aging. 2019;14:2041–53. https://doi.org/10.2147/cia.s225479.
25. Hajek A, König H-H. Falls are associated with decreased autonomy, and self-efficacy moderates this relation: results from a national study. Front Psych. 2019;10:447. https://doi.org/10.3389/fpsyt.2019.00447.
26. Hajek A, König H-H. The onset of falls reduces perceived autonomy among middle aged and older adults. Results from a longitudinal nationally representative sample. Arch Gerontol Geriatrics. 2020;90:104115. https://doi.org/10.1016/j.archger.2020.104115.
27. Hoyer WJ, Stawski RS, Wasylyshyn C, Verhaeghen P. Adult age and digit symbol substitution performance: a meta-analysis. Psychol Aging. 2004;19(1):211–4. https://doi.org/10.1037/0882-7974.19.1.211.
28. Jaeger J. Digit symbol substitution test. J Clin Psychopharmacol. 2018;38(5):513–9. https://doi.org/10.1097/jcp.0000000000000941.
29. Klaus D, Engstler H, Mahne K, Wolff JK, Simonson J, Wurm S, Tesch-Römer C. Cohort profile: the German ageing survey (DEAS). Int J Epidemiol. 2017;46(4):1105–1105g. https://doi.org/10.1093/ije/dyw326.
30. Klaus D, Engstler H, Vogel C. Längsschnittliches Design, Inhalte und Methodik des Deutschen Alterssurveys (DEAS). In: Frauen Und Männer in Der Zweiten Lebenshälfte. 2019;17–34. https://doi.org/10.1007/978-3-658-25079-9_2.
31. Blom AG, Schröder M. Sample composition 4 years on: retention in Share Wave 3. In M. Schröder (Hrsg.), Retrospective data collection in the Survey of Health, Ageing and Retirement in Europe (S. 55–61). Mannheim: MEA, 2011.
32. Schwarzer R. Perceived autonomy in old age [Online]. Available: http://userpage.fu-berlin.de/~health/autonomy.htm. 2008. [Accessed 2016].
33. Teno J, Kiel DP, Mor V. Multiple stumbles: a risk factor for falls in community-dwelling elderly; a prospective study. J Am Geriatr Soc. 1990;38(12):1321–5. https://doi.org/10.1111/j.1532-5415.1990.tb03455.x.
34. Schwarzer R, Jerusalem M. Generalized self-efficacy scale. In: Weinman J, Wright S, Johnston M, editors. Measures in health psychology: a user's portfolio. Causal and control beliefs. Windsor, UK: NFER-NELSON (1995). p. 35–37.
35. Hautzinger M, Bailer M. ADS—Allgemeine Depressions-Skala. Weinheim: Beltz; 1993.
36. Bullinger M, Kirchberger I. Der SF-36-Fragebogen zum Gesundheitszustand. Handanweisung [SF-36-Questionnaire on health status]. Göttingen: Hogrefe. 1998.
37. Hayes AF. Introduction to mediation, moderation, and conditional process analysis: a regression-based approach. New York, NY: The Guilford Press; 2013.
38. Cebreros-Valenzuela D, Mortis-Lozoya SV, Del Hierro-Parra E, Muñoz-Arteaga J. Efficacy of a cognitive stimulation programme using technology on older adults' self-esteem, self-efficacy, and autonomy. Rev Latinoamericana de Psicolog. 2020;52:42–50. https://doi.org/10.14349/rlp.2020.v52.5.
39. Pua Y-H, Ong P-H, Clark RA, Matcher DB, Lim EC-W. Falls efficacy, postural balance, and risk for falls in older adults with falls-related emergency department visits: prospective cohort study. BMC Geriatr. 2017;17(1):291. https://doi.org/10.1186/s12877-017-0682-2.
40. Dadgari A, Hamid T, Hakim M, Mousavi SA, Dadvar L, Mohammadi M, Amerian N. The role of self-efficacy on fear of falls and fall among elderly community dwellers in Shahroud, Iran. NPT. 2016;2(3):112–20.
41. Langer EJ. The illusion of control. J Pers Soc Psychol. 1975;32(2):311–28. https://doi.org/10.1037/0022-3514.32.2.311.
42. Wu F, Sheng Y. Social support network, social support, self-efficacy, health-promoting behavior and healthy aging among older adults: a pathway analysis. Arch Gerontol Geriatr. 2019;85: 103934. https://doi.org/10.1016/j.archger.2019.103934.
43. Moilanen T, Kangasniemi M, Papinaho O, Mynttinen M, Siipi H, Suominen S, Suhonen R. Older people's perceived autonomy in residential care: an integrative review. Nurs Ethics. 2020;28(3):414–34. https://doi.org/10.1177/0969733020948115.
44. Mazure CM, Maciejewski PK. A model of risk for major depression: effects of life stress and cognitive style vary by age. Depress Anxiety. 2003;17(1):26–33. https://doi.org/10.1002/da.10081.
45. O'Riley AA, Fiske A. Emphasis on autonomy and propensity for suicidal behavior in younger and older adults. Suicide Life-Threaten Behav. 2012;42(4):394–404. https://doi.org/10.1111/j.1943-278x.2012.00098.x.
46. Breton É, Beloin F, Fortin C, Martin A, Ouellet M-È, Payette H, Levasseur M. Gender-specific associations between functional autonomy and physical capacities in independent older adults: results from the NuAge study. Arch Gerontol Geriatr. 2014;58(1):56–62. https://doi.org/10.1016/j.archger.2013.07.011.
47. Bachrach N, Croon M, Bekker M. The role of sex and autonomy-connectedness in internalizing and externalizing personality pathology, coping and axis-I pathology: among psychiatric and healthy elderly. Aging Ment Health. 2016;21(6):642–50. https://doi.org/10.1080/13607863.2016.1146870.
48. Portegijs E, Rantakokko M, Mikkola TM, Viljanen A, Rantanen T. Association between physical performance and sense of autonomy in outdoor activities and life-space mobility in community-dwelling older people. J Am Geriatr Soc. 2014;62(4):615–21. https://doi.org/10.1111/jgs.12763.