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The onset of falls and its effects on perceived social exclusion and loneliness. Evidence from a nationally representative longitudinal study.

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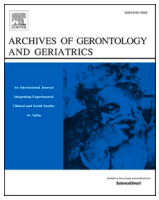

The onset of falls and its effects on perceived social exclusion and loneliness. Evidence from a nationally representative longitudinal study

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ABSTRACT

Purpose: It remains unclear how falls affect older people's social relations. In particular, the characteristics of fallers in their second half of life are unclear. Several studies have reported that people with a low educational level fall more often, and that low educational level is a predictor for perceived social exclusion. We conducted the first longitudinal analysis on the association between falls and social relations among people of different educational levels.

Methods: Longitudinal data were used from two waves (2014 and 2017) of the German Ageing Survey with an analytical sample of 11,227 individuals aged $\geq$ 40 years. Fall history in the past 12 months (yes; no) was assessed. Perceived social exclusion (outcome measure) was assessed using a validated scale developed by Bude and Lantermann. Loneliness (outcome measure) was measured using a short form of the validated De Jong Gierveld Loneliness Scale.

Results: Controlling for various potential confounding variables, fixed effects regression analysis stratified by educational level and gender revealed that experiencing a fall was associated with greater perceived social exclusion ($\beta = 0.21$ $p < 0.05$) among men with low/medium educational level. The experience of a fall was not associated with increased loneliness.

Conclusion: Our results suggest an association between falls and feelings of social exclusion. This association was found only for men in their second half of life with low/medium educational level. Falls were not associated with loneliness.

1. Introduction

1.1. Background

Around 40 percent of people aged 65 years and older report at least one fall per year (Rubenstein, 2006). Falls among older people represent a growing health problem worldwide (WHO, 2018). The World Health Organization reported that people aged above 65 years experience the largest number of fatal falls (WHO, 2018)(). Due to demographic ageing, the number of older people as a proportion of the total population is increasing (Murphy, 2020). It has been calculated, for example, that more than 31 percent of the German population will be over 65 years old in 2060 (Pötzsch & Rößger, 2015). The ageing of our population leads to several consequences and challenges in the health system (Yancik and Ries, 2000; Kurth, 2010). There are several health problems associated with the ageing of the population, inter alia, frailty (Clegg, 2013), cardiovascular diseases, cancer, as well as falls (Fuller, 2000; Yancik and Ries, 2000; Kurth, 2010). Indeed, falls are the 'second leading cause of accidental or unintentional injury deaths worldwide' (WHO, 2018). Therefore, it is important to investigate falls, their determinants and consequences, particularly among older individuals.

Falls have been linked to negative social, mental and physical consequences among older persons (Scheffer et al., 2008, Choi et al., 2014). Falls can lead to physical inactivity (Tinetti 1998), reduced health-related quality of life (Sánchez-García et al., 2017) or increased anxiety, including a fear of falling (Lavedán et al., 2018). Falls also lead to serious morbidity, mortality (Berková and Berka, 2018), and institutionalization (Estrella-Castillo et al., 2011), and are associated with high health care costs (; Peel, 2002, Florence et al., 2018).

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1.2. Literature overview

To date, a number of factors and their associations with falls have been investigated (Gale, 2016, Kendhapedi and Devasenapathy, 2019). For example, a number of studies have investigated the determinants of falls, including dementia (Lach, 2017)(Lach et al. 2017), frailty (Ensrud, 2008; de Vries, 2013) and Parkinson's disease (Fasano, 2017; Lieberman, 2019) among people in their second half of life. A key challenge associated with ageing is frailty (Gobbens, 2010; Clegg, 2013). Frailty describes the development of someone's 'vulnerability due to decreased homeostatic reserves after a stressor event' and the 'cumulative decline in several physiological systems' over the entire life-cycle (Clegg, 2013; Cesari, 2017; Tabue-Teguo, 2017).

However, to date, only a few studies have analyzed whether falls are related to social relations (Elliott et al., 2009; Schnittger et al., 2012; Hajek et al., 2017). It remains unclear whether falls influence the subjective feeling of perceived social exclusion or loneliness among those in their second half of life or older. Some studies have concluded that older individuals living alone fall more often, and report loneliness or perceived social exclusion (Victor, 2000; Faulkner et al., 2003; Schnittger et al., 2012; Hajek and König, 2017; Pohl et al., 2018; Petersen et al., 2020).

For example, a longitudinal study ($n = 7609$, participants aged 65 and older) found that the perceived social exclusion mean score was higher among those who fell in the last 12 months (Pohl et al. 2018). Moreover, a longitudinal study by Faulkner et al. (3 years, $n = 6692$ women aged 72 to 82 years) reported that larger family networks were inversely associated with the incidence rate of falls (Faulkner et al., 2003). These findings are in line with the results of the longitudinal study by Bu (data derived from seven waves from 2004 to 2017, $n = 13,061$ aged older than 50 years) that found that loneliness and social isolation were associated with a higher risk of falls, hospital admissions, and self-reported falls (Bu et al., 2020).

1.3. Rationale and hypotheses

Most of the aforementioned studies described the association between social ties (as explanatory variables) and falls (as outcome variable). This relationship seems reasonable in that loneliness or perceived social exclusion may induce functional limitations (Hacihasanoğlu et al., 2012; Perissinotto et al., 2012), and consequently lead to a higher risk of falls.

In this study, we hypothesize that the onset of falls (explanatory variable) is associated with changes in the subjective feeling of loneliness or perceived social exclusion (outcome variables). The analysis of this hypothesis will contribute further knowledge around the effect of falls on perceived loneliness and perceived social exclusion.

We hypothesize firstly that there is a significant association between falls and subjective assessment of social ties in terms of perceived loneliness and perceived social exclusion. Perceived social exclusion and perceived loneliness are strongly correlated (pairwise correlation was $r = 0.5, p < .001$). Therefore, it is useful to clarify the terms of our *outcome measures (loneliness* and perceived *social exclusion)*. *Loneliness* and perceived *social exclusion* should be recognized as two different concepts (de Jong Gierveld and Hagestad, 2006; Hajek and König, 2017; Finlay and Kobayashi, 2018).

Loneliness can be defined as the subjective, negative evaluation of someone's present and desired social relationships in either quality or quantity (Weiss, 1982; de Jong Gierveld, 1987; Bu et al., 2020). Loneliness can be understood as the experience of being lonely and 'as a negative feeling that can be topical even when in the company of others', e.g. when the individual wishes for a higher number of relationships (quantity) or more intimacy (quality) (de Jong Gierveld, 1987;(Lubben & Gironda, 2003) ; Stanley et al., 2010; McHugh, 2017). Whilst loneliness can be defined a 'subjective, emotional state' (Holt--Lunstad, 2015), perceived *social exclusion/isolation* defines a quantifiable state, in which someone perceives themselves not *to belong to society* (Wenger GC 1996; Holt-Lunstad, 2015; Primack, 2017; Primack, 2019). In this current study, social isolation is equated with perceived social exclusion. Social isolation can be seen as a part of perceived social exclusion which underlies a complex of geographical, economic, cultural, psychological and social influences on an individual's social fabric and integration possibilities (Gallie et al., 2003; (Nicholson Jr., 2009) ; (Taket, 2009); Nicholson, 2012).

In addition to our first hypothesis, we divide fallers into different groups of educational levels and consider the association between the onset of falls and social ties among these groups. Only a few studies have considered the different characteristics of fallers (Green et al., 2008; Yoo, 2016; Chippendale et al., 2017; Lee, 2018). It is possible that not all fallers are at the same risk of feeling lonely or socially excluded, and so it is important to understand falls and their link with social ties among different groups of people. For example, a recent study ($n = 45,857$ participants aged 14 to 85 years and above) found that participants aged 55 years and older, with an educational level lower than primary school, were at highest risk for falls (Li et al., 2013). Another prospective cohort study ($n = 534$, participants aged 65 and older) found different incidence rates for falls among frail elderly people linked to their educational level, with a higher number of falls among low educated elderly (Yoo, 2016). For further details, please see the discussion section.

Therefore, we *secondly* hypothesize that people in their second half of life with a low educational level are of a higher risk of feeling socially excluded or lonely after a fall. It seems plausible that fallers of a low educational level feel lonelier or more socially excluded after a fall, because (i) they are of a higher risk for falls and (ii) because they avoid or are unable to participate in activities of daily living such as meeting friends and family.

Limited involvement in daily activities may cause feelings of perceived social exclusion or loneliness, similar to findings in other studies that demonstrated that these feelings are associated with functional limitations (Green et al., 2008; Cohen-Mansfield et al., 2016; Hajek et al., 2017). Fallers with a low educational level may feel lonelier or more socially excluded because they may have difficulties compensating physical, functional restrictions after a fall, searching for alternative cognitive activities (Schumacher and Martin, 2009) when they were used to physical activities. Similarly, it may be that people with low educational levels in their second half of life may have difficulties in flexibly adapting their activity goals after an adverse fall, because they have different activity goals than those with a high educational level (Avlund and Legarth, 1994). For further information, please see the discussion section.

Finally, gender-stratified analyses were conducted in this analysis, as there are differential findings related to falls in men and women. For example, men are more likely to experience a fatal fall injury (Stevens, 2007). Additionally, some studies identified differences between men and women in terms of coping with the consequences of falls (Stevens et al., 2012; Sandlund, 2017; Sandlund, 2018). It seems like women are more likely to report falls to their doctor, benefit from medical care or consult a healthcare provider (Stevens et al., 2012). Furthermore, women may respond differently to a fall in terms of their social relations and support. It has been found that 'socially isolated men' of older age were more likely to have poor social support, in comparison to women (Vandervoort, 2000; Cloutier-Fisher & Kobayashi, 2009; Kim, 2020). Further details regarding men and their social relations after the experience of a fall, particularly those with a low educational level, are given in the discussion section.

In sum, the aim of this study is to deepen understanding around the onset of falls and its effects on perceived social exclusion and loneliness. This is the first longitudinal study to examine this association among individuals in their second half of life, stratifying by gender and different educational levels.

Findings may elaborate risk groups for falls and their associations. Moreover, study findings may emphasize the importance of the

development of fall interventions, whereby not only falls, but the negative consequences of falls (i.e. perceived social exclusion and loneliness) may be reduced (Wenger et al., 1996; Courtin and Knapp, 2017). Loneliness and perceived social exclusion are of special relevance because they are highly associated with later morbidity or rather mortality (Leigh-Hunt, 2017) and poor quality of life (Victor, 2000).

2. Methods

2.1. Sample

For the present study, data were derived from the fifth (2014) and sixth (2017) wave of the German Ageing Survey (DEAS, 'Deutscher Alterssurvey'). The German Ageing Survey is an ongoing, population-based, representative study of community dwelling persons aged 40 and above in Germany. The DEAS study has a cohort-sequential design and therefore provides cross-sectional and longitudinal data related to this German population. The DEAS study is supported by the German Centre of Gerontology (DZA, 'Deutsches Zentrum für Altersfragen') in Berlin. The Federal Ministry for Family Affairs, Senior Citizens, Women and Youth (BMFSFJ) funds the study, which first began in 1996 (first wave). Registry offices provide the addresses of all registered inhabitants for the baseline recruitment. Overall, there are 12,000 municipalities in Germany, from which a random sample of 290 municipalities was chosen in 1996.

The primary inclusion criterion for the study was that inhabitants were older than 40 years. First time interviewees were born after 1929 and living in private households. Since the first wave, further waves have followed in 2002 (second wave), 2008 (third wave), 2011 (fourth wave), 2014 (fifth wave) and 2017 (sixth wave). The inclusion criteria for participation in the following waves comprised not only one valid interview previously, but also an informed, signed consent. Further additional inclusion criteria included residence in Germany across all waves. The data collection took place via in-home interviews and supplementary self-administered questionnaires. Since the third wave, interviews have been conducted face-to-face by trained staff via computer-assisted personal interviewing (CAPI). Since 2017, the additional questionnaires could be answered online. Only those participants who completed both the questionnaire and the interview were included in the DEAS sample. Interviews included questions related to general topics associated with ageing, as well as socio-demographic information. The written questionnaire asked for more sensitive information, e.g. subjective health, psychological scales and income (Vogel, 2019). The main goal of the DEAS study is 'to provide a representative national database containing information describing the living conditions of the country's middle-aged and older population and to study diversity within the older section of the population, the process of aging as it affects individuals and processes of social change as they relate to old age and aging.' (Klaus, 2017). In wave five, 6,003 interviewees (base sample) participated for the first time and 4,352 interviewees re-participated from the previous four waves. Furthermore, in wave six there were 6,626 valid cases available for analysis, and the response rate of the panel reached around 63 percent (Schiel, 2018) . This response rate is similar to other longitudinal survey studies among this age group (Engstler, 2015) and is in line with the trend of decreasing participation in several European countries (Ineke et al., 2010).

The main reason for lack of follow-up data was a 'general refusal to participate'. In the sixth wave 1095 interviewees (10.44%) refused to participate in the CAPI again, and withdrew their agreement (Schiel, 2018). Further details concerning the DEAS study, such as panel mortality, instrumental techniques or sample selection, are provided elsewhere (Klaus, 2017; Schiel, 2018; Vogel, 2019). In this study, longitudinal data from the fifth and sixth wave were used for falls, loneliness and perceived social exclusion. Falls were quantified in 2014 for the first time (Engstler, 2015)(). The final analytical sample contains 11,227 observations, excluding participants with missing data for falls, perceived social exclusion and/or loneliness.

3. Ethical standards

The criteria for requiring an ethical statement were not met by this study, meaning an ethical statement for the DEAS study was not necessary. The German Centre for Gerontology in Berlin did not apply for an ethic vote and is responsible for DEAS. For further information read the German Research Foundation-guidelines (Deutsche Forschungsgemeinschaft, DFG) which are only available in German language at: http://dfg.de/foerderung/faq/geistes_sozialwissenschaften/. The study was performed following the ethical principles expressed in the Declaration of Helsinki in 1964, including all amendments and revisions.

3.1. Outcome

Perceived social exclusion was evaluated using a scale developed by Bude and Lantermann (Bude and Lantermann, 2006). The scale consists of four items, with possible answers ranging from 1 = 'strongly agree' to 4 = 'strongly disagree'. The scale asks for the following four items: 'I am worried to be left behind', 'I feel like I do not really belong to society', 'I feel that I am left out' and 'I feel excluded from society'. Following the DEAS guidelines, the scale represents the mean of at least two recorded valid items, with higher values representing greater feelings of perceived social exclusion. In the present study, Cronbach's Alpha was 0.88.

Loneliness was assessed using a short version of the established 11-item De Jong Gierveld Scale (de JongGierveld and Tilburg, 2006; Gierveld and Kamphuls, 1985). Loneliness was quantified using the following six items: 'I miss having people around among whom I feel comfortable', 'There are plenty of people I can rely on when I have problems', 'I often feel rejected', 'There are many people I can trust completely', 'I miss emotional security and warmth', and 'There are enough people I feel close to.' Possible answers were ranging from 1 = 'strongly agree', 2 = 'agree', 3 = 'disagree' to 4 = 'strongly disagree'. Half of the six items required valid values, meaning a loneliness score was not calculated where one participant answered 2 or less items. Thus, the scale demonstrates the mean of at least three required valid items. For example in 2017, 5,467 participants answered all six questions (97.49%), 73 participants answered more than three but less than six questions (1.3%) and only three participants answered one to three questions (0.05%) in 2017. Moreover, 65 participants answered none of the six questions (1.16%). Very similar values were observed in 2014 (and in perceived social exclusion). The loneliness scale has been examined as a reliable and valid instrument (De Jong Gierveld and Kamphuls, 1985; de Jong and Tilburg, 2006; De Jong, 2010). Higher values represent greater perceived loneliness. Cronbach's Alpha was 0.83.

3.2. Independent variable

The explanatory variable of interest was falls in the last 12 months. In accordance with previous studies, falls in the preceding 12 months (yes; no) were assessed measuring the history of falls (Muir, 2010; Duncan, 2015). In the DEAS study participants were asked: 'Have you fallen in the past twelve months?' In 2017, participants were supported in answering the written self-report questionnaire as required. The written questionnaire was given to the participants after their interview, so that the participants could also ask the interviewer for help if they required assistance, e.g. to read the questions (Schiel, 2018).

3.3. Covariates

Further important covariates were added to our regression model in line with empirical findings and theoretical assumptions. It has been

shown that self-rated health, socioeconomic and lifestyle factors are important factors associated with social relations (Victor, 2000; Gracia and Herrero, 2004; Mukamal et al., 2004; Cattan et al., 2005; Scharf et al., 2005; Cawthon et al., 2006; Hajek and König, 2017; Hajek et al., 2017; Singh et al., 2019). For example, sociodemographic variables such as age are associated with a higher risk of falls (Peel, 2002; Morsch et al., 2015; Prato, 2017). Consequently, we defined and included the following covariates for analysis: age in years, body mass index (BMI), family status (married and living together with spouse, married and living separated from spouse, single, divorced or widowed), and individual monthly net equivalent income (OECD scale). Additionally, covariates reporting lifestyle factors, such as smoking behavior (1 = 'I smoke daily', 2 = 'I smoke occasionally', 3 = 'I used to smoke, but not anymore', 4 = 'I have never smoked'), frequency of sports activities in the last 12 months (such as hiking, soccer, gymnastics, or swimming) and alcohol consumption (both with answer options: 1 = 'Daily', 2 = 'Several times a week', 3 = 'Once a week', 4 = 'One to three times a month', 5 = 'Less often', 6 = 'Never') were used (Engstler, 2018)(). It has been found that these lifestyle factors are related to falls (Heesch et al., 2008; Faulkner, 2009; Kwan et al., 2011; Chippendale et al., 2017).

The following covariates related to physical and mental health were also included in the analysis: state of health (self-rated health from 1 = 'very good' to 5 = 'very bad'), 'cognitive function' (measured using a digit symbol test according to the Digit Symbol Substitution Test (DSST) (Wechsler, 1939; Wechsler, 1955; Tewes, 1994) and the subscale 'physical functioning' of the SF-36 (ranging from 0 = worst score to 100 = best score) (Ware and Sherbourne, 1992; Bullinger, 1998). Moreover, the number of physical diseases (e.g. cardiac and circulatory disorders, joint, bone, spinal or back problems) and depressive symptoms were included in the analysis as covariates.

The subscale 'physical functioning' of the SF-36 was chosen for this study, as it offers information about how the individual's health limits their physical activity, basic mobility and daily activities by asking them the following 10 questions (Bohannon, 2010; White, 2011): '1. Vigorous activities, such as running, lifting heavy objects, participating in strenuous sports, 2. Moderate activities, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf?, 3. Lifting or carrying groceries, 4. Climbing several flights of stairs, 5. Climbing one flight of stairs, 6. Bending, kneeling, or stooping, 7. Walking more than one kilometer (0.62 miles), 8. Walking several blocks, 9. Walking one block, 10. Bathing or dressing yourself.' This scale has been found to be a valid and reliable scale for older persons living in private households (Bohannon, 2010; White, 2011).

Moreover, it has been shown that chronic diseases (Lawlor et al., 2003; Peng et al., 2019; Immonen et al., 2020) and depressive symptoms (Kvelde et al., 2013; Stubbs et al., 2016) are associated with a higher risk of falls. The following chronic diseases were identified by the participants in our study: '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; gall bladder, liver or kidney problems; bladder problems; eye problems or vision impairment; ear problems or hearing problems; other illnesses or health problems (open answer)'.

A short form with 15 items of the Center for Epidemiological Studies Depression Scale (CES-D) (Radloff, 1977) was used to assess depressive symptoms. The CES-D is a valid scale (Radloff, 1977) with a possible range of scores from 0 to 45 (higher scores indicating more depressive symptoms). To date, the cut-off score of 18 has been used to determine the presence of depressive symptoms (Helsing, 1977; APA, 1980; Teri, 1986; APA, 1987; APA, 1994). An optimal cut-off score for men and women of different educational level or age is still under research (Haringsma, 2004; Dozeman ,2011; Herge, 2013; Henry, 2018).

In an additional analysis, the main model in our study was extended by adding cognitive function. This covariate relied on a digit symbol test conducted during the interviews in accordance with the Digit Symbol Substitution Test (DSST). The DSST has been found to be a 'valid and sensitive measurement of cognitive dysfunction or performance of adults' (Hoyer et al., 2004; Jaeger, 2018). In addition, it is a sensitive, neuropsychological test to detect dementia, brain damage or depression (Rosano, 2016; Jaeger, 2018; Amieva, 2019). During the interviews participants had to remember a table of Arabic figures corresponding with geometric signs. Then the participants had to remember the combinations in order to fill out a table with the Arabic signs and corresponding figures in 90 seconds (Engstler, 2019)(). During the test, the speed of 'visual perception and information processing on the one hand' and the speed to write down or type the result into the computer were assessed (Engstler, 2019)(). The 'cognitive function' score represents the number of correct Arabic figure-geometric sign matches achieved in 90 s. Higher values correspond to higher cognitive performance (Hoyer et al., 2004; Rosano, 2016;(Engstler, 2019)).

3.4. Statistical analysis

First, sample characteristics stratified by educational level groups and gender were computed to describe the study sample, and to provide a more detailed overview of the distribution of the sample's characteristics. The educational level was evaluated using the ISCED-scale: including level 1 (low = ISCED 0-2; 'Respondents without a completed vocational qualification and up to entry qualification for a professional qualification.' (Engstler, 2019), level 2 (medium = ISCED 3–4; 'Respondents with vocational qualifications (including professional upgrading training) or entry qualifications for university or university of applied science.' (Engstler, 2019) and level 3 (high = ISCED 5-6; 'Respondents with completed university studies (university or university of applied science.' (Engstler, 2019).

Second, multiple linear fixed effects (FE) regressions were stratified by educational level and gender, and then conducted to analyze the association between (i) falls and loneliness as well as between (ii) falls and perceived social exclusion. These FE regressions were applied, controlling for several potential covariates, e.g. self-rated health, number of physical diseases, consumption of alcohol and more. FE regressions were used because they provide consistent estimates even when time-constant unobserved factors (e.g. genetic factors) are systematically associated with the explanatory variables (Cameron and Trivedi, 2005; Brüderl & Ludwig, 2015; Kohler and Kreuter, 2016). Other regression techniques such as random effects (RE) regressions would result in inconsistent estimates when such a correlation was present (Cameron and Trivedi, 2005; Brüderl & Ludwig, 2015). The FE estimator is also named the 'within-estimator', which means FE regressions only relate to intraindividual changes (within-individual variations). Thus, FE estimates are not biased by time-constant factors (observed and unobserved). This means that only time-dependent variables, e.g. self-rated health, income or physical functioning could be included as main effects in FE regressions. The covariates were taken from two waves (2014 to 2017) to examine intraindividual changes. For example, it was examined whether intraindividual changes in self-rated health (from 2014 to 2017) were associated with intraindividual changes in loneliness (from 2014 to 2017).

Third, gender and educational level were used as moderators in regression analysis.

The statistical significance level was set at $p < 0.05$. Stata version 16.1 was used to perform all statistical analyses (StataCorp, College Station, TX, USA).

4. Results

4.1. Sample characteristics

Table 1 depicts the descriptive sample characteristics of our analytical sample ($n = 11,227$) used in the FE regression analysis, stratified by educational level groups and gender. In total, 11,227 participants (mean

Table 1
. Characteristics of analytical sample, stratified by gender and educational level (n = 11,227).

Educational level (ISCED-Scale)	Women Low/Medium (n = 3,514) N/Mean	%/SD	High (n = 1,998) N/Mean	%/SD	Men Low/Medium (n = 2,777) N/Mean	%/SD	High (n = 2,933) N/Mean	%/SD	p-value t-test/ chi^2
Age in years	64.69	10.99	62.39	10.34	65.52	11.21	66.25	10.81	<0.001
Monthly net equivalent income in Euro	2,437.68	1,482.93	3,366.27	2,188.55	2,582.34	1,691.78	3,751.68	3,513.63	<0.001
Body Mass Index (BMI)	27.15	5.2	25.7	4.74	27.96	4.46	26.84	3.68	<0.001
Marital status									
1. Married, and living together with spouse	2,140	60.9 %	1,297	64.91 %	2,058	74.11 %	2,355	80.29 %	0
2. Married, and living separated from spouse	49	1.39 %	38	1.9 %	30	1.08 %	54	1.84 %	0
3. Single	195	5.55 %	185	9.26 %	271	9.76 %	127	4.33 %	0
4. Divorced	440	12.52 %	247	12.36 %	218	7.85 %	236	8.05 %	0
5. Widowed	690	19.64 %	231	11.56 %	200	7.2 %	161	5.49 %	0
Smoking status:									
1. I smoke daily	502	14.29 %	214	10.71 %	507	18.26 %	248	8.46 %	0
2. I smoke occasionally	113	3.22 %	69	3.45 %	118	4.25 %	140	4.77 %	<0.001
3. I used to smoke, but not anymore	982	27.95 %	612	30.63 %	1,246	44.87 %	1,350	46.03 %	<0.001
4. I have never smoked	1,917	54.55 %	1,103	55.21 %	906	32.61 %	1,195	40.74 %	<0.001
Consumption of alcohol:									
1. Daily	170	4.84 %	170	8.51 %	455	16.02 %	615	20.97 %	<0.001
2. Several times a week	517	14.71 %	493	24.67 %	776	27.94 %	1,018	34.71 %	<0.001
3. Once a week	503	14.31 %	378	18.92 %	442	15.92 %	465	15.85 %	<0.001
4. One to three times a month	494	14.06 %	307	15.37 %	263	9.47 %	287	9.79 %	<0.001
5. Less often	1,265	36 %	485	24.27 %	524	18.87 %	364	12.41 %	<0.001
6. Never	565	16.08 %	165	8.26 %	327	11.78 %	184	6.27 %	<0.001
Frequency of sports activities:									
1. Daily	255	7.26 %	223	11.16 %	205	7.38 %	276	9.41 %	<0.002
2. Several times a week	912	25.95 %	717	35.89 %	533	19.19 %	952	32.46 %	<0.002
3. Once a week	712	20.26 %	445	22.27 %	409	14.73 %	517	17.63 %	<0.002
4. Between 1-3 times per month	221	6.29 %	123	6.16 %	196	7.06 %	237	8.08 %	<0.002
5. Less often	343	9.76 %	182	9.11 %	408	14.69 %	366	12.48 %	<0.002
6. Never	1,071	30.48 %	308	15.42 %	1,026	36.95 %	585	19.95 %	<0.002
State of health (Subjective health)									
1. Very good	253	7.2 %	213	10.66 %	163	5.87 %	271	9.24 %	0.119
2. Good	1,569	44.65 %	1,005	50.3 %	1,206	43.43 %	1,441	49.13 %	0.119
3. Average	1,293	36.8 %	651	32.58 %	1,070	38.53 %	978	33.34 %	0.119
4. Bad	326	9.28 %	114	5.71 %	273	9.83 %	211	7.19 %	0.119
5. Very bad	73	2.08 %	15	0.75 %	65	2.34 %	32	1.09 %	0.119
Subscale of physical functioning (SF36 - Short form health survey)	78.05	24.56	84.36	21.37	80.39	23.54	86.72	18.52	<0.001
Number of physical diseases	2.7	1.98	2.3	1.81	2.73	1.97	2.57	1.88	0.001
Depressive symptoms (Depression Scale ADS/ CES-D Scale)									
1. Cut-off score above 18	328	9.33 %	124	6.21 %	129	4.65 %	98	3.34 %	<0.001
2. Score below 18	3,186	90.67 %	1,874	93.79 %	2,648	95.35 %	2,835	96.66 %	<0.001
Perceived social exclusion	2.66	0.61	2.53	0.54	2.64	0.6	2.51	0.54	<0.001
Loneliness	1.77	0.56	1.65	0.54	1.83	0.53	1.77	0.52	<0.001
Cognitive function (Digit Symbol Test)	46.34	13.86	51.56	12.77	40.5	12.96	45	12.72	<0.001
Experiencing a fall in the preceding 12 months	118	3.36 %	86	4.3 %	65	2.34 %	84	2.86 %	<0.001

Notes: The educational level was evaluated using the ISCED-Scale: ranging from level 1 (low = ISCED 0–2; 'Respondents without completed vocational qualification and up to a maximum of a graduation degree, which qualifies for a professional qualification.'(Engstler, 2019), level 2 (medium = ISCED 3-4;'Respondents with vocational qualifications (including professional upgrading training) or qualifications for university or university of applied science entrance.'(Engstler, 2019) and level 3 (high = ISCED 5–6;'Respondents with completed university studies (university or university of applied science.'(Engstler, 2019). Age in years: covers the age range of 40–97 years. Marital status: table lists status 'married and living together with spouse', further values of subgroups can be provided. Smoking status: divided into four subgroups from 1 = 'I smoke daily' to 4 = 'I have never smoked'. Consumption of alcohol: ranging from 1 = 'daily' to 6 = 'never'. Frequency of sport activities (such as hiking, soccer, gymnastics, or swimming): ranging from 1 = 'daily' to 6 = 'never'. State of health (Subjective health): ranging from 1 = 'very good' to 5 = 'very bad'. Physical functioning was evaluated using a scale created by Bullinger and Kirchberger (1998), ranging from 0-100 with higher values indicating a better physical functioning. Depressive symptoms were evaluated using the short form of the German translation of the CES-D (Center for Epidemiologic Studies Depression) developed by Hautzinger and Bailer (1993), ranging from 0 to 45 (higher values than 18 (cut-off-value) represent higher depressive symptoms). Perceived social exclusion was assessed using a scale evolved by Bude and Lantermann (2006), ranging from 1 to 4 (higher values pronounce a higher perceived social exclusion). Loneliness was assessed using a short version (Gierveld and Van Tilburg 2006) with six items of the De Jong Gierveld Scale (De Jong Gierveld and Kamphuls, 1985), ranging from 1 to 4 (higher values represent higher perceived loneliness). Cognitive function displays the total score of right characters (Engstler, 2019)() achieved by the participants in a short version of the Digit Symbol Substitution Test (DSST) by Wechsler (1955) and Tewes (1994). The achieved test values serve as 'a good measurement for cognitive performance' of the participants (Hoyer et al., 2004; Engstler, 2019).

age: 64.9 ± 10.97 years) reported on their perceived social exclusion, loneliness and whether they experienced a fall in the last 12 months. The age ranged from 40 to 97 years. In total, 49.1% of the individuals were female and most of the participants were married and living together with spouse (69.92%). On average, the participants had 2.6 ± 1.9 physical diseases. Furthermore, more than half of the participants reported a low or medium educational level (56.03%).

The average of depressive symptoms was 6.60 ± 5.91, ranging from

0 to 45 (cut-off point of 18 indicating probable depression) (Radloff, 1977; Teri, 1986; Engstler, 2019). In total, 452 women and 227 men had a cut-off point of 18 indicating probable depression. Moreover, the mean perceived social exclusion score was 2.59 ± 0.58 (ranging from 1–4) and the average score for loneliness was 1.76 ± 0.54 (ranging from 1-4). Further details of sample characteristics stratified by educational level and gender can be found in Table 1. 353 individuals did not report a fall in 2014, but did report a fall in 2017. The corresponding beta-coefficients (presented in the next section) regarding the link between falls and perceived social exclusion/loneliness exclusively refer to individuals reporting such a transition.

4.2. Regression analysis

4.2.1. Loneliness

Results of FE regressions stratified by educational level and gender with loneliness as the outcome variable are shown in Table 2. The regression analysis was first conducted without adjusting for covariates (Table 2). Each column of this table contains results of women and men of different educational levels (first column: women with low/medium educational level; second column: women with high educational level; third column: men with low/medium educational level; fourth column: men with high educational level). Without adjusting for several covariates, FE regressions did not identify a significant association between the onset of falls and an increase in loneliness in any of the different gender and educational level groups.

Table 3 depicts the results of FE regressions, stratified by the educational level and gender with loneliness as outcome variable, after adjusting for several covariates. Each column contains results related to the different gender and educational level groups. Following adjustment for several potential covariates, FE regressions revealed that the onset of falls was not associated with an increase in loneliness for men and women, neither in the group with low/medium nor high educational level.

Moreover, analysis was conducted to determine whether gender or educational level moderates the association between falls and loneliness. The results are shown in the last column of Table 3. No corresponding interaction term (gender x falls and educational level x falls) was significant.

Finally, the main model was extended by adding cognitive function. However, the (missing) link between falls and loneliness remained nearly the same in terms of significance and effect sizes (see Supplementary Table 1).

Table 2
Results of multiple linear regression (without covariates): Outcome variable loneliness among women and men with low/medium and high educational level - DEAS 2014 and 2017.

Variables	Female low/medium educational level	high educational level	Male low/medium educational level	high educational level
Falls since 2014	-0.01	0	-0.06	0.02
	(0.03)	(0.04)	(0.05)	(0.05)
Constant	1.77***	1.66***	1.83***	1.77***
Observations	4,345	2,439	3,250	3,396
Number of fallen persons	2,857	1,524	2,177	2,131
R^2	0	0	0	0

Beta-Coefficients are reported; Cluster-robust standard errors in parentheses. Loneliness was assessed using a short version (de Jong and Tilburg, 2006) with six items of the De Jong Gierveld Scale (De Jong Gierveld and Kamphuls, 1985), ranging from 1 to 4 (higher values represent higher perceived loneliness).
*** $p < 0.001$
** $p < 0.01$
* $p < 0.05$, + $p < 0.10$

4.2.2. Perceived social exclusion

Table 4 reveals the results of FE regressions stratified by the educational level and gender with perceived social exclusion as the outcome variable, without controlling for several covariates (first column: women with low/medium educational level; second column: women with high educational level; third column: men with low/medium educational level; fourth column: men with high educational level) The table is laid out in the same way described above. Table 4 details the following results: The onset of falls was associated with an increase in perceived social exclusion for men with a low/medium educational level ($\beta = 0.15$, $p < 0.05$). The onset of falls was not associated with an increase in perceived social exclusion among all women (low/medium and high educational level) and men with high educational level.

Table 5 displays the findings of FE regressions stratified by educational level and gender with perceived social exclusion as the outcome variable. FE regressions for perceived social exclusion as the outcome variable were conducted controlling for the same potential covariates. In Table 5 each column contains results relating to a different group of educational level and/or gender. In contrast to the results from Table 3, while the onset of falls was not associated with an increase in perceived social exclusion among all women and men with high educational level, it was associated with the onset of falls among men with a low/medium educational level ($\beta = 0.19$, $p < 0.05$)

The last column of Table 5 includes results relating to whether gender or the educational level moderate the association between falls and perceived social exclusion. The corresponding interaction term (gender x falls) was significant ($\beta = -0.12$, $p < 0.05$), however the other interaction term (educational level x falls) was not significant.

Finally, the main model was extended by adding cognitive function. The link between falls and perceived social exclusion remained nearly the same in terms of significance and effect sizes (see Supplementary Table 2), namely the onset of falls was still associated with an increase in perceived social exclusion, but only for men with low/medium educational levels ($\beta = 0.19$, $p < 0.05$).

5. Discussion

5.1. Main findings

Based on a large nationally representative sample of participants, the aim of this longitudinal study was to investigate the association between falls and social relations in terms of loneliness and perceived social exclusion. This present study is the first longitudinal study examining the onset of falls (explanatory variable) and its association with changes in perceived social exclusion and loneliness (outcome variables). We particularly focused on individuals in their second half of life and of different educational levels. FE regressions, controlling for several possible covariates, revealed that loneliness was not associated with the onset of falls in men and women, nor among persons with low/medium or high educational level. While an increase in perceived social exclusion was not associated with the onset of falls among women of both educational level groups and men of high educational level, it was associated with the onset of falls among men with a low/medium educational level with significant interaction (gender x falls). It should be noted that three-way-interaction terms (gender x educational level x falls) did not achieve statistical significance.

5.2. Relation to previous research and possible explanations

Findings from this longitudinal study contribute to a better understanding of the association between falls and social relations among individuals of different educational levels in their second half of life. To the best of our knowledge, few studies have examined this in research to date.

Table 3
Results of multiple linear regression: Outcome variable loneliness among women and men with low/medium and high education - DEAS 2014 and 2017.

Variables	Female low/medium education	high education	Male low/medium education	high education	Outcome for loneliness - men and women with interaction term
Falls since 2014	0.02	0.08	0.02	0.05	-0.05
	(0.05)	(0.05)	(0.06)	(0.05)	(0.06)
Age in years	0	0	0.01*	0	0*
	(0.01)	(0.01)	(0.01)	0	0
Marital status:					
other marital statuses (Ref.: married, living	0.29	0.12	0.26	0.07	0.21*
separated from spouse)	(0.32)	(0.16)	(0.16)	(0.13)	(0.1)
divorced, (civil union annulled)	0.14	0.07	0.06	0.16+	0.09
	(0.18)	(0.14)	(0.14)	(0.09)	(0.07)
widowed	0.01	0.29*	0.06	0.07	0.07
	(0.09)	(0.14)	(0.12)	(0.07)	(0.05)
single	0.33***	0.09	0.05	0.12	-0.06
	(0.08)	(0.31)	(0.08)	(0.09)	(0.08)
Monthly net equivalent income in Euro	0	0	0	0***	0**
	0	0	0	0	0
Body-Mass-Index (BMI)	0.01	0.01	0.02	0	-0.01*
	(0.01)	(0.01)	(0.01)	(0.01)	0
Smoking status:					
yes, sometimes (Ref.: daily)	0.04	0.04	0.02	0.17	-0.04
	(0.1)	(0.11)	(0.1)	(0.11)	(0.05)
not anymore	0.1	0.04	0.02	0.11	0.01
	(0.1)	(0.1)	(0.08)	(0.11)	(0.05)
never been a smoker	0.06	0.14	0.12	0.12	-0.06
	(0.12)	(0.11)	(0.1)	(0.14)	(0.06)
Consumption of alcohol:					
several times a week (Ref.: daily)	0.18	0.04	0.02	0.06+	0.03
	(0.09)	(0.07)	(0.05)	(0.03)	(0.02)
once a week	0.13	0.04	0.03	0.05	0.03
	(0.09)	(0.08)	(0.06)	(0.05)	(0.03)
one to three times a month	0.14	0.02	0.02	0.09+	0.05
	(0.09)	(0.1)	(0.07)	(0.05)	(0.03)
less frequently	0.1	0	0.04	0.03	0.02
	(0.09)	(0.1)	(0.07)	(0.06)	(0.04)
never	0.07	0.09	0.03	0.01	0.01
	(0.12)	(0.13)	(0.11)	(0.09)	(0.05)
Physical activity:					
several times a week (Ref.: daily)	0.04	0.03	0.05	0	-0.01
	(0.05)	(0.05)	(0.06)	(0.04)	(0.02)
once a week	0.04	0.01	0.07	0.01	0
	(0.05)	(0.05)	(0.05)	(0.05)	(0.03)
one to three times a month	0	0.07	0.06	0.01	0
	(0.06)	(0.08)	(0.06)	(0.06)	(0.03)
less frequently	0.03	0.03	0.06	0.01	0
	(0.06)	(0.07)	(0.06)	(0.05)	(0.03)
never	0.01	0.03	0.02	0.01	-0.01
	(0.05)	(0.07)	(0.05)	(0.05)	(0.03)
Subjective health:					
good (Ref.: very good)	0.08+	0.05	0.01	0.03	0.03
	(0.05)	(0.05)	(0.06)	(0.04)	(0.02)
average	0.1+	0.06	0.04	0.01	0.05
	(0.05)	(0.06)	(0.07)	(0.05)	(0.03)
bad	0.15*	0.07	0.01	0.03	0.05
	(0.07)	(0.09)	(0.08)	(0.07)	(0.04)
very bad	0.24	0.13	0.18	0.23*	0.2**
	(0.16)	(0.19)	(0.14)	(0.11)	(0.08)
Subscale of physical functioning (SF-36)	0	0*	0	0	0
	0	0	0	0	0
Number of physical illnesses	0	0.02+	0.03**	0.01	0.01+
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Depressive symptoms (CES-D short form)	0.01*	0.01*	0	0.01**	0.01***
	0	0	0	0	0
Interaction term: Falls x gender x educational level					0.01
					(0.1)
Constant	1.83***	2.31***	3***	2.08***	2.26***
	(0.39)	(0.44)	(0.49)	(0.36)	(0.21)
Observations	3,509	2,002	2,787	2,927	11,227
Number of Individuals	2,453	1,339	1,941	1,938	7,671
R^2	0.03	0.06	0.04	0.04	0.02

Beta-Coefficients are reported; Cluster-robust standard errors in parentheses. Loneliness was assessed using a short version (de Jong and Tilburg, 2006) with six items of the De Jong Gierveld Scale (De Jong Gierveld and Kamphuls, 1985), ranging from 1 to 4 (higher values represent higher perceived loneliness).
*** $p < 0.001$

** $p < 0.01$
* $p < 0.05$, + $p < 0.10$. It should be noted that conditional main effects for sex and education cannot be estimated in FE models since these factors do not vary within individuals over time (i.e., they are time-constant).

Table 4
Results of multiple linear regression (without covariates): Outcome variable perceived social exclusion among women and men with low/medium and high educational level - DEAS 2014 and 2017.

Variables	Female low/medium educational level	high educational level	Male low/medium educational level	high educational level
Falls since 2014	0	-0.06	0.15*	0.05
	(0.05)	(0.05)	(0.07)	(0.05)
Constant	2.66***	2.53***	2.64***	2.51***
Observations	4,372	2,446	3,250	3,401
Number of fallen persons	2,860	1,529	2,172	2,127
R^2	0	0	0.01	0

Beta-Coefficients are reported; Cluster-robust standard errors in parentheses. Perceived social exclusion was assessed using a scale evolved by Bude and Lantermann (2006), ranging from 1 to 4 (higher values pronounce a higher perceived social exclusion).
*** p<0.001
** p<0.01
* p<0.05, + p<0.10

This current study's results lead to the following question: Why is the onset of a fall notably associated with (i) men of (ii) low/medium educational level and their (iii) perceived social exclusion (and not loneliness)? To find explanations for the link between falls and perceived social exclusion, only among men in their second half of life with low/medium educational level, it is worth highlighting that findings from other studies indicate a higher risk and frequency of falls for men with a low educational level (Kiadaliri, 2018). Namely, some studies have described differences in the mortality related to falls according to educational level and gender, finding greater mortality linked to falls among older men with a low educational level (Alicandro et al., 2018; Kiadaliri, 2018; van Hedel, 2018). Moreover, Kiadaliri observed a link between low educational level and deaths linked to falls among men but not women (Kiadaliri, 2018).

There are only a few studies investigating the relationship between (ii) education and falls among older people. For example, some studies have emphasized how low educational levels relate to a higher risk of falls among older people (Borrell et al., 2002; WHO, 2018; Abreu, 2015; Kiadaliri, 2018; Sotoudeh et al., 2018; Janakiraman et al., 2019; Lee, 2019; Susilowati et al., 2020). Moreover, some studies found that age and low educational level lead to poorer performance in the Timed Up and Go Test (TUG) among elderly women, which serves as a reliable predictor for frailty and falls (Thrane, 2007; Gomes, 2015). Another longitudinal study from Sweden (15 years, n = 566,478, participants aged 50 to 75 years, Study of Educational inequalities in falls mortality among older adults) found that there was a 'higher risk of falls mortality in men with low and medium educational level' (Kiadaliri, 2018). They found that 'falls mortality risk was two times higher in men with the lowest position on the education scale', compared to those in the highest position (Kiadaliri, 2018).

Older people with low educational levels may fall more often because they may be less concerned about their healthcare leading to an increased risk of falls' (WHO, 2010; Abreu, 2015; Abreu, 2016). Moreover, a cross-sectional study (n = 34,123, aged 50 years and above) found that a protective factor against frailty and disability was a higher educational level (Biritwum 2016). Findings from these studies suggest that older people with a low educational level represent a vulnerable group for falls.

This present study's results are in line with these findings. Furthermore, our study provides new information about the (iii) effect of falls on social ties. We found that there is an association between falls and greater perceived social exclusion using a longitudinal approach. More precisely, this study's results suggest that only men with low/medium educational level are affected. In no other groups of educational level, age and gender was an association found between falls and perceived social exclusion. Our findings did not reveal an association between falls and loneliness.

Men in their second half of life with a low/medium educational level adversely fall more often (Alicandro et al., 2018; Kiadaliri, 2018; van Hedel, 2018), however it remains unclear as to why this affects higher perceived social exclusion in this population. For example, a study with n = 2,641 people aged 65 years and older found that the 'risk of social isolation was associated with low educational level' (Iliffe et al., 2007). To explain this groups' higher perceived social exclusion after a fall, the impact of falls on social relations needs to be better understood. There remains a lack of studies that examine social relations and their association with falls (Faulkner et al., 2003; Iliffe et al., 2007; Kharicha et al., 2007; Elliott et al., 2009; Hajek and König, 2017; Petersen et al., 2020). There are some studies which have emphasized an association between falls and individuals living alone (Kharicha et al., 2007; Elliott et al., 2009; Chen and While 2019). A possible reason for a significant relation between falls and social ties among older people may therefore be that 'experiencing a fall is strongly associated with a change in the perception of social ties' (Hajek and König, 2017). However, after a fall, which may result in injuries and physical limitations, social ties may weaken if the individual is unable to maintain social connections. A concerned, fallen individual may state that the social connections are of poorer quality due to disability and the inability to participate in social life. The consequence may be more time at home alone, and an increase in perceived social exclusion and loneliness. Additionally, it may be challenging for the affected individuals to accept support by friends and family after a fall. If the affected person feels ashamed to ask social contacts for support, this may result in increased loneliness levels.

The studies described above stress significant associations between falls and social relations, however it remains unclear why older adults experiencing a fall develop higher feelings of perceived social exclusion or loneliness. Further studies are needed to understand the link between falls and social relations and the reasons underlying changes in social relations following a fall, such as difficulties coping with the consequences and restrictions after a fall.

Furthermore, it is important to determine why men with a low/medium educational level in their second half of life are affected by higher feelings of perceived social exclusion after a fall. Namely, it is necessary to better understand the social ties of this particular group of men. While women are more likely to require social support because women tend to have larger networks and social supports from various sources, 'men tend to rely on their spouses' or build social connections at work (Antonucci & Akiyama, 1987; Vandervoort, 2000; Antonucci, 2003; Carr & Bodnar-Deren, 2009; Kim, 2020; Streeter, 2020). Men's reliance on their spouses or colleagues after a fall could evoke feelings of loneliness or perceived social exclusion, particularly where an individual does not have a spouse, or is in retirement (Kim et al., 2020). Furthermore, studies indicate that individuals with low levels of education prefer to have friends with low education levels (Verbrugge, 1977). Several studies have emphasized that a low educational level can lead to a poor well-being (Lawton, 1999; Verhaeghen, 2000; Clarke, 2002; Ihle, 2020) and poor physical (Lawton, 1999; Clarke, 2002) and psychosocial functioning (Verhaeghen, 2000; Amoretti, 2016; Cutler, 2017; Joo, 2017; Ihle, 2020). Additionally, individuals with low education levels are at a greater risk of decreased cognitive function in older

Table 5
. Results of multiple linear regression: Outcome variable perceived social exclusion among women and men with low/medium and high educational level - DEAS 2014 and 2017.

Variables	Female low/medium educational level	high educational level	Male low/medium educational level	high educational level	Outcome for perceived social exclusion - men and women with interaction term
Falls since 2014	0.01	0.1+	0.21*	0.02	0.06
	(0.06)	(0.06)	(0.08)	(0.06)	(0.04)
Age in years	0	0	0	0	0
	(0.01)	(0.01)	(0.01)	0	(0.47)
Marital status:					
other marital statuses (Ref.: married, living	0.52	0.34+	0.44	0.27*	0.27+
separated from spouse)	(0.37)	(0.18)	(0.27)	(0.13)	(0.15)
divorced, (civil union annulled)	0.06	0.1	0.22	0.11	0.02
	(0.18)	(0.21)	(0.17)	(0.09)	(0.08)
widowed	0.02	0.32	0	0.08	0.03
	(0.11)	(0.21)	(0.11)	(0.07)	(0.06)
single	0.3*	0.19	0.36+	0.04	-0.05
	(0.12)	(0.15)	(0.2)	(0.08)	(0.09)
Monthly net equivalent income in Euro	0+	0	0	0	0
	0	0	0	0	0
Body-Mass-Index (BMI)	0.01	0.01	0	0.01	0
	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)
Smoking status:					
yes, sometimes (Ref.: daily)	0.04	0.02	0.15	0.19*	0.01
	(0.1)	(0.11)	(0.13)	(0.09)	(0.05)
not anymore	0.2+	0.04	0.05	0.13	0.04
	(0.11)	(0.1)	(0.09)	(0.08)	(0.05)
never been a smoker	0.19	0.06	0	0.11	0.04
	(0.14)	(0.14)	(0.13)	(0.09)	(0.07)
Consumption of alcohol:					
several times a week (Ref.: daily)	0.02	0.09	0	0.04	-0.02
	(0.1)	(0.07)	(0.05)	(0.04)	(0.03)
once a week	0.07	0.12	0.02	0.02	-0.01
	(0.11)	(0.09)	(0.07)	(0.05)	(0.04)
one to three times a month	0.04	0.07	0.08	0.04	0.02
	(0.11)	(0.1)	(0.09)	(0.06)	(0.04)
less frequently	0.05	0	0.06	0.01	0.02
	(0.11)	(0.1)	(0.09)	(0.06)	(0.04)
never	0.09	0.11	0.06	0.05	0.01
	(0.14)	(0.14)	(0.13)	(0.08)	(0.06)
Physical activity:					
several times a week (Ref.: daily)	0.01	0.08	0.03	0.02	-0.02
	(0.06)	(0.07)	(0.08)	(0.05)	(0.03)
once a week	0.02	0.09	0.04	0.03	0.01
	(0.06)	(0.07)	(0.08)	(0.05)	(0.03)
one to three times a month	0.02	0.12	0.02	0.05	-0.02
	(0.08)	(0.09)	(0.09)	(0.06)	(0.04)
less frequently	0.05	0.04	0.05	0.03	0
	(0.07)	(0.08)	(0.08)	(0.06)	(0.03)
never	0.05	0.02	0.02	0.06	0.01
	(0.06)	(0.08)	(0.08)	(0.05)	(0.03)
Subjective health:					
good (Ref.: very good)	0.07	0.07	0.03	0.04	0
	(0.06)	(0.05)	(0.06)	(0.04)	(0.03)
average	0.06	0.02	0.06	0.04	0.01
	(0.07)	(0.06)	(0.07)	(0.05)	(0.03)
bad	0.09	0.07	0.05	0.01	0.03
	(0.1)	(0.12)	(0.1)	(0.08)	(0.05)
very bad	0.09	0.33	0.13	0.09	-0.03
	(0.17)	(0.38)	(0.18)	(0.16)	(0.1)
Subscale of physical functioning (SF-36)	0+	0	0	0	0
	0	0	0	0	0
Number of physical illnesses	0	0.02	0.04*	0.03**	0.02**
	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)
Depressive symptoms (CES-D short form)	0.01***	0	0	0.01**	0.01***
	0	0	0	0	0
Interaction term: Falls x educational level					-0.09
					(0.06)

(*continued on next page*)

Table 5 (*continued*)

Variables	Female low/medium educational level	high educational level	Male low/medium educational level	high educational level	Outcome for perceived social exclusion - men and women with interaction term
Interaction term: Falls x gender					-0.12*
					(0.06)
Constant	1.8***	2.32***	2.4***	2.77***	2.23***
	(0.49)	(0.59)	(0.6)	(0.41)	(0.27)
Observations	3,514	2,000	2,778	2,934	11,227
Number of Individuals	2,453	1,340	1,929	1,935	7,657
R^2	0.04	0.06	0.05	0.04	0.02

Beta-Coefficients are reported; Cluster-robust standard errors in parentheses. Perceived social exclusion was assessed using a scale evolved by Bude and Lantermann (2006), ranging from 1 to 4 (higher values pronounce a higher feeling of perceived social exclusion)

*** $p < 0.001$

** $p < 0.01$

* $p < 0.05$, + $p < 0.10$. It should be noted that conditional main effects for gender and educational level cannot be estimated in FE models since these factors do not vary within individuals over time (i.e., they are time-constant).

age (Meeks and Murrell, 2001; Murrell, 2002; Hertzog, 2008; Guzmán-Vélez, 2015; Perani, 2015; Opdebeeck, 2016; Ihle ,2020). If individuals with low educational levels prefer having friends of the same educational level, it is possible that their friends have a lower state of health and shorter life expectancy (Albert, 1995; Kubzansky, 1998; Meeks and Murrell, 2001; Murrell, 2002; Antonucci, 2003).

Thus, their friends' poor state of health and shorter life expectancy may lead to a lesser number of friends. For individuals with low education levels, it could be more difficult to manage the loss of long-term friends or to find new friends with their own poorer state of health (Ross and Wu, 1995; Lawton, 1999; Meeks and Murrell, 2001; Murrell, 2002), low psychosocial (Ross and Mirowsky, 1989; Albert, 1995; Murrell, 2002; Cutler, 2017) and physical functioning (Meeks and Murrell, 2001; Murrell, 2002; Groffen, 2012). Ha found that the 'availability of friend networks' for older people was associated with their educational level (Hogan, 1993; Ha, 2019). They found that older and less educated persons with 'more functional limitations had fewer friends' (Ha, 2019). Other studies reported that individuals with a low educational level had smaller social networks (Antonucci, 2003; Broese van Groenou and van Tilburg, 2003; Ajrouch, 2005). Furthermore, Ross and Wu found that a lower educational level was associated with less social support (Ross and Wu, 1995; Marmot, 1998; Ross and Zhang, 2008). The results of these studies, that individuals with low education levels have less friends and smaller social networks, may be explained by their own lower physical and cognitive function during the ageing process (Meeks and Murrell, 2001). Their ageing process may lead to difficulties in managing larger social networks (Miche, 2013). On the other hand, a poorer state of health and more diseases among men with lower education levels may lead to a smaller number of friends or poorer maintenance of these relationships due to a lack of energy (Antonucci, 2003).

Moreover, a further reason should be considered: some studies described 'a low educational level as a chronic stressor' (Wu and Rudkin, 2000) concerning undesirable life events (McLeod and Kessler, 1990; Adler, 1994). 'A low educational level as a chronic stressor' (Wu and Rudkin, 2000) may prevent men with a low educational level from having sufficient energy reserves to mainatin social connections as well (Baum, 2006; Kopp, 2007).

It seems surprising that only men with a low educational level experience higher feelings of perceived social exclusion after a fall. Various studies showed that women and men perceive and experience social relations and support differently (Antonucci, 2003). Some studies suggest that in contrast to men, women have more intimate friendships and are more likely to be 'kin keepers' of their families (Antonucci & Akiyama, 1987; Turner and Troll, 1994; Turner and Marino, 1994; Bengston 1996; Antonucci, 2003). With regard to the results of our study, future research is needed to explore not solely the different experiences of social ties among men and women; future research should also determine how the onset of falls influences the experience of social relations and social exclusion for women and men of different educational levels.

Considering our findings that fallen men with a low/medium educational level in their second half of life consequently have greater perceived social exclusion, we conclude that there may be differences between men with a low/medium and those of high educational levels coping with the consequences of a fall. The management of functional restrictions may be more difficult for men with a low educational level because they may have difficulties to compensate for physical, functional restrictions through cognitive activities (Schumacher and Martin, 2009) and miss their physical activities. Men in their second half of life with high educational level may compensate for their functional restrictions through cognitive activities such as reading or playing cards, being more likely to have engaged in these cognitive activities through their life span (Schumacher and Martin, 2009; Mao et al., 2020). Men with high educational level who engage in these activities feel more engaged in daily life than men in their second half of life with a low educational level who do not engage in these activities (Zhu et al., 2017; Cao et al., 2019). The lack of alternatives to daily activities that depend on good physical functioning may lead to the feelings of higher perceived social exclusion among older men with low educational levels (Ross and Zhang, 2008; Teh and Tey, 2019).

Men with a low educational level may consequently suffer from difficulties in flexibly adapting their activity goals after an adverse fall in order to avoid perceived social exclusion, because they have different activity goals than men of high educational level (Cao et al., 2019). They seek to continue conducting their common daily activities so as to not be socially excluded, which include mobile activities such as sports activities in a club, meeting friends in a sports bar etc. (Avlund and Legarth, 1994). It has been found that individuals with good flexible goal adjustments (FGA), are able to adapt to worsening self-rated health and can therefore orientate themselves in other activities, rather than perceiving their life situation as hopeless (Brandtstädter, 2009).

Another explanation may be that these older men with low education levels are unable to recover from a fall as quickly or as well as older men with a high educational level, because of worse coping strategies (e.g., in terms of self-efficacy) (Eldar et al., 1995; Dalgard et al., 2007; Wong et al., 2010; de Groot, 2011; Merom et al., 2012; Moraes et al., 2019). Furthermore, they may also have difficulties in accessing health support or have poorer health literacy (Merom et al., 2012; D'Anna et al., 2018; Moraes et al., 2019).

In sum, future studies are necessary to determine why falls lead to higher perceived social exclusion and why men in their second half of life of different educational level may differ in their coping strategies. Further research, for example based on qualitative approaches, should consider the perspectives of this group of individuals about their support after a fall and which obstacles they face as well.

This current study with a representative sample of individuals in

their second half of life in Germany offered rare insights into the link between falls and social relations, stratified by different educational levels and gender groups.

5.3. Strengths and limitations

This is the first longitudinal study offering insight into the association of falls and social ties among specific groups of different educational levels. A large, population-based sample of participants in their second half of life was used. It offers a three year period (from 2014 to 2017). This course of time is unique considering current data (Petersen et al., 2020). Due to FE regression analysis, the problem of unobserved heterogeneity was diminished (Brüderl & Ludwig, 2015; Kohler and Kreuter, 2016). Established scales were used to quantify perceived social exclusion (Bude and Lantermann, 2006) and loneliness (De Jong Gierveld and Kamphuls, 1985; de Jong and Tilburg, 2006; De Jong, 2010).

It should be noted that we focused on the association between falls and perceived social isolation. Thus, future research is required to clarify the association between falls and objective social isolation (such as a lack of social engagement or social activities) (de Jong Gierveld, Vangelisti, & Perlman, 2006).

Sample selectivity among the participants in their second half of life may be a limitation of this study. However, the effects of sample selection bias and panel attrition were only small in analyses of the DEAS study's cohorts (Klaus, 2017). Central socio-demographic characteristics of the sample (such as household size, family status) are similar to official statistics of the German population (Klaus, 2017; Klaus et al., 2019).

Analyses in this study adjusted for chronic diseases, which are closely related to falls. However, there are further diseases, such as Menier disease (Imbaud, 2007; Iwasaki, 2014; Pyykkö, 2019), polypharmacy (Zia, 2015; Burt, 2018; Zaninotto, 2020), malnutrition (Meijers, 2012; Eglseer, 2020), poor balance (Muir, 2010), sarcopenia (Yeung, 2019) or diabetic neuropathy (Hewston, 2016; Vinik, 2017), that act as risk factors for falls. Future studies are required to investigate the link between falls and perceived loneliness/social exclusion whilst adjusting for these factors. While a measure for cognitive function was included in the DEAS study, a tool to assess cognitive impairment (e.g., Mini Mental State Exam) has not been included. Additionally, future research is required to clarify the impact of balance enhancing, strength activities, walking volume and walking frequency on the association between falls and social relationship perception.

Moreover, we cannot dismiss the possibility that future falls lead to higher feelings of loneliness even though our results do not underline this possibility. Future research is required to clarify this link. Finally, it should be noted that we only identified two waves for our study (2014 and 2017). Future long-running longitudinal studies are required to identify potential long-term effects.

The main limitation of this study relates to the level of detail around falls experienced by the sample, namely the number of falls and the reasons for falls. However, there is also a general lack of information about the circumstances of falls in other studies (Berg, 1997; Börsch-Supan, 2005; Pitchai, 2019). Therefore, another interesting aspect for future studies may be the severity of falls and how different severity degrees cause greater feelings of perceived social exclusion. The assessment of falls in our study is in line with other large well-known cohort studies (e.g. SHARE), so future studies should seek to differentiate between single and recurrent fallers (Börsch-Supan, 2005).

The participants were asked for falls in the last 12 months in 2017, but another study in 2017 used data from DEAS in 2014 asking for falls in the previous period (Hajek and König, 2017). Findings from Hajek et al. are in accordance with this current study's results. Notwithstanding, it is difficult to gather knowledge about falls for this large number of participants in view of the financial and time restrictions found in large cohort studies. It is difficult to adapt these questions for each group of educational level and cognitive capacities.

In general, independent of cognitive function, recall bias is possible among all participants (Zacks, 2000; Rizio and Dennis, 2014), especially if the falls were inconsequential (Ganz, 2005). However, a fall most commonly represents a key event, which cannot easily be forgotten, especially if the individual experiences consequences like traumatic injuries (Rau, 2014; Boltz et al., 2015; Evans et al., 2015), a fear of falling (Jefferis et al., 2014) or greater perceived social exclusion. Furthermore, even falls with milder consequences, such as feelings of insecurity, a fear of falling, or among individuals with gait disorder, are unlikely to be forgotten.

6. Conclusion

Findings of this current study highlight opportunities for future research concerning falls and social relations among a particular population that has not been studied to date. Results emphasize the association between falls and perceived social exclusion among men in their second half of life with low/medium educational levels. Falls were not associated with loneliness in all groups. Furthermore, no significant association between falls and perceived social exclusion was found in any other studied sub-group. Several previous studies have reported a higher fall risk or limited physical functioning for men with low educational level (Gomes, 2015; Kiadaliri, 2018). Various studies have suggested fall-prevention, cognitive- and physical-training programs and highlight the need for more research (Gillespie et al., 2001; Tricco, 2013; Cheng, 2016; Fougère, 2017; Guirguis-Blake, 2018). In sum, the association between falls and perceived social exclusion among this certain group of men is very complex. More longitudinal studies are needed to achieve a better understanding of the relation between falls and social ties, especially among men with low education levels in their second half of life. Moreover, future studies are required to elucidate the underlying mechanisms.

CRediT authorship contribution statement

Nicola Petersen: Conceptualization, Methodology, Software, Formal analysis, Resources, Data curation, Writing – original draft, Writing – review & editing, Visualization. **Hans-Helmut König:** Validation, Writing – review & editing, Supervision. **André Hajek:** Conceptualization, Methodology, Software, Validation, Formal analysis, Resources, Data curation, Writing – review & editing, Supervision.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.archger.2022.104622.

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II. Zusammenfassende Darstellung der Dissertation

Diese Dissertation bezieht sich auf die Publikation „**The onset of falls and its effects on perceived social exclusion and loneliness. Evidence from a nationally representative longitudinal study.**“ Diese Publikation ist in einem in PubMed gelisteten und „peer-reviewed“ Journal („*Archives of Gerontology and Geriatrics*”, 100:104622.(2022)) veröffentlicht worden. Bei dieser Arbeit fungierte ich als alleinige Erstautorin.

Einleitung

In den letzten Jahrzehnten hat sich zunehmend gezeigt, welche Herausforderungen der demographische Wandel für unsere Gesellschaft und unser Gesundheitswesen bereithält. Ein besonderer Fokus sollte auf der Problematik liegen, dass sich durch den Anstieg der absoluten Anzahl älterer Menschen ebenso eine höhere Belastung des Gesundheitswesens entwickelt hat (Fendrich und Hoffmann, 2007, Schulz et al., 2004). Die Anzahl an Menschen mit chronischen Erkrankungen und Multimorbidität steigt stetig an (Fendrich und Hoffmann, 2007).
Ein wichtiges Gesundheitsproblem für Menschen ab 65 Jahren, nach den führenden Herz-Kreislauf-Erkrankungen (Böhm et al., 2009), stellen muskuloskelettale Erkrankungen, aber auch Stürze und sturzbedingte Verletzungen dar (Böhm et al., 2009). Ein Sturz beschreibt einen unbeabsichtigten Verlust des Gleichgewichts aus dem Stand, Sitzen oder einer Bewegung heraus, sodass der Körper auf dem Boden oder einer tieferen Ebene landet (Gibson et al., 1987, Zecevic et al., 2006).
Bereits 2009 stürzten in Deutschland circa ein Drittel der 65-Jährigen und Älteren mindestens einmal jährlich und unter den über 80-Jährigen stürzten mehr als die Hälfte (Böhm et al., 2009). Im Jahre 2009 ergab sich somit eine geschätzte Anzahl von mindestens fünf Millionen Stürzen älterer Menschen pro Jahr (Böhm et al., 2009). Zu diesem Zeitpunkt wurden in Deutschland mehr als 350.000 Krankenhausaufenthalte in dieser Altersklasse durch Stürze verursacht (Böhm et al., 2009). Besonders bei älteren Menschen kommt es zu folgenschweren Verletzungen durch einen Sturz und in 50 % der Fälle nach stationärem Aufenthalt auch innerhalb eines Jahres zum Versterben (Böhm et al., 2009, Rosenbrock, 2007). Neben der erhöhten Wahrscheinlichkeit innerhalb eines Jahres zu versterben, ergeben sich oft viele Einschränkungen für die betroffenen Personen. Zum Einen verfügen nur noch wenige gestürzte Personen über die Fähigkeiten, ihre täglichen Aktivitäten eigenständig durchführen zu können, darunter auch Grundlegendes wie die eigene Körperpflege (Rosenbrock, 2007). Dies liegt mitunter an der Sturzangst (FOF = ‚fear of falling‘), unter der circa ein Drittel der Betroffenen nach einem Sturzereignis leiden (Rosenbrock, 2007). Somit ergibt sich nicht nur häufig eine eingeschränkte körperliche Aktivität, sondern auch u.a. die Entwicklung einer sozialen Isolation (Rosenbrock, 2007). Stürze älterer Menschen stellen jedoch ein weltweites Problem dar (WHO, 2018).

Die Relevanz der Stürze für unsere Gesellschaft und unser Gesundheitswesen zeigt sich auch in der Studienlage. Zum einen stellte sich in einigen Studien die Frage, welche Ursachen mit Stürzen in Zusammenhang stehen (Zhou et al., 2019, Lord et al., 2001, Kwan et al., 2011, Robbins et al., 1989) und darüber hinaus, welche Konsequenzen durch Stürze für ältere Menschen entstehen können (de Baat et al., 2017). Die Erkenntnisse könnten helfen, rechtzeitig zu intervenieren (Shimada et al., 2011) und u.a. Interventionsprogramme schaffen zu können (Sherrington et al., 2008, Gillespie et al., 2003). Einer der wichtigsten ursächlichen Zusammenhänge besteht zwischen Stürzen und dem sogenannten ‚Frailty-Syndrom' (aus dem Englischen für Gebrechlichkeit) (Ensrud et al., 2008, de Vries et al., 2013, Hayashi et al., 2020). ‚Frailty' führt nicht nur zu einem erhöhten Risiko von Stürzen (Benzinger et al., 2021). Das ‚Frailty-Syndrom' oder ‚Frailty' (Gebrechlichkeit) beschreibt das komplexe, geriatrische Syndrom durch verminderte funktionelle, physiologische Reserven, von zunehmender Vulnerabilität, also u.a. körperlicher Anfälligkeit betroffen und weniger widerstandsfähig gegenüber internen und externen Stressfaktoren zu sein (Clegg et al., 2013, Gobbens et al., 2010, Cesari et al., 2017).
Neben der ‚Frailty' beschäftigten sich viele Studien mit weiteren möglichen Determinanten für Stürze, wie z.B. Demenz (Lach et al., 2017), Depression (Iaboni und Flint, 2013, Gambaro et al., 2022), Parkinson (Fasano et al., 2017, Lieberman et al., 2019), Sturzangst (Scheffer et al., 2008, Lavedán et al., 2018), Polypharmazie (Zaninotto et al., 2020) oder Vitamin-D-Mangel (Murad et al., 2011).
Weiterführend ist aus einigen Studien hervorgegangen, dass Stürze negative soziale, seelische und körperliche Konsequenzen zur Folge haben (Scheffer et al., 2008, Choi et al., 2014). Dies umfasst nicht nur körperliche Inaktivität (Tinetti, 1998), eine reduzierte Lebensqualität (Sánchez-García et al., 2017), Sturzangst (Lavedán et al., 2018), sondern auch erhöhte Morbidität und Mortalität (Berková und Berka, 2018). Darüber hinaus führen Stürze zu Konsequenzen wie Krankenhausaufenthalten (Estrella-Castillo et al., 2011) und hohen Kosten im Gesundheitswesen (Florence et al., 2018, Peel et al., 2002).

Insgesamt zeigt sich jedoch, dass es gegenwärtig wenig Studien gibt, die untersuchten, wie Stürze im Zusammenhang mit sozialen Beziehungen älterer Menschen stehen (Hajek und König, 2017, Schnittger et al., 2012, Rosenbrock, 2007). Dies war auch das Ergebnis einer systematischen Übersichtsarbeit (Petersen et al., 2020). Diese Untersuchung scheint jedoch besonders für ältere Menschen von Bedeutung zu sein, da Einsamkeit und soziale Isolation weltweit ein großes Problem in dieser Bevölkerungsgruppe darstellen und besonders ältere Menschen von fatalen Stürzen betroffen sind (Klinenberg, 2016, Coyle und Dugan, 2012, Courtin und Knapp, 2017, Wenger et al., 1996, Grenade und Boldy, 2008, Schnittger et al., 2012, WHO, 2018). Im Jahre 2020 lebten in Deutschland ein Drittel der älteren Menschen alleine in Privathaushalten, vor allem bei den über 85-Jährigen stellt das Alleinleben die häufigste Lebensform dar (Kühntopf und Tivig, 2008). Es gibt Studien, die zu dem Schluss gekommen sind, dass ältere Menschen, die alleine leben, häufiger stürzen

und von Einsamkeit und empfundener sozialer Exklusion betroffen sind (Schnittger et al., 2012, Pohl et al., 2018, Faulkner et al., 2003, Victor et al., 2000).
Die wenigen bisherigen Studien untersuchten den Einfluss von sozialer Isolation/Exklusion oder Einsamkeit auf das Sturzrisiko für ältere Menschen (Faulkner et al., 2003, Bu et al., 2020). Es stellte sich beispielsweise heraus, dass Einsamkeit und soziale Isolation mit einem höheren Risiko zu stürzen und Krankenhausaufenthalten verbunden waren (Bu et al., 2020). Eine weitere longitudinale Studie zeigte, dass größere Familiennetzwerke mit einer niedrigeren Sturzrate verbunden waren (Faulkner et al., 2003). Dieser Zusammenhang erscheint plausibel, da Einsamkeit und soziale Isolation funktionelle Einschränkungen und somit auch ein erhöhtes Risiko zu stürzen hervorrufen könnten (Hacihasanoğlu et al., 2012, Perissinotto, 2012).

Zunächst gilt es jedoch im Folgenden empfundene Einsamkeit und empfundene soziale Exklusion zu definieren. Einsamkeit kann als subjektive Bewertung und Wahrnehmung der gegenwärtig tatsächlich vorhandenen und der gewünschten sozialen Beziehungen in Qualität und Quantität einer Person definiert werden (Peplau und Perlman, 1982, de Jong Gierveld, 1987, Bu et al., 2020). Einsamkeit beschreibt demnach das subjektive negative Gefühl, sich allein zu fühlen, obwohl die Person sich beispielsweise in Gesellschaft anderer Personen befindet, wenn die sich allein fühlende Person sich mehr Beziehungen (Quantität) und/oder mehr Intimität (Qualität) wünscht (de Jong Gierveld, 1987, Lubben und Gironda, 2003, Stanley et al., 2010, McHugh Power et al., 2017). In Bezug auf die Qualität und Quantität sozialer Beziehungen wird daher auch zwischen einer emotionalen Einsamkeit (Qualität), wenn die sich allein fühlende Person einen Mangel an Intimität in ihren Beziehungen feststellt, und einer sozialen Einsamkeit unterschieden (Quantität). Soziale Einsamkeit (Quantität) bedeutet also die Person wünscht sich mehr persönliche Beziehungen.
Unter der empfundenen sozialen Isolation/Exklusion versteht man die Wahrnehmung einer Person, sich gesellschaftlich oder vom sozialen Umfeld ausgeschlossen zu fühlen durch beispielsweise Mobilitätseinschränkungen oder gesundheitliche Einschränkungen (Bude und Lantermann, 2006, Wenger et al., 1996).

Diese Arbeit befasst sich schließlich mit der Hypothese, dass das Ereignis eines Sturzes (unabhängige Variable) älterer Menschen mit dem Empfinden von Einsamkeit und sozialer Exklusion (abhängige Variablen) in Zusammenhang steht. Eine weitere zweite Hypothese dient der Untersuchung, den Zusammenhang zwischen Stürzen und sozialen Beziehungen älterer Menschen nach Geschlecht und Bildungsgrad zu stratifizieren, um herauszufinden, ob manche Personen je nach Geschlecht oder Bildungsgrad anfälliger sind für das Empfinden von Einsamkeit oder sozialer Exklusion nach einem Sturz. Nicht nur der Zusammenhang zwischen Stürzen und sozialen Beziehungen an sich wurde bisher wenig untersucht, die Eigenschaften von stürzenden Personen wurden ebenfalls selten berücksichtigt (Green et al., 2008, Yoo et al., 2016, Chippendale et al., 2017, Lee et al., 2018). Es ist möglich, dass nicht alle älteren Personen ein gleich hohes Risiko tragen, nach einem Sturzereignis einen

Anstieg an empfundener sozialer Exklusion oder Einsamkeit zu entwickeln. Bisherige Studien kamen zu dem Ergebnis, dass über 55-Jährige mit geringerem Bildungsniveau ein erhöhtes Sturzrisiko hatten (Li et al., 2013, Yoo et al., 2016). Folgt man den Erkenntnissen bisheriger Studien, dass ältere Menschen mit niedrigerem Bildungsgrad häufiger Stürzen, könnte dies dazu führen, dass sie u.a. weniger an Aktivitäten mit sozialen Beziehungen teilhaben können und sich folglich sozial ausgeschlossener und einsamer fühlen könnten. Des Weiteren verfügen Individuen über unterschiedliche Kapazitäten, ihre Aktivitäten nach einem Sturz flexibel anzupassen (Schumacher und Martin, 2009, Avlund und Legarth, 1994), beispielsweise von körperlichen Aktivitäten auf kognitive zu wechseln, um sich somit weniger einsam oder ausgeschlossen zu fühlen. Die Stratifizierung der Analyse erfolgte auch nach dem Geschlecht, da Männer häufiger stürzen (Stevens et al., 2007) und Männer und Frauen unterschiedlich mit den Konsequenzen von Stürzen umgehen (Stevens et al., 2012, Sandlund et al., 2017, Sandlund et al., 2018). Es zeigte sich u.a., dass Frauen eher ihrem Arzt von Stürzen berichten oder medizinische oder pflegerische Hilfe in Anspruch nehmen (Stevens et al., 2012).

Schließlich dient diese Arbeit dazu, die aktuelle Studienlage zum Zusammenhang zwischen Stürzen und sozialen Beziehungen älterer Menschen um eine erste longitudinale Studie zu diesem Thema zu ergänzen. Das Ziel dieser Arbeit wird in zwei Hypothesen unterteilt: erstens führen Stürze zu höherer empfundener sozialer Exklusion und Einsamkeit älterer Menschen und zweitens tragen vor allem Männer mit niedrigerem Bildungsniveau ein höheres Risiko, sich nach einem Sturz stärker sozial ausgeschlossen oder einsam zu fühlen. Die Ergebnisse dieser Arbeit könnten dabei helfen, Risikogruppen für Stürze und deren Folgen besser zu detektieren und zu betonen, wie wichtig es ist, präventiv gegen Stürze und deren Folgen gerade unter älteren Menschen vorzugehen.

Methodik

In dieser Arbeit wurden Daten aus der fünften (2014) und sechsten (2017) Befragungswelle des Deutschen Alterssurveys (DEAS) verwendet. Insgesamt wurden vom Deutschen Alterssurvey bereits sieben Befragungswellen (1996, 2002, 2008, 2011, 2014, 2017, 2020/2021) erfasst (Klaus et al., 2019). Der Deutsche Alterssurvey wurde erstmalig 1996 vom Deutschen Zentrum für Altersfragen (DZA) geschaffen und mit Hilfe des Bundesministeriums für Familie, Senioren, Frauen und Jugend (BMFSFJ) gefördert. Seit 1996 stellt der Deutsche Alterssurvey somit eine fortlaufend bundesweit bevölkerungsbasierte Längs- und Querschnittsbefragung zur Verfügung. Befragt wurden Personen ab 40 Jahren und aus allen Sozialschichten Deutschlands kommend (Klaus et al., 2017). Die Befragung der Personen erfolgte 1996 per Zufall aus insgesamt 290 Kommunen von 12.000. Neben dem Alter als erstes Einschlusskriterium sollten die Teilnehmer in einem Privathaushalt leben. Nach der Datenerhebung für die erste Befragungswelle 1996, folgten als Einschlusskriterien

unter anderem ein deutscher Wohnsitz, bereits an der ersten Befragung in 1996 teilgenommen und eine Einverständniserklärung nach Aufklärung unterschrieben zu haben. Schließlich bietet der Deutsche Alterssurvey Einblick in Themenbereiche, wie zum Beispiel soziale Beziehungen, das Einkommen, Altersarmut, Gesundheit, Altersdiskriminierung, freiwilliges Engagement und mehr (Klaus et al., 2019). Diese Studie umfasst keine Daten aus den Befragungswellen vor 2014, da zuvor noch keine *Stürze* als Variable erfasst wurden (Engstler et al., 2015).

Die unabhängige Variable dieser Studie wurde als *Stürze* in den letzten zwölf Monaten festgelegt. Befragte des Deutschen Alterssurveys konnten die Frage nach Stürzen in den letzten zwölf Monaten mit ja oder nein auf einem Fragebogen beantworten und wurden 2017 beim Beantworten des Fragebogens, der nach einem Interview ausgeteilt wurde, von den Interviewern bei Unklarheiten unterstützt (Schiel et al., 2018).
Einsamkeit und *empfundene soziale Exklusion* wurden als abhängige Variablen definiert. Die *empfundene soziale Exklusion* wurde mit Hilfe der validierten Skala von Bude und Lantermann gemessen (Bude und Lantermann, 2006). Die Skala umfasst vier Aussagen: „1. Ich habe Angst, den Anschluss zu verpassen, 2. Ich habe das Gefühl, gar nicht richtig zur Gesellschaft zu gehören, 3. Ich fühle mich außen vor, 4. Ich habe das Gefühl, im Grunde gesellschaftlich überflüssig zu sein“ (Engstler et al., 2019). *Einsamkeit* wurde mittels einer Kurzversion der 11-Item Einsamkeitsskala von De Jong Gierveld erfasst (de Jong Gierveld und van Tilburg, 2006, de Jong Gierveld und van Tilburg, 2010, de Jong Gierveld und Kamphuis, 1985). Folgende sechs Aussagen bezüglich *Einsamkeit* sollten von den Befragten bewertet werden: „1. Ich vermisse Leute, bei denen ich mich wohlfühle, 2. Es gibt genug Menschen, die mir helfen würden, wenn ich Probleme habe, 3. Ich fühle mich häufig im Stich gelassen, 4. Ich kenne viele Menschen, auf die ich mich wirklich verlassen kann, 5. Ich vermisse emotionale Geborgenheit und Wärme, 6. Es gibt genügend Menschen, mit denen ich mich eng verbunden fühle (Engstler et al., 2019).“ Befragte gaben für beide abhängigen Variablen an, wie die jeweiligen Aussagen auf sie zutrafen (1 = Trifft genau zu, 2 = Trifft eher zu, 3 = Trifft eher nicht zu, 4 = Trifft gar nicht zu) (Engstler et al., 2019).
Außerdem wurden folgende Kovariaten ergänzt: *Alter, Body-Mass-Index (BMI), Familienstand* (verheiratet und mit Ehepartner zusammenlebend, verheiratet und vom Ehepartner getrennt lebend, geschieden, verwitwet, ledig), *monatliches Nettohaushaltseinkommen* (nach der OECD-Skala), Gesundheitsverhalten, wie z.B. das *Rauchen*, *körperliche Aktivität* in den letzten zwölf Monaten (z.B. Schwimmen, Fußball) und *Alkoholkonsum* (1 = täglich, 2 = mehrmals, 3 = einmal in der Woche, 4 = ein- bis dreimal im Monat, 5 = seltener, 6 = nie) (Engstler et al., 2019). Des Weiteren wurden ebenfalls die physische und geistige Gesundheit mit Hilfe der folgenden Kovariaten berücksichtigt: *chronische Krankheiten* (z.B. Herz- und Kreislauf-Erkrankungen, Asthma, Krebs oder Diabetes), *Depressivität* (erfasst mit Hilfe von 15 Items als Kurzversion der ‚Depression Scale‘ (CES-D) (Radloff, 1977)), *subjektive Gesundheit* (Frage: „Wie bewerten Sie Ihren derzeitigen Gesundheitszustand?“ Antwortmöglichkeiten von 1 = sehr gut, 2 = gut, 3 = mittel, 4 = schlecht, 5 = sehr

schlecht (Engstler et al., 2019, Fayers und Sprangers, 2002)), *kognitive Funktion* (gemessen mit Hilfe des Digit-Symbol-Tests angelehnt an den ‚Digit Symbol Substitution Test' (DSST)) (Wechsler, 1939, Wechsler, 1955, Tewes, 1994) und die *Subskala „Körperliche Funktionsfähigkeit" des SF-36* (Probanden werden gefragt, ob ihr Gesundheitszustand sie in zehn verschiedenen Aktivitäten des täglichen Alltags einschränkt) (Bullinger und Kirchberger, 1998, Bullinger, 1998, Bohannon und DePasquale, 2010, White et al., 2011).
Eine Analyse der Eigenschaften der Probanden dieser Studie erfolgte anhand einer Stratifizierung nach Geschlecht und Bildungsniveau der Probandengruppe. Das Bildungsniveau wurde unter Verwendung der ISCED-Klassifizierung erfasst (ISCED = International Standard Classification of Education) und unterscheidet drei verschiedene Bildungsgruppen: die erste Gruppe (ISCED 0-2) entspricht den Niedriggebildeten „ohne abgeschlossene berufliche Ausbildung", die zweite Gruppe (ISCED 3-4) den mittelgradig Gebildeten „mit Abschluss einer betrieblichen oder berufsbildend-schulischen Ausbildung", die dritte Gruppe (ISCED 5-6) die hochgebildeten Befragten „mit abgeschlossenem Studium einer Fachhochschule, Universität oder Hochschule oder mit abgeschlossener Aufstiegsfortbildung" (z.B. Meisterschule) (Klaus und Engstler, 2017). Um den Einfluss von *Stürzen* auf *Einsamkeit* und *empfundene soziale Exklusion* zu untersuchen wurden zwei lineare Fixed-Effects-Analysen, stratifiziert nach Bildungsniveau und Geschlecht, für beide abhängige Variablen durchgeführt. FE-Regressionen sind hilfreich, um das Problem unbeobachteter Heterogenität zu reduzieren. In einer FE-Analyse wird die unbeobachtete, individuelle Heterogenität in zwei Fehlertermen unterschieden. Ein Fehlerterm bezieht sich auf alle unbeobachteten Variablen, die sich innerhalb der Individuen im Laufe der Zeit ändern und ein weiterer Fehlerterm sammelt alle Variablen, die sich innerhalb der Individuen nicht verändern. Fixed Effects-Regressionen nehmen an, dass die individuelle, unbeobachtete Heterogenität über die Zeit konstant ist.

Ergebnisse

In Tabelle 1 wird ein Auszug der Ergebnisse der Fixed-Effects-Analyse nach Geschlecht und Bildungsgrad stratifiziert mit *Einsamkeit* als abhängige Variable dargestellt. Es handelt sich um einen Auszug der Ergebnisse für die Übersichtlichkeit, in dem nicht alle Ergebnisse für die jeweiligen Kovariaten aufgelistet werden. Die ersten beiden Spalten der Tabelle 1 listen die Ergebnisse für Frauen mit niedrigerem/mittleren und höherem Bildungsgrad auf, letztere Spalten für Männer mit den jeweiligen Bildungsgraden. In der Fixed-Effects-Analyse ergab sich keine Zunahme der *Einsamkeit* als abhängige Variable durch das Ereignis von *Stürzen* in den letzten zwölf Monaten in allen Untergruppen nach Geschlecht und Bildungsgrad stratifiziert. In der letzten Spalte der Tabelle 1 findet sich außerdem das Ergebnis einer zusätzlichen Untersuchung: Es gab keinen signifikanten, korrespondierenden Interaktionsterm für das *Geschlecht* und den *Bildungsgrad* als mögliche Moderatoren

der Beziehung zwischen *Stürzen* (unabhängige Variable) und *Einsamkeit* (abhängige Variable).

Die Tabelle 2 zeigt einen Auszug der Ergebnisse der Fixed-Effects-Analyse nach Geschlecht und Bildungsgrad stratifiziert mit *empfundener sozialer Exklusion* als abhängige Variable, die ebenfalls für die Übersichtlichkeit verkürzt wurde. Die Anordnung der Spalten entspricht derer aus Tabelle 1 für Bildungsgrad, Geschlecht und Interaktionsterm. In der Fixed-Effects-Analyse ergab sich eine signifikante Zunahme der *empfundenen sozialen Exklusion* (abhängige Variable) durch das Ereignis von *Stürzen* (unabhängige Variable) nur für Männer mit niedrigerem/mittlerem Bildungsgrad (β = 0.19, p = < .05). In der letzten Spalte der Tabelle 2 findet sich ein signifikantes Ergebnis für den folgenden Interaktionsterm: *Stürze* x *Geschlecht* (β = -0.12, p = < .05). Somit gilt das Geschlecht als möglicher Moderator der Beziehung zwischen *Stürzen* und der *empfundenen sozialen Exklusion*, wohingegen der Interaktionsterm für den *Bildungsgrad* und *Stürze* nicht signifikant war.

Insgesamt ergab sich in beiden Fixed-Effects-Analysen jeweils für *Einsamkeit* und *empfundene soziale Exklusion* in einigen nach Geschlecht und Bildungsgrad stratifizierten Untergruppen ein signifikanter Zusammenhang zwischen *Stürzen* und *depressiven Symptomen*.

In der Publikation wird außerdem von den Ergebnissen zweier Fixed-Effects-Analysen berichtet, ohne dass die Kovariaten mit einbezogen wurden. Es ergab sich für die Fixed-Effects-Analyse nach Geschlecht und Bildung stratifiziert, ohne Berücksichtigung der Kovariaten, kein signifikanter Zusammenhang zwischen *Stürzen* und *Einsamkeit* (abhängige Variable). In einer weiteren Fixed-Effects-Analyse, ohne Berücksichtigung der oben genannten Kovariaten, ergab sich ein signifikanter Zusammenhang zwischen *Stürzen* und *empfundener sozialer Exklusion* nach Geschlecht und Bildungsniveau stratifiziert (β = 0.15, p = < .05).
Des Weiteren wurden die analytischen Hauptmodelle, wie in Tabelle 1 und 2 dargestellt, in der Publikation um eine weitere Kovariate *kognitive Funktion* ergänzt. Unter Berücksichtigung der *kognitiven Funktion* zeigte sich ein signifikanter Zusammenhang zwischen *Stürzen* und der *empfundenen sozialen Exklusion* nur für Männer mit niedrigem/mittleren Bildungsgrad (β = 0.19, p = < .05). Unter Berücksichtigung der *kognitiven Funktion* als Kovariate ergab sich in der Fixed-Effects-Analyse unter Verwendung der *Einsamkeit* (abhängige Variable) kein signifikanter Zusammenhang mit Stürzen.

Tabelle 1 - Resultate der multiplen linearen FE Regressionsanalyse: Abhängige Variable *Einsamkeit* für Frauen und Männer mit niedrigem/mittlerem sowie hohem Bildungsgrad - DEAS 2014 und 2017

Variablen	Frauen		Männer		Resultate für *Einsamkeit* - Frauen & Männer mit Interaktionsterm
	niedriger/ mittlerer Bildungsgrad	hoher Bildungsgrad	niedriger/ mittlerer Bildungsgrad	hoher Bildungsgrad	
Stürze seit 2014	0.02	0.08	0.02	0.05	-0.05
	(0.05)	(0.05)	(0.06)	(0.05)	(0.06)
Interaktionsterm: Stürze x Geschlecht x Bildungsgrad					0.01 (0.1)
Kontrollvariablen	✓	✓	✓	✓	✓
Konstante	1.83***	2.31***	3***	2.08***	2.26***
	(0.39)	(0.44)	(0.49)	(0.36)	(0.21)
Beobachtungen	3,509	2,002	2,787	2,927	11,227
Anzahl der Individuen	2,453	1,339	1,941	1,938	7,671
R^2	0.03	0.06	0.04	0.04	0.02

Berichtet werden Beta-Koeffizienten; Cluster-robuste Standardfehler sind in Klammern dargestellt. Einsamkeit wurde mit einer Kurzversion unter Verwendung von sechs Items der De Jong Gierveld Skala gemessen (Gierveld und Kamphuls 1985, Gierveld und van Tilburg 2006), Werte von 1 bis 4 (hohe Werte stehen für große Einsamkeit). *** p<0.001, ** p<0.01, * p<0.05, + p<0.10. Es sollte berücksichtigt werden, dass die Effekte durch das Bildungsniveau und Geschlecht im Fixed-Effects-Modell nicht untersucht werden können, da diese Faktoren zeitinvariant sind und sich nicht für ein Individuum ändern.
Zeitveränderliche Kontrollvariablen: Alter, Familienstand, Einkommen, BMI, Raucherverhalten, Alkoholkonsum, körperliche Aktivität, subjektive Gesundheit, Subskala „körperliche Funktionsfähigkeit", Anzahl chronischer Krankheiten und Depressivität.

Tabelle 2 - Resultate der multiplen linearen FE Regressionsanalyse: Abhängige Variable *empfundene soziale Exklusion* für Frauen und Männer mit niedrigem/mittlerem sowie hohem Bildungsgrad - DEAS 2014 und 2017

Variablen	Frauen		Männer		Resultate für *empfundene soziale Exklusion* - Frauen & Männer mit Interaktionsterm
	niedriger/ mittlerer Bildungsgrad	hoher Bildungsgrad	niedriger/ mittlerer Bildungsgrad	hoher Bildungsgrad	
Stürze seit 2014	0.01	0.1+	0.21*	0.02	0.19*
	(0.06)	(0.06)	(0.08)	(0.06)	(0.08)
Interaktionsterm: Stürze x Geschlecht x Bildungsgrad					0.15 (0.13)
Kontrollvariaben	✓	✓	✓	✓	✓
Konstante	1.8***	2.32***	2.4***	2.77***	2.23***
	(0.49)	(0.59)	(0.6)	(0.41)	(0.27)
Beobachtungen	3,514	2,000	2,778	2,934	11,227
Anzahl der Individuen	2,453	1,340	1,929	1,935	7,657
R^2	0.04	0.06	0.05	0.04	0.02

Berichtet werden Beta-Koeffizienten; Cluster-robuste Standardfehler sind in Klammern dargestellt. Empfundene soziale Exklusion wurde mit einer Skala von Bude und Lantermann gemessen (Bude 2006), Werte von 1 bis 4 (hohe Werte stehen für große empfundene soziale Exklusion). *** p<0.001, ** p<0.01, * p<0.05, + p<0.10. Es sollte berücksichtigt werden, dass die Effekte durch das Bildungsniveau und Geschlecht im Fixed-Effects-Modell nicht untersucht werden können, da diese Faktoren zeitinvariant sind und sich nicht für ein Individuum ändern.
Zeitveränderliche Kontrollvariablen: Alter, Familienstand, Einkommen, BMI, Raucherverhalten, Alkoholkonsum, körperliche Aktivität, subjektive Gesundheit, Subskala „körperliche Funktionsfähigkeit", Anzahl chronischer Krankheiten und Depressivität.

Diskussion

Diese Studie untersuchte den Zusammenhang zwischen Stürzen und sozialen Beziehungen bezüglich empfundener Einsamkeit und sozialer Exklusion. Dieser Zusammenhang wurde nach Geschlecht und Bildungsgrad stratifiziert untersucht, wobei die Individuen sich hinsichtlich ihres Alters im zweiten Lebensabschnitt befanden. Die Ergebnisse zeigten, dass es keinen signifikanten Zusammenhang zwischen Stürzen (unabhängige Variable) und empfundener Einsamkeit (abhängiger Variable) in allen Gruppen nach Geschlecht und Bildungsgrad stratifiziert gab. Es zeigte sich, dass ein Anstieg empfundener sozialer Exklusion nach einem Sturzereignis weder für Frauen mit niedrigeren/mittleren oder hohen Bildungsgrad noch für Männer mit hohem Bildungsgrad zu beobachten war. Es konnte jedoch ein signifikanter Zusammenhang für Männer mit niedrigeren/mittleren Bildungsniveau zwischen einem Sturzereignis und empfundener sozialer Exklusion festgestellt werden. Es ist also anzunehmen, dass Männer mit niedrigeren/mittleren Bildungsniveau nach einem Sturzereignis stärker von empfundener sozialer Exklusion betroffen sein könnten. Bisher gibt es wenig longitudinale Studien, die den Zusammenhang zwischen Stürzen und dem sozialen Gefüge älterer Menschen untersuchten (Hajek und König, 2017, Pohl et al., 2018). Insbesondere gibt es keine Studien, die diesen möglichen Zusammenhang nach Geschlecht und Bildung differenziert beleuchten, um mögliche vulnerable Gruppen detektieren zu können, die besonders von Stürzen und möglichen Auswirkungen auf ihr soziales Gefüge betroffen sein könnten. Somit soll diese Studie dabei helfen, diese Forschungslücke zu schließen und bezieht sich dabei auf einen zeitlichen Verlauf über drei Jahre.

Die Ergebnisse dieser Studie werfen die Fragen auf, warum womöglich nur ältere Männer mit niedrigerem/mittleren Bildungsniveau nach Ereignis eines Sturzes von mehr empfundener sozialer Exklusion betroffen sind und warum nicht von Einsamkeit. In Anbetracht der bisherigen Literatur scheinen Männer mit niedrigerem Bildungsniveau ein höheres Risiko zu haben, an sich und auch häufiger zu stürzen (Ahmad Kiadaliri et al., 2018). Es scheint, als ob ältere Männer mit niedrigerem Bildungsniveau häufiger von Stürzen mit Komplikationen und erhöhter Mortalität betroffen sind (Alicandro et al., 2018, van Hedel et al., 2018, Ahmad Kiadaliri et al., 2018). Generell wurde aber auch ein Zusammenhang zwischen niedrigerem Bildungsgrad und einem erhöhten Risiko zu stürzen unter älteren Menschen beschrieben (Borrell et al., 2002, WHO, 2018, Abreu et al., 2015, Ahmad Kiadaliri et al., 2018, Sotoudeh et al., 2018, Susilowati et al., 2020). Außerdem sprechen Studien dafür, dass das Risiko für soziale Isolation älterer Menschen mit einem niedrigeren Bildungsgrad assoziiert war (Iliffe et al., 2007, Ross und Wu, 1995). Schließlich weisen diese aktuelle Studie und bisherige Studien auf eine mögliche vulnerable Gruppe hin, welche zwecks Vermeidung von Stürzen und möglichen Auswirkungen auf das soziale Gefüge dieser Menschen weiter erforscht werden sollte.

Ältere Männer mit niedrigerem Bildungsniveau könnten anfälliger sein für Stürze, wenn man die Ergebnisse einiger Studien berücksichtigt, dass ein niedrigerer Bildungsgrad zu einer schlechteren Performance im „Timed Up and Go“-Test geführt hat, welcher in der Geriatrie als zuverlässiges Instrument zum Messen des Risikos von Gebrechlichkeit („frailty“) und Stürzen dient (Thrane et al., 2007, Gomes et al., 2015). Es hat sich auch gezeigt, dass ein höherer Bildungsgrad protektiv gegenüber der Entwicklung eines Frailty-Syndroms wirksam war (Biritwum et al., 2016). Möglicherweise entwickeln weniger gebildete ältere Menschen ein oft mit Stürzen einhergehendes Frailty-Syndrom (Sánchez-García et al., 2017, Ensrud et al., 2008), weil sie sich weniger um ihre Gesundheitsvorsorge kümmern (Abreu et al., 2015, Abreu et al., 2016). Der mögliche Zusammenhang zwischen Stürzen und der Entwicklung einer stärker empfundenen sozialen Exklusion könnte dadurch entstehen, dass die betroffene Person nach dem Sturz durch mögliche Verletzungen physisch eingeschränkter ist. Die sozialen Beziehungen könnten somit durch erworbene Immobilität und physischen, aber auch kognitiven Funktionsverlust verschlechtert sein. Für eine betroffene, gestürzte Person könnte es aufgrund der Immobilität oder neuen physischen, kognitiven Einschränkungen schwieriger sein, soziale Kontakte aufrecht zu erhalten. Mögliche Konsequenzen wären eingeschränkte tägliche Aktivitäten, mehr Zeit alleine zu Hause und weniger Teilnahme am sozialen Leben.

Bezüglich sozialer Bewältigungsressourcen hat sich bereits in einigen Studien gezeigt, dass Frauen eher soziale Unterstützung einfordern, da sie über größere, variable soziale Netzwerke verfügen als Männer, die sich auf Verwandte oder Arbeitskollegen konzentrieren (Antonucci und Akiyama, 1987, Vandervoort, 2000, Antonucci et al., 2003, Carr und Bodnar-Deren, 2009, Kim et al., 2020, Streeter, 2020). Die Entwicklung von empfundener sozialer Exklusion oder Einsamkeit der Männer ließe sich dann dadurch erklären, dass Verwandte bereits verstorben sind und der Kontakt zu ehemaligen Arbeitskollegen im Rentenalter bereits weniger intensiv geworden sein könnte (Kim et al., 2020). Ein weiteres Risiko für das soziale Gefüge weniger gebildeter Personen entsteht dadurch, dass sich niedriggradig gebildete Menschen gerne Freunde mit ähnlichem Bildungsstand suchen (Verbrugge, 1977). Einige Studien belegen, dass ein geringerer Bildungsgrad mit einem schlechten Gesundheitszustand und geringerer kognitiver Funktion im höheren Alter assoziiert sein kann (Verhaeghen et al., 2000, Lawton et al., 1999, Clarke et al., 2002, Ihle et al., 2020, Amoretti et al., 2016, Meeks und Murrell, 2001, Murrell und Meeks, 2002, Hertzog et al., 2008). Somit könnten Menschen mit geringerem Bildungsgrad, die sich Freunde mit gleichem Bildungsniveau suchen, einem schlechteren Gesundheitszustand und somit geringerer Lebenserwartung unterliegen (Albert et al., 1995, Kubzansky et al., 1998, Murrell und Meeks, 2002, Antonucci et al., 2003). Demnach könnten ältere Männer niedrigerem Bildungsgrads bereits über geringere physische (schlechterer Gesundheitszustand, Fallneigung, kognitive Beeinträchtigungen) und emotionale (weniger soziale Kontakte) Bewältigungsressourcen verfügen. Des Weiteren weisen Studien darauf hin, dass Menschen mit höherem Bildungsgrad weniger Schwierigkeiten haben, ihre Alltagsaktivitäten flexibel anzupassen, was ihnen bei neu

erworbener physischer Einschränkung die Bewältigungsstrategie verschafft, physische Aktivitäten gegen kognitiven Zeitvertreib einzutauschen (Cao et al., 2019). Sollte es zu einem Sturzereignis kommen, verfügen ältere niedrig gebildetere Männer möglicherweise über weniger physische und emotionale Bewältigungsressourcen, um mit den Folgen des Sturzes umzugehen und könnten daher anfälliger für die Entwicklung sozialer Exklusion sein (Eldar et al., 1995, Dalgard et al., 2007, Wong et al., 2010, Moraes et al., 2020).
Unter Berücksichtigung der unterschiedlichen Bewältigungsressourcen von älteren Menschen, wie sie sich laut dieser Studie womöglich besonders wichtig für ältere Männer mit niedrigerem Bildungsgrad zeigt, könnten weitere Studien zur Entwicklung von Präventionsprogrammen dienen. Eine erste Anlaufstelle für ältere Menschen bei gesundheitlicher Beeinträchtigung stellt häufig der Hausarzt dar. Bisher wurde beispielsweise der Barthel-Index als Fragebogen zur Bewertung der Alltagsfähigkeiten älterer Patienten u.a. in die hausärztliche Praxis eingeführt, dieser berücksichtigt jedoch keine Stürze (Lübke et al., 2004). Gerade in der hausärztlichen Praxis, sollte ein Screening nach Stürzen unter älteren Patienten eingeführt werden, sodass das Screening nach Stürzen nicht vergessen wird. Die Frage nach Stürzen kann in der Praxis häufig untergehen und der Moment verpasst werden, ältere Menschen präventiv gegen Stürze zu schützen, z.B. mit Physiotherapie bei Gleichgewichtsstörungen, Stolperfallen in der Wohnung zu bereinigen etc. Die Bundesinitiative Sturzprävention empfiehlt die Verwendung des „Steadi“ Algorithmus (aus dem Englischen Abkürzung für „Stopping Eldery Accidents, Deaths & Injuries“), welcher ebenfalls in den Software-Programmen der ambulanten Praxen implementiert werden sollte zur standardisierten Befragung älterer Patienten.

Zusammengefasst ist dies die erste longitudinale Studie, die den Zusammenhang von *Stürzen* und *sozialen Beziehungen* älterer Menschen unterschiedlichen Bildungsgrads untersucht. Es handelt sich um eine große repräsentative Probandengruppe höheren Alters über einen zeitlichen Verlauf von drei Jahren. Hervorzuheben ist, dass validierte Skalen zur Beurteilung von *Einsamkeit* (de Jong Gierveld und Kamphuis, 1985, de Jong Gierveld und van Tilburg, 2010) und *empfundener sozialer Exklusion* (Bude und Lantermann, 2006) verwendet wurden.
Eine wichtige Limitation dieser Studie ist ein möglicher Selektionsbias, weil Probanden höheren Alters eingeschlossen wurden. Jedoch war der Effekt des Selektionsbias der DEAS Kohortenstudie gering (Klaus und Engstler, 2017) und die zentralen sozio-demographischen Eigenschaften der Probandengruppe sind denen der offiziellen Statistik der deutschen Bevölkerung sehr ähnlich (Klaus und Engstler, 2017, Klaus et al., 2019). Die wichtigste Limitation bezieht sich jedoch auf die Erfassung der *Stürze*, da nur nach einem Sturzereignis in den letzten zwölf Monaten gefragt wird, auch wenn sich die Erfassung von *Stürzen* mit anderen großen Kohortenstudien deckt (z.B. SHARE, Abkürzung aus dem Englischen für „Survey of Health, Ageing and Retirement in Europe“). Weitere Forschung erscheint notwendig (die bspw. die Sturzhäufigkeit und den Schweregrad der Stürze berücksichtigt). Die Datenerhebung des Deutschen

Alterssurveys oder weitere Studien sollten zudem in Zukunft u.a. mehr zu den Ursachen, zum Sturzvorgang und Verletzungen nach *Stürzen* erfragen.
Wichtigstes Ergebnis dieser Studie ist, dass es einen signifikanten Zusammenhang zwischen *Stürzen* und *empfundener sozialer Exklusion* unter älteren Männern mit niedrigerem Bildungsgrad gibt. Diese Männer könnten besonders von *sozialer Exklusion* nach einem Sturz betroffen sein. Auch wenn es keinen signifikanten Zusammenhang zwischen *Stürzen* und *Einsamkeit* in dieser Studie gab, sollten auch weitere Studien diesen Zusammenhang untersuchen.

III. Literaturverzeichnis

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IV. Zusammenfassung/Summary

Diese Arbeit untersuchte die Auswirkungen von *Stürzen* auf die *empfundene soziale Exklusion* und *Einsamkeit* älterer Menschen unterschiedlichen Geschlechts und Bildungsgrads. Es handelt sich um die erste longitudinale Studie, die diesen Zusammenhang untersucht hat. Die Daten wurden vom Deutschen Alterssurvey zur Verfügung gestellt und entstammten zwei Befragungswellen von 2014 und 2017. Insgesamt ergab sich eine analytische Menge von 11.227 Probanden, die im Durchschnitt 64,9 Jahre alt waren. Zunächst wurde eine Analyse der Eigenschaften der Probanden je nach Bildungsgrad (ISCED-Klassifizierung) und Geschlecht durchgeführt, um Kenntnis über u.a. das Alter und den Familienstand zu erhalten. Um die unabhängige Variable *Stürze* zu erfassen, wurden die Probanden gefragt, ob sie in den letzten 12 Monaten gestürzt waren. Die *empfundene soziale Exklusion* als eine der beiden abhängigen Variablen wurde mithilfe der Skala nach Bude und Lantermann erfasst. Die weitere abhängige Variable *Einsamkeit* wurde mittels einer Kurzversion der Skala nach de Jong Gierveld erfasst. Unter Anwendung von einigen Kovariaten und einer Stratifizierung nach dem Geschlecht und Bildungsgrad zeigte die Regressionsanalyse, dass das Erlebnis eines *Sturzes* nur für Männer mit niedrigerem Bildungsgrad mit einer stärkeren Wahrnehmung von *empfundener sozialer Exklusion* verbunden war. Das Erlebnis eines *Sturzes* war in keiner der nach Geschlecht und Bildungsgrad unterteilten Gruppen mit einem erhöhten Empfinden von *Einsamkeit* assoziiert. Diese Studie verdeutlicht, dass Männer mit niedrigem Bildungsniveau durch Stürze von *sozialer Exklusion* betroffen sind. Folglich bedarf es weiterer Studien, die diesen Zusammenhang untersuchen, damit mögliche präventive Interventionen geschaffen werden, um die entsprechenden Folgen von Stürzen zu vermeiden.

This was the first longitudinal study analyzing the relation between *falls* and *perceived social exclusion* and *loneliness* among older people of different educational levels and gender. Longitudinal data were derived from two waves (2014 and 2017) of the German Ageing Survey, which offered an analytical sample of 11,227 individuals. The average age was 64.9 years. First, sample characteristics stratified by gender and educational level (ISCED-scale) were analyzed to describe characteristics like, e.g. the age and family status. The independent variable *falls* was assessed asking the individuals for falls in the past 12 months. *Perceived social exclusion* (outcome measure) was measured using a scale developed by Bude and Lantermann. *Loneliness* (outcome measure) was measured using a short form of the De Jong Gierveld Loneliness Scale. Controlling for various covariates, fixed effects regression analysis stratified by gender and educational level revealed that *falls* were associated with greater *perceived social exclusion* only among men with lower educational level. *Falls* were not related to increased *loneliness* in any group of different gender or educational level. This study highlights that men of low educational level are threatened by *perceived social exclusion* after a fall. Thus, future studies are needed to investigate this relationship to realize preventive interventions to avoid negative consequences of falls.

V. Erklärung des Eigenanteils an der Publikation

Hiermit versichere ich, Nicola Petersen, dass ich die folgenden Anteile für die Verfassung der Publikationspromotion „**The onset of falls and its effects on perceived social exclusion and loneliness. Evidence from a nationally representative longitudinal study.**“ selbständig erarbeitet habe:

- Promotionsskizze
- Literaturrecherche und -auswertung
- Vertragsabschluss mit dem Deutschen Alterssurvey (DEAS) zur Nutzung der DEAS-Daten
- Datenaufbereitung und Datenauswertung der zur Verfügung gestellten Mikrodaten mittels Stata (Version 16) in Zusammenarbeit mit Prof. Dr. phil. André Hajek
- Erstentwurf des Manuskripts
- Einreichen und Bearbeitung des Manuskripts nach Rücksprache mit meinem Betreuer und Univ.-Prof. Dr. med. Hans-Helmut König
- Bearbeitung des Manuskriptes für die Revision beim Journal unter Rücksprache mit meinem Betreuer und Univ.-Prof. Dr. med. Hans-Helmut König

VI. Danksagung

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VII. Lebenslauf

Aus datenschutzrechtlichen Gründen wurde der Lebenslauf entfernt.

VIII. Eidesstattliche Erklärung

Ich versichere ausdrücklich, dass ich die Arbeit selbständig und ohne fremde Hilfe verfasst, andere als die von mir angegebenen Quellen und Hilfsmittel nicht benutzt und die aus den benutzten Werken wörtlich oder inhaltlich entnommenen Stellen einzeln nach Ausgabe (Auflage und Jahr des Erscheinens), Band und Seite des benutzten Werkes kenntlich gemacht habe.
Ferner versichere ich, dass ich die Dissertation bisher nicht einem Fachvertreter an einer anderen Hochschule zur Überprüfung vorgelegt oder mich anderweitig um Zulassung zur Promotion beworben habe.
Ich erkläre mich einverstanden, dass meine Dissertation vom Dekanat der Medizinischen Fakultät mit einer gängigen Software zur Erkennung von Plagiaten überprüft werden kann.

Unterschrift: ……