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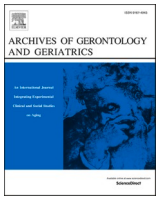

Factors associated with loneliness among individuals aged 80 years and over: Findings derived from the nationally representative "Old Age in Germany (D80+)" study

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HIGHLIGHTS

- Data from a large, nationally representative sample was used (community-dwelling and institutionalized).
- Valid tools were used to quantify the factors associated with loneliness.
- Several sociodemographic and health-related factors can contribute to loneliness among the oldest old in Germany.
- Low education was only associated with higher loneliness among men, but not women.
- Such knowledge can aid to address individuals with higher loneliness levels.

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ABSTRACT

Objectives: To clarify the factors associated with loneliness in individuals aged 80 years and older in Germany (also stratified by sex).
Methods: Data from the nationally representative "Old Age in Germany (D80+)" were employed. The analytic sample equaled 10,031 individuals. The D80+ study included community-dwelling and institutionalized individuals ≥ 80 years in Germany. Multiple linear regressions were used (with sociodemographic and health-related explanatory factors). The collection of data occurred between November 2020 and April 2021 (written questionnaire).
Results: Higher loneliness was significantly associated with not being married (e.g., widowed compared to being married, β=0.37, $p<.001$), being institutionalized (β=0.33, $p<.001$), low education (high education compared to low education, β=-0.07, $p<.01$), a higher number of chronic conditions (β=0.02, $p<.001$), poor self-rated health (β=-0.19, $p<.001$) and greater functional impairment (β=0.15, $p<.001$). Sex-stratified regressions produced comparable results. However, low education was only associated with higher loneliness among men, but not women (with significant interaction: education x sex).
Conclusion: Several sociodemographic and health-related factors can contribute to loneliness among the oldest old in Germany, with sex-specific associations between education and loneliness. Overall, such knowledge can aid to address individuals with higher loneliness levels.

1. Introduction

A significant increase in the proportion of people aged 80 and over, often referred to as the "oldest old", is expected in the coming decades (Statistisches Bundesamt, 2019). Furthermore, the oldest old particularly face losses of friends and family members and health challenges, including multiple chronic diseases, immobility, sensory loss, cognitive decline and frailty – which can ultimately contribute to loneliness. A

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very recent systematic review and meta-analysis revealed an estimated prevalence of severe loneliness of 27.1 % (95 % CI: 23.7 % to 30.4 %; moderate loneliness: 32.1 %, 95 % CI: 15.8 % to 48.4 %) among individuals aged 80 years and above (Hajek et al., 2023c). In women, the estimated prevalence of severe loneliness equaled 33.6 % (95 % CI: 6.6 % to 60.7 %) in this age group. In men, the estimated prevalence of severe loneliness equaled 22.7 % (95 % CI: 3.0 % to 42.4 %) in this age group. Furthermore, former research showed that greater loneliness can contribute to poor mental health (Chou & Chi, 2005), low life satisfaction (Lay-Yee et al., 2022) and low quality of life (Costenoble et al., 2023) among the oldest old. Due to its frequency and its adverse effects, some studies examined loneliness in this age bracket.

It should be noted that individuals aged 80 and over differ from older adults aged 65 to 79 years, particularly in terms of health-related factors (e.g., functional or cognitive impairment, frailty or sensory impairment), the need for care as well as loss of friends and relatives (Field & Gueldner, 2001; von Heideken Wågert et al., 2006; Lee et al., 2018). Such factors can contribute to high loneliness scores among the oldest old (Luhmann & Hawkley, 2016). Based on data from the Shanghai Urban Neighborhood Survey, a previous study from China also identified that the correlates of loneliness differ between individuals aged 60 to 79 years and individuals aged 80 years and over. For example, living arrangement was only significantly associated with loneliness among individuals aged 80 years and over, whereas volunteering was only significantly associated among individuals aged 60 to 79 years. Such findings stress the need for further evidence regarding the factors associated with loneliness among individuals aged 80 years and over.

Thus far, only a few studies investigated the determinants of loneliness explicitly among the oldest old (Nyqvist et al., 2013; Brittain et al., 2017; Leitch et al., 2018). These studies mostly found that living situation (living alone) is associated with a higher likelihood of reporting loneliness. Moreover, two of these studies showed that being widowed is linked to a higher likelihood of loneliness (Brittain et al., 2017; Leitch et al., 2018). Other research showed that having depressive symptoms is associated with the presence of loneliness among oldest old individuals (mean age of 89 years) in Sweden (Lampinen et al., 2022). Moreover, using the internet for social purposes (compared to being offline) was found to be associated with lower loneliness levels among the oldest old in North Rhine-Westphalia (most populous state in Germany) (Rennoch et al., 2023).

Due to the limited knowledge, this aforementioned systematic review (Hajek et al., 2023c) also emphasized the need for future research in this area amongst the oldest old. More specifically, this previous work (Hajek et al., 2023c) clarified that most of the existing studies did not use data from nationally representative samples (also covering individuals living in institutionalized settings) limiting the ability to generalize their findings to whole populations in this age bracket. To address this knowledge gap, our aim was to investigate the determinants of loneliness (also stratified by sex) among individuals aged 80 years and over in Germany using data from a nationally representative sample both including community-dwelling and institutionalized individuals. Because the determinants may vary depending on sex (Takagi et al., 2020; Ten Kate et al., 2023), sex-stratified regressions were also conducted. Detecting these factors is essential, as it can aid in identifying men and women in the oldest old category who may be susceptible to loneliness.

2. Methods

2.1. Sample

Data from the study "Ageing in Germany (D80+)" was used for this study. The D80+ study represents a sizable, nationally representative sample of individuals aged 80 years and above in Germany. The D80+ study includes participants from both independent community living and institutionalized settings. In partnership with ceres (Cologne Center for Ethics, Rights, Economics, and Social Sciences of Health) and the German Center of Gerontology (DZA), the University of Cologne performed the study. Financial support for the study was granted by the Federal Ministry for Family Affairs, Senior Citizens, Women, and Youth (BMFSFJ).

Owing to the pandemic, modifications were necessary in the study design. Initially intended as in-person interviews, the study opted for written questionnaires and supplementary telephone interviews (from May to October 2021). The written questionnaires concentrated mainly on high-priority content, while telephone interviews primarily addressed topics of somewhat lower priority.

The survey was conducted using samples drawn from resident registration records in randomly selected municipalities. It was organized and executed by the GESIS - Leibniz Institute for the Social Sciences. The sampling process employed a multi-stage design. Once the municipal sample was selected, ceres requested resident registration offices to provide individual addresses, which were then passed on to infas by ceres. The sample was then drawn in two phases: initially, a random selection of individuals was made from the population registers of the chosen municipalities using a predetermined procedure. Subsequently, the deployment sample for fieldwork was derived from the cumulative individual samples. This deployment sample was stratified disproportionately based on gender and age criteria. Additional methodological insights are provided in the corresponding method report (Angela Prussog-Wagner et al., 2022). Overall, the survey involved the participation of over 10,000 individuals. Data collection for it took place from November 2020 to April 2021. Albrecht et al. provided further details (Albrecht et al., 2022).

The D80+ study has received approval from the Ethics Committee of the Medical Faculty of the University of Cologne (protocol number: 19–1387_1). Telephone interviews were exclusively conducted when the respondents gave their consent. The questionnaire included a brief introduction and outlined data protection regulations. Respondents provided consent by completing and returning the questionnaire.

2.2. Dependent variable: loneliness

Aligning with former research (Hajek & König, 2023; Hajek et al., 2023c, 2023d), loneliness was measured using a single item. This item ranges from 1 (reflecting “never or almost never”) to 4 (“always or almost always”). Former research showed that the UCLA loneliness scale is strongly associated with such a single-item to quantify loneliness (Nersesian et al., 2018). Another recent study clearly demonstrated the reliability and validity of such single item measures (Mund et al., 2023). A further recent study also offered evidence that such single-item measures for loneliness can serve as a valid and cost-effective screening tool, particularly in large population studies (Reinwarth et al., 2023).

2.3. Independent variables

Based on former research in this field (Barjaková et al., 2023), we included these sociodemographic- and health-related independent variables in regressions: sex (men; women), chronological age (in years), marital status (classified into five groups: married, married but living separately from spouse, single, divorced, and widowed), living arrangement (private living; institutionalized setting), educational attainment (low, medium, or high education, based on the ISCED-2011 classification (Bohlinger, 2012)). People living in a retirement or nursing home, a care facility or a residential group were classified as "institutionalised". Private living was assumed for traditional forms of independent living (also covering: multi-generational homes, outpatient assisted living and flat-sharing communities).

Moreover, these health-related factors were included in regression analysis: Self-rated health measured using a 1-item tool, ranging from 1 to 4, where higher values indicate more positive self-rated health.

Additionally, chronic conditions and functional impairment were considered. Adhering to the multimorbidity index in old age (Diederichs et al., 2010; Diederichs, 2012), the count of chronic conditions includes the presence (1) or absence (0) of the following 21 chronic conditions: myocardial infarction; heart failure; hypertension; stroke; mental illness; cancer; diabetes, respiratory or lung disease; back pain; gastrointestinal disease; kidney disease; liver disease; blood disease; joint or bone disease; bladder disease; sleep disorders; eye disease or visual impairment; ear disease or hearing impairment; neurological disease; (blood) vascular disease; thyroid disease. Functional impairment was assessed using a modified version of the IADL tool by Lawton and Brody (Lawton et al., 1969), which comprises seven items. Each item, rated on a scale from 0 (only possible with help) to 2 (no help required), relates to specific areas: using the telephone, planning routes on public transport or cabs, shopping for food and clothing, preparing meals, completing household chores, adhering to medication schedules and managing financial matters. The scores for all items were averaged. The coding was then reversed and ranged from 0 to 2, with higher scores indicating greater functional impairment. Cronbach's alpha for this tool was 0.91.

2.4. Statistical analysis

First, the characteristics of the analytic sample is depicted. Thereafter, multiple linear regressions were used to investigate the determinants of loneliness. Cluster-robust standard errors were calculated. To address non-response and disproportionate sampling design (i.e., oversampling of older age groups and men), sampling weights were used (Angela Prussog-Wagner et al., 2022).

In a first analysis, listwise deletion was used to handle missings. No missing values were reported for sex, age, and living arrangement. The other variables had some missings (percentage of missing data in parentheses): loneliness (3.0 %), marital status (1.6 %), educational attainment (3.4 %), count of chronic conditions (1.8 %), self-rated health (2.3 %) and functional impairment (1.3 %). In our main analysis, full information maximum likelihood (FIML) (Von Hippel, 2016) was used to deal with missings because 88.1 % of the respondents (9323 out of 10,578 respondents) had no missing data.

Effect sizes (partial eta-squared values) from regression analysis were also calculated. Such values can be classified as follows [22]: 0.01 as "small", 0.06 as "medium, and 0.14 as "large", respectively. In this study, statistical significance was established at $p<.05$. Statistical analyses were conducted using Stata 18.0 (Stata Corp., College Station, Texas).

3. Results

3.1. Sample characteristics

In Table 1, the analytic sample (weighted, $n = 10,031$) is shown (we also displayed the analytic sample stratified by living situation in Supplementary Table 1). A majority of the participants (62.0 %) were women. The average age was 86.4 years (SD: 4.3 years), from 80 to 100 years. It may be worth noting that 43.5 % of male individuals had a high education, whereas 13.7 % of female individuals had a high education. More details are shown in Table 1.

Table 1
Sample characteristics (stratified by sex, weighted analytic sample).

Variables	Total sample $N = 10,031$ Mean (SD)/ n (%)	Men $N = 3811$ Mean (SD) / n (%)	Women $N = 6220$ Mean (SD)/ n (%)
Age	85.5 (4.1)	84.9 (3.7)	85.9 (4.3)
Marital status			
Married	3975 (40.2 %)	2464 (65.9 %)	1511 (24.6 %)
Married, living separated from spouse	102 (1.0 %)	53 (1.4 %)	50 (0.8 %)
Divorced	467 (4.7 %)	135 (3.6 %)	332 (5.4 %)
Widowed	4915 (49.7 %)	953 (25.5 %)	3962 (64.5 %)
Single	425 (4.3 %)	137 (3.7 %)	287 (4.7 %)
Living situation			
Private living	9006 (89.8 %)	3584 (94.0 %)	5422 (87.2 %)
Institutionalized	1025 (10.2 %)	227 (6.0 %)	797 (12.8 %)
Education			
Low education	2263 (23.3 %)	274 (7.4 %)	1989 (33.1 %)
Medium education	5005 (51.6 %)	1811 (49.1 %)	3194 (53.2 %)
High education	2426 (25.0 %)	1602 (43.5 %)	824 (13.7 %)
Number of chronic conditions (based on 21 chronic conditions)	4.6 (2.7)	4.3 (2.6)	4.9 (2.7)
Self-rated health (from 1 = very poor to 4 = very good)	2.6 (0.7)	2.7 (0.7)	2.6 (0.7)
Functional impairment (from 0 to 2, with higher values reflecting greater functional impairment)	0.6 (0.7)	0.5 (0.6)	0.7 (0.7)
Loneliness (from 1 to 4, with higher values reflecting higher loneliness levels)	1.7 (0.8)	1.5 (0.7)	1.8 (0.8)

3.2. Regression analysis

3.2.1. Analyses among the total sample

The results of multiple linear regressions (with listwise deletion to address missings: column 2; with FIML to address missings: column 3) are shown in Table 2. Comparing the results of column 2 and 3, the results were very similar (in terms of effect sizes and significance). In this section, we thus focused on the findings of the main model (column 3, with FIML): Higher loneliness was significantly associated with not being married (e.g., widowed compared to being married, β=0.37, $p<.001$), being institutionalized (β=0.33, $p<.001$), low education (high education compared to low education, β=−0.07, $p<.01$), a higher number of chronic conditions (β=0.02, $p<.001$), poor self-rated health (β=−0.19, $p<.001$) and greater functional impairment (β=0.15, $p<.001$).

Regressions stratified by sex are presented in Table 3. Among men, higher loneliness was significantly associated with not being married (e.g., widowed compared to being married, β=0.41, $p<.001$), being institutionalized (β=0.25, $p<.001$), low education (e.g., high education compared to low education, β=−0.17, $p<.001$), a higher number of chronic conditions (β=0.02, $p<.001$), poor self-rated health (β=−0.13, $p<.001$) and greater functional impairment (β=0.15, $p<.001$).

3.2.2. Analyses stratified by sex

Among women, higher loneliness was significantly associated with not being married (e.g., widowed compared to being married, β=0.35, $p<.001$), being institutionalized (β=0.35, $p<.001$), a higher number of chronic conditions (β=0.02, $p<.001$), poor self-rated health (β=−0.23, $p<.001$) and greater functional impairment (β=0.14, $p<.001$). The interaction terms (not shown in Table 3) between sex and educational level were as follows: medium education x female, β=0.07, $p=.16$; high education x female, β=0.14, $p=.02$). Effect sizes (in terms of partial eta squared values) are shown in Supplementary Tables 2 to 4.

4. Discussion

Based on data from a sizable, nationally representative survey, our aim was to explore the factors linked to loneliness amongst individuals

Table 2
Determinants of loneliness. Results of multiple linear regressions.

Independent variables	Loneliness (with listwise deletion to address missings)	Loneliness (with FIML to address missings)
Sex: Women (Reference category: Men)	−0.06 (−0.19 - 0.07)	−0.05 (−0.17 - 0.08)
Age (in years)	0.01 (−0.00 - 0.02)	0.01 (−0.00 - 0.02)
Marital status: - Married, living separated from spouse (Reference category: Married)	0.17* (0.03 - 0.32)	0.15* (0.01 - 0.29)
- Divorced	0.37*** (0.28 - 0.46)	0.37*** (0.28 - 0.46)
- Widowed	0.37*** (0.33 - 0.41)	0.37*** (0.34 - 0.41)
- Single	0.32*** (0.21 - 0.42)	0.30*** (0.20 - 0.40)
Living situation: Being institutionalized (Reference category: Private living)	0.35*** (0.26 - 0.44)	0.33*** (0.24 - 0.41)
Education: - Medium education (Reference category: Low education)	−0.03 (−0.08 - 0.01)	−0.04+ (−0.08 - 0.01)
- High education	−0.07** (−0.12 - −0.02)	−0.07** (−0.12 - −0.02)
Number of chronic conditions (based on 21 chronic conditions)	0.02*** (0.01 - 0.03)	0.02*** (0.02 - 0.03)
Self-rated health (from 1 = very poor to 4 = very good)	−0.19*** (−0.22 - −0.16)	−0.19*** (−0.22 - −0.16)
Functional impairment (from 0 to 2, with higher values reflecting greater functional impairment)	0.15*** (0.11 - 0.19)	0.15*** (0.11 - 0.18)
Constant	1.20* (0.27 - 2.13)	1.31** (0.53 - 2.10)
Observations	9323	10,031
R^2	0.24	0.23

*** $p<.001$,.
** $p<.01$,.
* $p<.05$,.
+ $p<.10$;
unstandardized beta-coefficients are displayed; 95% CI are shown in parentheses; cluster-robust standard errors were computed (based on the primary sampling unit); sampling weights were also used; furthermore, it was adjusted for sample cells (which are used for the stratification of the secondary sampling unit).

aged 80 years and older in Germany. Our main findings were as follows: Higher loneliness was significantly associated with not being married, being institutionalized, low education, a higher number of chronic conditions, poor self-rated health and greater functional impairment. Sex-stratified regressions yielded comparable results. However, low education was only associated with higher loneliness among men, but not women (with significant interaction: high education x sex). In terms of effect sizes, most associations were small (e.g., self-rated health or functional impairment), whereas the effect size for marital status can be classified as medium (particularly among men) stressing the importance of marital status in this age bracket. It should also be emphasised that many people of this age are affected by health restrictions - which accentuates the relevance accordingly. Our large, nationally representative current study clearly extends our current knowledge mainly based on geographically restricted samples with a modest sample size among the *oldest old*. Moreover, other existing studies often focused on older adults in general (but not explicitly on oldest old) (Hajek & König, 2020a; Richardson et al., 2023).

In our study, we found an association between not being married and higher loneliness levels. Two former studies among the oldest old also identified such a link. In our study, family status was the most important factor (in terms of effect size). As family losses occur relatively frequently in old age, the practical relevance of this should be emphasised. Such findings therefore stress the relevance of marital

Table 3
Determinants of loneliness (stratified by sex). Results of multiple linear regressions.

Independent variables	Loneliness (with listwise deletion to address missings) - Men	Loneliness (with FIML to address missings) - Men	Loneliness (with listwise deletion to address missings) - Women	Loneliness (with FIML to address missings) - Women
Age (in years)	0.01 (−0.01 - 0.02)	0.00 (−0.01 - 0.01)	0.01 (−0.01 - 0.02)	−0.00 (−0.01 - 0.01)
Marital status: - Married, living separated from spouse (Reference category: Married)	0.28** (0.09 - 0.47)	0.28** (0.09 - 0.47)	0.05 (−0.19 - 0.28)	0.01 (−0.22 - 0.24)
- Divorced	0.39*** (0.21 - 0.56)	0.40*** (0.23 - 0.56)	0.35*** (0.24 - 0.47)	0.34*** (0.23 - 0.46)
- Widowed	0.41*** (0.35 - 0.47)	0.41*** (0.35 - 0.47)	0.36*** (0.31 - 0.41)	0.35*** (0.31 - 0.40)
- Single	0.24** (0.07 - 0.42)	0.26** (0.09 - 0.43)	0.34*** (0.21 - 0.46)	0.30*** (0.17 - 0.43)
Living situation: Being institutionalized (Reference category: Private living)	0.29** (0.11 - 0.48)	0.25** (0.07 - 0.42)	0.37*** (0.26 - 0.47)	0.35*** (0.25 - 0.45)
Education: - Medium education (Reference category: Low education)	−0.10* (−0.18 - −0.01)	−0.10* (−0.19 - −0.02)	−0.03 (−0.08 - 0.02)	−0.03 (−0.08 - 0.02)
- High education	−0.17*** (−0.26 - −0.08)	−0.17*** (−0.25 - −0.08)	−0.02 (−0.10 - 0.05)	−0.03 (−0.10 - 0.05)
Number of chronic conditions (based on 21 chronic conditions)	0.02*** (0.01 - 0.03)	0.02*** (0.02 - 0.03)	0.02*** (0.01 - 0.03)	0.02*** (0.01 - 0.03)
Self-rated health (from 1 = very poor to 4 = very good)	−0.14*** (−0.19 - −0.09)	−0.13*** (−0.18 - −0.09)	−0.22*** (−0.26 - −0.18)	−0.23*** (−0.27 - −0.18)
Functional impairment (from 0 to 2, with higher values reflecting greater functional impairment)	0.15*** (0.09 - 0.20)	0.15*** (0.10 - 0.20)	0.15*** (0.10 - 0.20)	0.14*** (0.09 - 0.19)
Constant	0.99 (−0.28 - 2.26)	1.61** (0.65 - 2.57)	1.39* (0.08 - 2.70)	1.95*** (1.39 - 2.52)
Observations	4487	4838	4836	5193
R^2	0.22	0.21	0.21	0.20

*** $p<.001$,.
** $p<.01$,.
* $p<.05$,
+ $p<.10$; unstandardized beta-coefficients are displayed; 95% CI are shown in parentheses; cluster-robust standard errors were computed (based on the primary sampling unit); sampling weights were also used; furthermore, it was adjusted for sample cells (which are used for the stratification of the secondary sampling unit).

status (especially among men, where there are differences between married men living together and married men living apart) in this age bracket. The importance of a partner becomes particularly clear in this crucial phase of life characterized by the loss of friends and other relatives, as well as declining physical health, contributing to loneliness (Hajek et al., 2023b).

Compared to old age in general: A former study, for example, showed that widowhood increases loneliness scores among older adults in China (Yang & Gu, 2021). More precisely, this study also showed that the association between widowhood and loneliness was stronger in young-old compared to oldest-old individuals (Yang & Gu, 2021). Likewise, previous research also demonstrated the importance of partnership specifically among Dutch young-old adults (van Tilburg et al., 2014). Based on data from Norway, a further study also showed a similar association between marital status and loneliness levels in young-old and old-old individuals (Nicolaisen & Thorsen, 2014).

The association of being institutionalized and higher loneliness scores appears very plausible and supports former research conducted in Germany (Hajek & König, 2022). Nursing home residents may have less contact with their familiar surroundings than people who continue to live at home (Bondevik & Skogstad, 1996) (and therefore remain in familiar surroundings). The quality of (meaningful) relationships could also suffer as a result (Paque et al., 2018). These factors could promote loneliness among nursing home residents (Paque et al., 2018). In comparison to young-old adults, we assume that this relationship may be particularly pronounced among the oldest old since the latter age group usually faces more social-related and health-related obstacles compared to younger age groups such as young-old individuals (University et al., 2013). However, there is a general lack of evidence comparing the association between living arrangement (in terms of being institutionalized vs. community-dwelling living arrangement) and loneliness explicitly between the young-old and the oldest old – probably due to a lack of available data.

Interestingly, we found an association between higher education and lower loneliness – which supports prior research (Kaiser & Luhmann, 2023) in our study. While we found such an association in men, we did not find such link in women (with a significant interaction between high education and sex). Higher-educated men in this age bracket may have more pronounced coping strategies to better deal with the challenges of ageing - such as family losses or deteriorating health - than lower-educated men (Ranchor et al., 1996). They could, for example, adapt their activities accordingly (Hajek & König, 2020b, 2021). For example, they might reshape their aims and priorities in their lives (Hajek & König, 2020b, 2021) (e.g., focusing on certain forms of volunteering) - which in turn can promote lower levels of loneliness (Richardson et al., 2023). However, at first glance, it is questionable why there are no such differences among women. It is possible that the low level of formal education among women in these birth cohorts is less an expression of actual cognitive skills and more an expression of patriarchal structures (and social class affiliations) in Germany at the time of their formal education in Germany (see also: (Cooke, 2006)). Other possible explanations could refer to the fact that women (irrespective of education) may have better access to community resources and support networks, such as social clubs, religious organisations or community centres, which can help to alleviate feelings of loneliness in this age bracket. These resources may be less accessible or attractive to older men with lower levels of education. However, future research is required to test these potential pathways. Of note, a former review (Dahlberg et al., 2022) found an association between higher education and a lower loneliness risk among older adults in general only in two out of ten studies. In contrast to old age in general or young old-age, the particular relevance of education for loneliness scores among male individuals in this age bracket (aged 80 years and over) may be explained by the aforementioned coping skills – which are particularly important to deal with the various hurdles of highest age (University et al., 2013). However, upcoming research is required to examine it in more detail.

All included health-related factors were associated with higher loneliness scores in our study aligning with prior research in this field (Hajek & König, 2020a; Barjaková et al., 2023). Former research showed that the high prevalence of functional limitations particularly explained why loneliness scores increase in late-life (Luhmann & Hawkley, 2016). Poor health (in terms of poor self-rated health, a high number of chronic conditions and functional impairment) may signify an increased demand for extended care which is accompanied by reduced social activities (Hajek et al., 2023a). Additionally, a poor health may diminish satisfaction in both marital partnership and friendship (Hajek et al., 2023a). Poor health can also lead to relationships being perceived as one-sided. More precisely, individuals in poor health may deal with feelings of guilt and a sense of not being able to reciprocate the potential help provided (Hajek & König, 2017). Consequently, as noted, individuals in poor health may perceive most social interactions as one-sided, fostering dissatisfaction with the quality of the relationship. Finally, this can contribute to feelings of loneliness (Hajek & König, 2017). A former systematic review focusing on risk factors for loneliness in general longitudinally also demonstrated the importance of health-related factors for loneliness among older adults (Dahlberg et al., 2022). Another study also showed that loneliness was associated with depression among both young-old and oldest-old groups (based on data from the National Social Life, Health, and Aging Project) (Son et al., 2022). Comparable associations between health and loneliness have been also shown among young-old and old-old individuals in Norway (Nicolaisen & Thorsen, 2014).

It may be worth noting that age was not significantly associated with loneliness in our current study. We assume that potential age effects may be mainly covered by marital status (e.g., spousal loss) and health-related factors (as an overview: (Kaiser & Luhmann, 2023)). A previous study from China found that age was not associated with loneliness in either young-old or old-old individuals (Yang & Gu, 2021). Comparable findings were made by a study from Norway (Nicolaisen & Thorsen, 2014).

Additionally, sex was not significantly associated with loneliness. Kaiser and Luhmann (Kaiser & Luhmann, 2023) attributed these factors to opposing effects that can balance each other out: While women often have larger social networks and more frequent social contacts, they often outlive their spouse and have to care for them, which in turn can restrict their leisure activities. Indeed, a former meta-analysis also did not identify loneliness differences between women and men in later life (Maes et al., 2019). An earlier study found no differences in loneliness between men and women - neither in young-old nor old-old individuals in Denmark (Lasgaard et al., 2016). Overall, it should be noted that our findings regarding the oldest old are frequently comparable to studies focusing on young-old or older adults in general (Dahlberg et al., 2022), with some potentially age-specific findings (e.g., regarding the association between education and loneliness). Moreover, upcoming research is necessary to compare the association between living arrangements (being institutionalized vs. community-dwelling) between young-old and old-old individuals.

Recognizing specific strengths and limitations in the present study is important. Our data stem from a substantial, nationally representative sample. The D80+ study focused on individuals $\geq$ 80 years and over. Moreover, both, community-dwelling and institutionalized participants were included. Such individuals (e.g., individuals aged 90 years and over residing in institutionalized settings) are usually difficult to reach. Sampling weights were used and a FIML approach was used to tackle missing data. One limitation is that loneliness was assessed using a single item – which may not fully capture loneliness in its full complexity. However, as already noted in the methods section, such items usually perform quite well and are closely associated with multi-item scales (Nersesian et al., 2018). Furthermore, the cross-sectional design is another limitation of this study introducing constraints in establishing causal relationships.

5. Conclusion and future research

Several sociodemographic and health-related factors can contribute to loneliness among the oldest old in Germany, with sex-specific associations between education and loneliness. Overall, such knowledge can aid to address individuals with higher loneliness levels. With regard to future research, we recommend studies using longitudinal data from nationally representative samples (whenever available). Furthermore, upcoming studies could explore the mediating factors - and explore other moderating factors apart from sex.

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CRediT authorship contribution statement

André Hajek: Writing – review & editing, Writing – original draft, Visualization, Project administration, Methodology, Formal analysis, Data curation, Conceptualization. **Razak M. Gyasi:** Writing – review & editing, Visualization, Project administration. **Hans-Helmut König:** Writing – review & editing, Visualization, Supervision, Resources.

Declaration of competing interest

The authors have no conflicts of interest to declare.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.archger.2024.105443.

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