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Development of Loneliness in Midlife and Old Age: Its Nature and Correlates

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Abstract

Research has long demonstrated that loneliness is a key risk factor for poor health. However, less is known about the development and predictors of loneliness across later adulthood. We examined these questions using two-wave data obtained 5 years apart in the population-based Norwegian NorLAG study ($N = 5,555$; age 40-80 years; 51% women). We considered direct measures of loneliness (asking directly about feeling lonely) and indirect measures (avoiding the term loneliness) and linked them to self-report data on personality and contact with friends, and to register data on socioeconomic (education, income, unemployment), physical health (sick leave, lifetime history of disability), and social factors (children, marriage/cohabitation, lifetime history of divorce and widowhood). Results indicated that levels of loneliness increased steadily for women, whereas men's levels followed a U-shaped curve, with highest loneliness at ages 40 and 80. At age 40, loneliness declined between the two data waves, but with increasing age the decrease abated and turned into increases when loneliness was measured indirectly. Disability, no spouse/cohabitating partner, widowhood, and little contact with friends were each associated with more loneliness. Similarly, people high in emotional stability and extraversion reported less loneliness and experienced steeper loneliness declines on one or both loneliness measures. We take our results to illustrate the utility of combining self-report and register data and conclude that the development of loneliness across the second half of life is associated with both individual difference characteristics and aspects of social embedding. We discuss possible mechanisms underlying our findings and consider practical implications.

Keywords: loneliness, old age, health, social relationships, personality

Development of Loneliness in Midlife and Old Age: Its Nature and Correlates

Loneliness is commonly defined as a response to a perceived discrepancy between the desired quantity and quality of social life and actual social relationships, and definitions emphasize that loneliness is the subjective experience of being socially isolated, in contrast to being alone (Luhmann & Hawkley, 2016; Peplau & Perlman, 1982). Loneliness has long been considered an important research topic in social, health, and developmental psychology, with an abundance of empirical studies documenting that loneliness is a risk factor for numerous negative life outcomes, including depressive symptomatology (Cacioppo, Hawkley, & Thisted, 2010), poor physical health (Caspi, Harrington, Moffitt, Milne, & Poulton, 2006), and mortality (Holt-Lunstad, Smith, Baker, Harris, & Stephenson, 2015). Although it is thus pivotal to know the nature and correlates of loneliness, we are only at the beginning of understanding how loneliness manifests and develops across adulthood and old age and what the factors are that operate as sources of individual differences. To complicate matters, because of its subjective nature, the sources and correlates of loneliness may depend upon how the phenomenon is assessed.

To better understand these issues, in this study we use two-wave longitudinal data obtained five years apart from the population-based NorLAG study in Norway ($N = 5,555$; age 40-80 years at baseline; 51% women) and consider both direct measures of loneliness (asking directly about being or feeling lonely) and indirect measures (avoiding the terms lonely and loneliness). In a first step, we examine how loneliness manifests and develops in both men and women from midlife to old age. In a second step, we combine self-report data and register data to investigate the role of socioeconomic (education, income, unemployment), physical health (sick leave, lifetime history of disability), and social factors (children, spouse/cohabitating partner,

lifetime history of divorce and widowhood) as well as the Big Five personality traits as sources of individual differences in levels and rates of change in loneliness. We also test whether and how the relevance of predictors of loneliness differs across age, gender, and the way that loneliness is measured.

Development of Loneliness Across the Second Half of Life

Theoretical accounts of age trends in loneliness have focused mainly on changes in social relationships and networks as determinants of loneliness. Those theories predict that feelings of loneliness increase in old age when the frequency of social contacts typically decreases as a result of loss of social roles through retirement, widowhood, death of peers, and decreased physical mobility (Pinquart & Sörensen, 2001b). However, there are also perspectives that do not assume age-related increases in loneliness. For example, socioemotional selectivity theory suggests that older adults focus more strongly than younger people on relationships that are emotionally rewarding and avoid social contacts that are primarily aimed at obtaining information or are emotionally unpleasant (Carstensen, Isaacowitz, & Charles, 1999). Older adults may thus maintain the kinds of relationships that are of particular importance for counteracting loneliness, whereas other kinds of social contacts may be reduced without affecting people's loneliness. This is supported by recent empirical evidence showing that even though the quantity of social contacts in general decreases with increasing age, contact with family members, which may be of particular importance for providing emotionally rewarding interactions, remains rather stable (Sander, Schupp, & Richter, 2017). If the assumptions in socioemotional selectivity theory hold true, loneliness should remain relatively stable across later adulthood, even when the quantity of social contacts decreases. At the same time, the loss of significant others, more frequent and more serious health complaints, and physical limitations

may limit social interactions even with important social partners to a severe degree in old age, thereby prompting increases in loneliness (Pinquart & Sörensen, 2001b).

Several cross-sectional studies indicate that levels of loneliness do increase in old age. For example, two cross-sectional studies from the United Kingdom found non-linear age differences, with slightly decreasing levels of loneliness during midlife and steadily increased levels of loneliness starting at about age 70 (Demakakos, Nunn, & Nazroo, 2006; Victor & Yang, 2012). Similar findings were obtained in a study using cross-sectional data from 25 European nations, reporting increasing loneliness levels in old age, but rather stable or even declining levels of loneliness in midlife (Yang & Victor, 2011). Another study using cross-sectional data from 11 European countries provided a somewhat different picture, with levels of loneliness in most countries increasing steadily with increasing age from midlife to old age (Hansen & Slagsvold, 2016). However, studies are limited by categorizing persons into age groups instead of treating age as a continuous variable, thus not allowing fine-grained modeling of cross-sectional age differences in loneliness. To our knowledge, only one large-scale cross-sectional study has specifically targeted age differences by treating age as a continuous variable. In this study, Luhmann and Hawkey (2016) used large-scale cross-sectional data from the population-based German Socio-Economic Panel and found that loneliness increased slightly between the ages of 40 and 60, then declined from age 60 to 75, and then rapidly increased again after age 75.

As noted in a recent review (Mund, Freuding, Möbius, Horn, & Neyer, 2017), large-scale longitudinal studies providing a comprehensive overview of mean-level change across the life course are scarce, even though such studies have several methodological advantages compared to cross-sectional research. The existing longitudinal studies almost exclusively cover old people,

whereas longitudinal age trends among the middle-aged are understudied (Mund et al., 2017). Most of the conducted longitudinal studies show that loneliness increases with increasing age among people 65 years or older (Dahlberg, Andersson, McKee, & Lennartsson, 2015; Dykstra, van Tilburg, & de Jong Gierveld, 2005; Hawkey & Kocherginsky, 2017; Heikkinen & Kauppinen, 2011; Jylhä, 2004). However, the size of the increase in loneliness is uncertain. For example, while longitudinal data from the Berlin Aging Study show that loneliness increased between the ages of 70 and 100 by a considerable amount of about one third of a standard deviation per decade (Gerstorf, Ram, Lindenberger, & Smith, 2013), other studies found rather small increases in loneliness across old age (see Victor & Bowling, 2012). Diverging findings may be caused by the rather crude analytical methods used in most studies to examine change in loneliness, as most research only provides overall estimates of mean-level changes in loneliness among groups of old people with considerable variations in age (e.g., Dahlberg et al., 2015; Heikkinen & Kauppinen, 2011; Jylhä, 2004). As a result, studies provide limited information about longitudinal changes at specific ages.

In sum, empirical studies converge in reporting that loneliness increases in old age. However, longitudinal research is scarce among middle aged adults. Moreover, only one large scale cross-sectional study examined age trends without categorizing samples into rather large age groups. Longitudinal studies spanning from middle adulthood to old age using age as a continuous variable are needed to provide detailed information about age trends in loneliness in the second half of life. To address this gap, this study makes use of 5-year, two-wave longitudinal data to examine age differences and age-related changes from midlife to old age.

Predictors of Loneliness

The second aim of this study is to focus on a wide array of predictors of loneliness and to examine the unique predictive effects of these factors for both level of and change in loneliness. Theoretical accounts have identified four sets of variables as possible sources of loneliness, including (a) socioeconomic status (SES) variables, (b) physical health problems and functional status, (c) social relationships, and (d) personality (Pinquart, 2003). In the following, we present theoretical accounts and empirical findings for these four sets of potential predictors of loneliness.

Socioeconomic status. SES has been suggested to be an important socio-demographic source of variations in loneliness (Pinquart & Sörensen, 2000). Sufficient financial resources may increase people's opportunities to participate in social activities and to engage in a greater variety of activities that counteract loneliness (Hawkey et al., 2008). Particularly older adults that have sufficient financial resources have the option to use paid services for caregiving and transportation, which in turn increases people's mobility. In a similar vein, more education often involves better knowledge of opportunities for social interaction and may thereby also be linked to lower levels of loneliness (Pinquart & Sörensen, 2001b).

Empirically, two reviews showed that lower income is associated with higher levels of loneliness (Cohen-Mansfield, Hazan, Lerman, & Shalom, 2016; Pinquart & Sörensen, 2001b). Moreover, Pinquart and Sörensen's (2001b) meta-analysis found associations between more education and low levels of loneliness, although the associations were weaker than for income. Given that an association between SES and loneliness exists, a further step is to examine how such an association can be understood. In particular, if SES in fact is associated with loneliness because sufficient financial resources promote opportunities for social interactions, one would expect the association between SES and loneliness to hold even when taking into account

potential confounders in the health, social, and personality domains. Cross-sectional research indeed shows that both education and financial resources predict loneliness, even when controlling for several potential covariates such as social networks, health, and life events (Cohen-Mansfield & Parpura-Gill, 2007; Cohen-Mansfield, Shmotkin, & Goldberg, 2009; de Jong Gierveld, Keating, & Fast, 2015). However, reviews note that longitudinal studies on this issue are scarce, even though results from such studies could disentangle potential mechanisms of the association between SES and loneliness (Cohen-Mansfield et al., 2016; Pinqart & Sörensen, 2001b). An exception is a study showing that insufficient financial resources predicted increased loneliness 3.5 years later among old people, even when controlling for several covariates (Cohen-Mansfield et al., 2009). More large-scale longitudinal research is needed to corroborate this finding.

Physical health. Physical health problems are as well hypothesized to be related to loneliness. More specifically, it has been proposed that poor physical health and functional impairment may result in fatigue and mobility difficulties, which constitute barriers to social participation and social relationships and thereby generate or strengthen already existing feelings of loneliness (Cohen-Mansfield et al., 2016; Cohen-Mansfield & Parpura-Gill, 2007).

Reviews of empirical studies have consistently found poor physical health to be cross-sectionally related to higher loneliness (Cohen-Mansfield et al., 2016; Hawkley & Capitano, 2015; Ong, Uchino, & Wethington, 2016). Longitudinal studies on the issue have repeatedly demonstrated that loneliness is predictive of poor health and mortality risks, but have less frequently examined reversed temporal dynamics, with poor health being a risk factor for loneliness (see, e.g., Cacioppo, Grippo, London, Goossens, & Cacioppo, 2015; Ong et al., 2016). As one of the few studies available, Luo, Hawkley, Waite, and Cacioppo (2012) found that both

self-rated health and functional limitations were predictive of subsequent changes in loneliness, whereas the opposite predictive effects were considerably smaller in size. Similar results were obtained by other longitudinal studies, showing that somatic health indicators were associated with increasing loneliness (Cohen-Mansfield et al., 2009; Dykstra et al., 2005; Jylhä, 2004). As health measures used in the large majority of studies were based on self-reports among older adults, it appears that more objective assessments of disabling health conditions and how these are associated with loneliness are needed for a more comprehensive understanding of the role of health problems as potential sources of loneliness. Moreover, studies extending our knowledge about the health–loneliness association to other age groups than old people are needed.

Social relationships. Due to the social nature of loneliness, a lack of social ties—and particularly a lack of close social relationships—is considered to be one of the main sources of loneliness (Peplau & Perlman, 1982; Pinqart, 2003). Generally, there is agreement in the literature that the quality of relationships is more important for loneliness than quantity (Hawkley et al., 2008; Pinqart & Sörensen, 2001b). For this reason, there has been a research focus on indicators of high-quality social relationships, such as having close friends or having a spouse/cohabitating partner as predictors of loneliness. In line with this focus, a recent review reported consistent cross-sectional associations between non-married status and loneliness in older adults (Cohen-Mansfield et al., 2016). Likewise, in a meta-analysis, high quality relationships were found to be more predictive of not being lonely than mere quantity of social contact (Pinqart & Sörensen, 2001b).

Theoretical accounts have long proposed that loneliness is particularly influenced by changes in social relations, such as the dissolution of close relationships by death, divorce, or breakup (Peplau & Perlman, 1982). Because these events can decrease the size of one's personal

and family network considerably (Wrzus, Hanel, Wagner, & Neyer, 2013), it is important not only to take into account current marital/cohabitation status but also to examine the predictive utility of prior relationship dissolutions. One empirical study investigating these issues found that widowed persons felt indeed less lonely than divorced persons, but all widowed, divorced, and never-married persons alike reported higher levels of loneliness than married persons (Pinquart, 2003). To account for the potential influence of both current social relationships and relationship experiences in the past, this study will include both current aspects and lifetime history of cohabitating partnerships/marriages as predictors of loneliness.

Personality. When examining broad personality traits, reviews have indicated that extraversion is the most important predictor of social factors such as popularity and social status among adults (Ozer & Benet-Martínez, 2006). Extraversion thus seems to be particularly important for engaging in social interactions that counteract loneliness. Moreover, extraversion is generally related to positive affect (Lucas & Fujita, 2000). High levels of extraversion may thus be related to low levels of loneliness both because extraversion promotes social participation and because extraverted people may have a more positive outlook on life. Other personality traits may also be important. More specifically, studies have shown that a high level of neuroticism and low levels of agreeableness are detrimental for satisfaction with and quality of close (e.g., romantic) social relationships (Ozer & Benet-Martínez, 2006), which may in turn increase feelings of loneliness. High levels of neuroticism are also related to a heightened sensitivity to negative stimuli (Larsen & Ketelaar, 1991). As a result, people with high neuroticism levels may feel lonelier than emotionally stable persons because their relationships are to a greater degree characterized by interpersonal difficulties and they additionally interpret social situations more negatively. In particular, the heightened sensitivity of people with high neuroticism scores may

be an important source of loneliness even after accounting for other relevant factors such as SES, physical health, and social factors.

Given the above theoretical rationale for how and why several broad personality traits are supposed to be linked with loneliness, surprisingly few empirical studies have indeed examined such links. Because of the noted scarcity of research, personality factors are typically not included in meta-analytic studies examining predictors of loneliness (Pinquart & Sörensen, 2001b). In a literature search we identified five studies that used cross-sectional data based on adolescents (Asendorpf & van Aken, 2003; Vanhalst et al., 2012) or undergraduate student samples (Cacioppo et al., 2006; Saklofske & Yackulic, 1989; Stokes, 1985); all five found low levels of extraversion and high levels of neuroticism to be associated with more loneliness, whereas the findings for the other three Big Five personality traits were inconsistent across the studies. Two studies among people aged 85 or older also indicated similar associations of extraversion and neuroticism with loneliness, whereas other personality traits were not assessed (Hensley et al., 2012; Long & Martin, 2000). To our knowledge, only one study has used longitudinal data to examine associations of the Big Five personality traits with loneliness. In that study, neuroticism in young adults was related to increases in loneliness over a 15-year period, but other personality traits were not predictive of changes in loneliness (Mund & Neyer, 2016). We thus know very little about how broad personality traits are related to loneliness among middle-aged and older adults.

Age, Gender, and Type of Loneliness Measurement as Moderators

The literature has repeatedly noted that age trends in loneliness and predictors thereof may differ by three sets of relevant moderators: age, gender, and type of measure of loneliness.

To begin with, links between individual difference factors and loneliness may depend on age (Hawkley & Cacioppo, 2007). For example, socioemotional selectivity theory predicts that factors that promote emotionally rewarding social contacts are more important for older than for younger adults (Carstensen et al., 1999). As a result, close social relationships, such as having a romantic partner, may be more important for loneliness in older age, whereas factors such as network size may be more important in younger age groups (Carmichael, Reis, & Duberstein, 2015; Green, Richardson, Lago, & Schatten-Jones, 2001). Other theoretical accounts emphasize that the relevance of predictors for loneliness may vary across age because of shifts in normative expectations concerning social relationships (Luhmann & Hawkley, 2016). Following that reasoning, having a romantic partner and being married should be most important for loneliness in midlife, when living with a spouse/cohabitating partner is the most common. Empirical research on this issue provides conflicting results, with one study demonstrating that partnership status is indeed more relevant for loneliness in midlife than in old age (Luhmann & Hawkley, 2016), but another study reporting that the relevance of partnership status for loneliness increases with advancing age (Green et al., 2001). Similarly inconsistent findings emerged for age-differential predictors in other domains, with one study reporting that the relevance of physical health and disability for loneliness decreases with age (Victor & Yang, 2012), but another study finding no significant differences in the strength of the associations of the variables with loneliness (Luhmann & Hawkley, 2016).

Second, gender has been proposed to be an important moderator of associations between predictors and loneliness. For example, it has been suggested that deficits in social contacts may be associated with women's loneliness more than with men's loneliness, because women's socialization is focused more strongly on investing and maintaining social ties (Pinquart &

Sörensen, 2001b). However, empirical studies examining moderating effects of gender are scarce. We were not able to find any study that had tested gender differences in the strength of associations between predictor variables and loneliness using appropriate statistical techniques.

Finally, it has been repeatedly suggested that the way that loneliness is measured is important. One way to categorize assessments of loneliness is to distinguish between direct and indirect approaches (Shiovitz-Ezra & Ayalon, 2012; Victor, Grenade, & Boldy, 2005). A direct approach uses single items that ask directly about the frequency of feelings of loneliness, including the term “loneliness” or “lonely” in the assessment of the construct. Direct measures of loneliness have been shown to have good face validity and predictive utility (Nicolaisen & Thorsen, 2012). However, they have also been criticized because of their comparably low reliability and because people may not always admit being lonely because of the social stigma attached to loneliness (de Jong Gierveld, van Tilburg, & Dykstra, 2006). In contrast, indirect approaches assess loneliness using multiple-item scales that do not explicitly use the word “loneliness,” such as the UCLA Loneliness Scale (Russel, Peplau, & Cutrona, 1980) and the De Jong Gierveld Loneliness Scale (de Jong Gierveld & Kamphuls, 1985). Indirect measures are thought to reduce social desirability biases and the use of multiple items increases the reliability of such measures. However, some researchers have questioned whether indirect loneliness scales in fact capture the genuinely personal experience of loneliness (Jylhä & Saarenheimo, 2010).

Studies comparing direct and indirect measures of loneliness have indeed found that differences in loneliness by age and gender vary across measurement types. Beginning with age, Shiovitz-Ezra and Ayalon (2012) reported that cross-sectional levels of loneliness increased in a US sample from age 50 onwards when direct measures were used but not when indirect measures were used. In contrast, in Norway, Nicolaisen and Thorsen (2014b) found greater

cross-sectional increases from midlife to old age for indirect measures than for direct measures of loneliness. The conflicting findings may be caused by cultural differences, as it has been proposed that the social stigma to report loneliness is less pronounced in North America than in most European societies, because values such as individual achievements and competitiveness are more highly valued in North America (Rokach, Orzeck, Cripps, Lackovic-Grgin, & Penezic, 2001). Old people in Norway may, as a result, be more reluctant to report increased feelings of loneliness when asked directly about it, compared to old people in the US. Additionally, differences in how age groups were categorized in the two studies may have contributed to diverging findings. For example, whereas the oldest age group was defined as age 65 and above in the Norwegian study (Nicolaisen & Thorsen, 2014b), the US study categorized those 76 or older in the oldest age group (Shiovitz-Ezra & Ayalon, 2012). Studies using continuous measures of age are needed to further examine fine-grained differences in age trends in indirect versus direct measures of loneliness.

For gender, it has been proposed that men more than women underreport being lonely when direct measures of loneliness are used, because disclosing loneliness may be less socially acceptable for men than women (Borys & Perlman, 1985). In accordance with that notion, a meta-analysis found that women more frequently than men reported feelings of loneliness when loneliness was assessed directly, whereas substantially smaller or no gender differences were found when indirect measures were used (Pinquart & Sörensen, 2001a). However, a recent large-scale population-based study found higher loneliness scores among women than men consistently across the age range considered, even though indirect measures of loneliness were used (Luhmann & Hawkey, 2016). To clarify this issue, there is therefore a need for empirical studies comparing gender differences in loneliness using direct and indirect measures. Research

on how measurement type shapes associations between other individual difference factors and loneliness is scarce. The two studies examining the issue found that indicators of health and marital/cohabitation status were consistently associated with loneliness independent of measurement type (Nicolaisen & Thorsen, 2014b; Shiovitz-Ezra & Ayalon, 2012).

The Present Study

In this study, we investigate key questions about the nature and correlates of how loneliness manifests and develops in the second half of life. We aim to move the field forward by targeting loneliness in midlife and old age (rather than targeting old age only); by examining unique predictive effects of a broad set of potential predictors, including personality (rather than focusing on a limited set, which typically does not include personality variables); by using register data that reliably cover SES, physical health, and social variables (rather than using only self-reports); and by applying statistical models that provide fine-grained information about how loneliness develops with age (instead of categorizing respondents in rather coarse age groups). More specifically, we (a) examine mean levels of and change in loneliness from midlife to old age; (b) combine self-report and register data to consider the role of a myriad of individual difference factors, including socioeconomic (education, income, unemployment), physical health (sick leave, lifetime history of disability), social (children, contact with friends, spouse/cohabitating partner, lifetime history of divorce and widowhood), and personality factors; and (c) explore whether associations differ by age, gender, and how loneliness is measured. We expect that levels of loneliness are stable in midlife but increase in older ages. We expect that factors in the domains of SES, social relationships, health problems, and personality predict both level of and change in loneliness. Finally, we expect that the way that loneliness is assessed

shapes the size of age and gender differences in loneliness, and how other individual difference correlates are associated with loneliness.

Methods

The Norwegian Centre for Research Data, which is the Data Protection Official for Research for the University of Oslo, distributed the data and approved the use of the data for the present study.

Procedure and Participants

In this study we used data from the population-based Norwegian Life Course, Aging, and Generation (NorLAG; for a detailed account of data collection procedures, see Slagsvold et al., 2012). Data were collected in two waves by Statistics Norway in collaboration with Norwegian Social Research (NOVA). At the first wave (T1) in 2002, a representative sample of non-institutionalized adults aged 40 to 79, stratified by age and gender, was drawn from 30 municipalities in Norway representing different geographic regions. Respondents were initially contacted through telephone interviews and then followed up by using a postal questionnaire. Data from nationwide official registers were added after respondents gave informed consent. Of the 8,298 individuals who were asked to participate, 5,555 (67.0%) were interviewed, and 4,149 completed the questionnaire (74.6% of those who were interviewed; combined response rate 50.0%).

The second wave (T2) was conducted in 2007, when all those who had participated in T1 were asked to be interviewed by telephone again (aged 45 to 84 years at T2). Between T1 and T2, 265 persons had died, and another 25 had moved abroad, reducing the sample to be approached to 5,269 individuals. The same data collection methods as at T1 were used, and 3,774 persons participated in the telephone interviews (71.6% of those eligible to participate at

T2). Of these, 2,984 persons (79.1%) completed the T2 questionnaire. In this study, all persons who participated at least in the telephone interview at T1 were included ($N = 5,555$; $M_{\text{age}} = 57.9$ years; 51.4% women). Individuals from the original gross sample who could not be reached at T1 and did thus not participate in the first data collection were also asked to participate at T2. Data from 737 persons responding only at T2 were thus obtained and these data were used in follow-up analyses in this study.

As reported in prior publications (Slagsvold et al., 2012; von Soest, Wagner, Hansen, & Gerstorf, 2018), participation bias at T1 was small for gender, age, and place of residence; however, participation rates were somewhat higher among those with a higher education level compared to those with lower education levels. To examine sample attrition over the study period, we conducted two sets of analyses. First, we compared respondents at T1 who had completed the questionnaire after the telephone interview with those who participated only in the telephone interview. Respondents did not differ significantly in age ($p > .05$); however, participants who completed the questionnaire had more years of education compared to non-participants (Cohen's $d = 0.29$, $p < .001$), they reported slightly higher earnings ($d = 0.10$, $p < .01$) and slightly lower loneliness, when measured both directly ($d = -0.10$, $p < .001$) and indirectly ($d = -0.12$, $p < .001$), were more often women (52.5% versus 48.2%, $p < .01$), were less likely to have received a disability pension (14.6% versus 17.6%, $p < .01$), and were more likely to have a spouse/cohabitating partner (72.4% versus 64.5%, $p < .001$). Second, we examined if and how respondents who remained in the study at both data waves differed from those who did not respond at T2. Respondents who stayed in the study were younger ($d = -0.61$, $p < .001$), had more years of education ($d = 0.46$, $p < .001$), had higher earnings ($d = 0.23$, $p < .001$), reported slightly lower loneliness scores on both direct ($d = -0.07$, $p < .05$) and indirect

measures ($d = -0.12, p < .001$), and had more often a spouse/cohabitating partner (74.3% versus 63.2%, $p < .001$). Gender and a history of disability pension were not significantly related to sample attrition over time ($p > .05$). Conjointly, our analyses indicated selectivity effects of moderate size for age and education; group differences for other variables were of minor size.

Data from the NorLAG study have been used in a comprehensive number of publications covering a variety of research questions (see <https://blogg.hioa.no/norlag/scientific-articleschapters/?lang=en> for a list of all publications using NorLAG). Two previous publications using longitudinal data from NorLAG have focused on loneliness (Nicolaisen & Thorsen, 2012, 2014a). Predictors of loneliness from these studies do not overlap with variables used in the present study, except for basic demographics. Moreover, the two previous studies examined direct measures of loneliness only. A similar set of predictors as applied here has been used in the NorLAG study to examine individual differences in self-esteem across the second half of life (von Soest et al., 2018).

Measures

Loneliness. Loneliness was measured by means of telephone interviews in two distinct ways at both T1 and T2. First, a direct measure of loneliness asked participants to respond to the single question: “Do you feel lonely?” Response categories were 1 (*never*), 2 (*seldom*), 3 (*sometimes*), and 4 (*often*). Second, loneliness was measured indirectly with three items from the widely used De Jong Gierveld Loneliness Scale (de Jong Gierveld & Kamphuls, 1985): “I miss having a really close friend,” “I find my circle of friends and acquaintances too limited,” “There are many people I can trust completely.” Response options ranged from 1 (*agree strongly*) to 5 (*disagree strongly*), and mean scores were computed with higher scores indicating more feelings of loneliness. The 3-item scale correlated $r = .91$ with longer versions of the same instrument

(Hansen, Slagsvold, & Ingebretsen, 2013). Internal consistency was $\alpha = .64$ at both time points. In loneliness research, a common analytic strategy has been to dichotomize measures of loneliness to obtain prevalence estimates of individuals scoring above a certain threshold. Even though such an approach may provide valuable information about the prevalence of serious and problematic levels of loneliness, the practice of dichotomization has been heavily criticized from a methodological perspective, because among other reasons, dichotomization comes with costs such as loss of information, reduction of statistical power, and arbitrarily defined cutoffs (MacCallum, Zhang, Preacher, & Rucker, 2002; Royston, Altman, & Sauerbrei, 2006). We therefore based our analyses on mean levels of loneliness, using the whole range of the loneliness measure. However, we conducted follow-up analyses where the direct measure of loneliness was dichotomized into those who never or seldom experienced loneliness (1 or 2) versus those who experienced loneliness sometimes or often (3 or 4), to examine whether similar results were obtained by using a common methodological approach in loneliness research.

Self-reported correlates. Big Five personality traits were assessed at T1 by a short version of the 5-Personality Factors – adjective (5-PFa) instrument (Engvik, 1993), which was included in the questionnaire. The instrument contains adjective-anchored bipolar items (e.g., “friendly – unfriendly”; “extravert – introvert”), which are rated on 7-point scales. Each of the Big Five personality traits neuroticism, extraversion, conscientiousness, agreeableness, and openness were assessed with four items. The instrument was developed in Norwegian and has shown good validity and reliability (Engvik, 1993). For a less complex presentation of the results, the neuroticism subscale was reverse-coded, such that the subscale indicated emotional stability instead of neuroticism. In this study, internal consistency was $\alpha = .74$ for emotional stability, $\alpha = .58$ for extraversion, $\alpha = .71$ for conscientiousness, $\alpha = .69$ for agreeableness, and α

= .66 for openness. The moderate reliabilities reflect the heterogeneity of the items selected to measure relatively broad constructs and are comparable to other brief personality scales (Donnellan, Oswald, Baird, & Lucas, 2006; Lang, John, Lüdtke, Schupp, & Wagner, 2011; Mueller et al., 2016; Mueller, Wagner, Smith, Voelke, & Gerstorf, 2017).

Contact with friends was measured by asking participants in the telephone interview how often they had been together with friends the last 12 months, with response options ranging from 1 (*not at all*) to 5 (*daily*).

Register data correlates. Self-report data were linked with three sets of data from nationwide official registries, as provided by Statistics Norway. First, as indicators of SES, education was divided into five categories, ranging from 1 (*completed junior high school or lower*) to 5 (*completed higher university degree*). Respondents' income in the year of T1 (i.e., 2002) was also assessed by register data (in Norwegian kroner per year). We also assessed whether respondents were unemployed in the year they participated at T1. Persons who already had been retired at T1 were scored 0, because unemployment is not applicable to retired individuals (0 is the mean score, as all dichotomous variables were mean centered; see the Statistical Analysis section for further details).

Second, as indicators of health problems, we obtained register data on receipt of disability pension annually from 1991 and thereafter (yes/no). Moreover, we assessed by register data whether the respondent was on sick leave the year of T1 for two weeks or more at a stretch (yes/no). As for unemployment, persons who already had been retired at T1 were scored 0 on the sick leave variable.

Third, relationship and family variables were also assessed with register data. We used the information on (a) whether the respondents had a spouse/cohabitating partner at the time of

T1 (yes/no); (b) whether they had children or not (yes/no), and whether the respondents at any time after 1974 had been (c) divorced (yes/no) or (d) widowed (yes/no). Data on divorce and widowhood history were only available for respondents who participated in the study at T2.

Additionally, age and gender were assessed.

Statistical Analyses

We conducted our analyses in a structural equation modeling framework, using Mplus 7.3 (Muthén & Muthén, 2012). Missing data were accommodated using full information maximum likelihood under the usual missing at random (MAR) assumptions underlying longitudinal designs (Little & Rubin, 1987; Preacher, Wichman, MacCallum, & Briggs, 2008; Schafer & Graham, 2002). We note that several of the variables included in our models (e.g., age, gender, education, income) predicted attrition and that our missing data handling by using full information maximum likelihood helped to accommodate for such longitudinal selectivity under MAR assumptions (McArdle, 1994).

Analyses were carried out in three steps. First, because measurement invariance is an important requirement for longitudinal analyses, we constructed latent loneliness measurement models for the indirect measure of loneliness and tested for measurement invariance. For the direct measure of loneliness, no such tests were conducted because the construct was assessed with one item only. Second, to estimate individual change in loneliness from T1 to T2, we constructed latent change score models (McArdle, 2009). Third, to examine potential sources of loneliness, we regressed initial level of and change in loneliness, as measured by change score models, on potential predictors of loneliness.

Measurement invariance. We conducted confirmatory factor analyses to test whether the indirect loneliness measure shows measurement invariance across time. Following Widaman,

Ferrer, and Conger (2010), we first tested for configural invariance by constructing latent factors based on the three items for each wave, and factors were modeled to correlate across time points. Error variances from identical items at different time points were allowed to correlate. Model fit was evaluated by inspecting χ^2 statistics, the Bayesian information criterion (BIC), the comparative fit index (CFI), the Tucker-Lewis index (TLI), and the root mean square error of approximation (RMSEA). Following good practice, CFI and TLI values of .95 or greater and RMSEA values of .06 or lower were considered as indicating good fit (Hu & Bentler, 1999). For a graphical representation of the model, see Figure 1A. The fit for this model was adequate (see Table 1). Next, we tested for weak invariance by comparing the basic configural invariant model with a model in which factor loadings were forced to be equal across time points. χ^2 -difference tests showed no statistically significant difference in fit between the configural invariant model and the weak invariant model (Δ Satorra-Bentler Scaled $\chi^2[2] = 4.58; p = .10$); further, other fit indices showed equal or even better fit for the weak invariant model. Strong invariance was tested by additionally constraining the intercepts of the items to be equal across time. In these analyses, significantly worsened model fit was obtained when comparing the weak invariant model with the strong invariant model (Δ Satorra-Bentler Scaled $\chi^2[3] = 121.88; p < .001$). Likewise, other fit indices such as BIC, TLI, CFI, and RMSEA showed somewhat reduced model fit, even though model fit still was good following usual conventions (Hu & Bentler, 1999). Further investigations showed that the reduced fit was particularly due to constraining the intercepts of the item “There are many people I can trust completely” to be equal across time. We therefore modeled a partial strong invariant model where the invariance constraint for the intercept of this particular item was relaxed, with a resulting improvement in fit (see Table 1, last row). Even though the partially strong invariant model still showed significantly reduced fit

compared to the weak invariant model (Δ Satorra-Bentler Scaled $\chi^2[2] = 10.61; p < .01$), the model showed similar or even better fit on other model fit indices, thereby supporting partial strong time invariance. To accommodate for partial misfit, we followed Widaman et al.'s (2010) recommendation to use a full strong invariance model and compare that model with a partial strong model in all further analyses. Because both types of models exhibited literally the same patterns of significance and the same magnitudes of point estimates, the issue of full versus partial invariance was not of crucial importance in this study; in the following, we report only results from the full strong invariant model.

Latent change score models. Next, we constructed latent change score models based on loneliness measures at T1 and T2. For the direct measure of loneliness, change score models were based on the manifest loneliness item. For indirect measures, models were based on latent loneliness factors at T1 and T2 with strong invariance. The first latent factor for the indirect loneliness measure was scaled following Ferrer, Baluerka, and Widaman's (2008) suggestion to establish an approximate standard metric, such that the variance of the latent loneliness factor at T1 was set to 1, and the mean of the factor was set to 0. Initial values of and change in loneliness can thus be interpreted in terms of a standardized metric with a mean of 0 and a standard deviation of 1 relative to loneliness at T1. To facilitate comparison of direct and indirect measures of loneliness, we recoded the direct measure of loneliness in a similar manner, by recoding loneliness scores to a mean of 0 and a standard deviation of 1 relative to loneliness at T1. As proposed by McArdle (2009) and Selig and Preacher (2009), the latent change score in the models was controlled for the initial level of loneliness, thereby providing an estimate of change that was not confounded by initial mean-level differences in loneliness and in this way ensured that associations between potential predictors of change in loneliness were not an artifact

of a correlation between initial value and change in loneliness (see von Soest & Hagtvet, 2011, for a detailed discussion of this issue).

Predictors of loneliness. Next, level of and change in loneliness were regressed on predictors. In a first model, only gender, age, and polynomials of age were included as predictors so as to examine age trends and gender-specific trends in loneliness. For our analyses, age was divided by 10, so as to express the rate of change by decade, and centered at age 60, near the average age of the sample. In a final step, we examined potential sources of loneliness by including all potential predictor variables simultaneously as predictors of initial level of and change in loneliness, together with age, its polynomials, and gender. All continuous predictor variables except age were mean centered, whereas all dichotomous variables were effect coded. We used a weighted effect coding scheme, such that the effect indicators were mean centered (see Cohen, Cohen, West, & Aiken, 2003). For the variables unemployment and sick leave, persons who already had been retired at T1 were scored 0 (the mean score). As a consequence, parameter estimates refer to age 60 and indicate sample averages (across all individuals).

We also tested for interaction effects of potential predictor variables with gender and age by including interaction terms as predictors of initial level and change. In general, $p < .05$ was chosen as the level of significance. However, for interaction analyses, we used a more conservative significance level of $p < .01$ to avoid statistically significant results by chance because interaction effects with 15 different predictor variables were tested.

Results

Table 2 presents descriptive statistics and intercorrelations of all variables included in the study. Mean levels of around 2 on both indirect and direct measures of loneliness at both time points indicated that participants on average reported being seldom lonely (direct measure) and

rather not lonely (indirect measure). The correlations of indirect with direct measures of loneliness of $r = .47$ and $r = .49$ at T1 and T2, respectively, indicated that the two modes of assessment were substantially related, but most of the variance was not shared. This suggested that direct and indirect measures of loneliness tap into slightly different areas of the larger construct space. Moreover, the correlation of $r = .53$ for the indirect measure and $r = .50$ for the direct measures of loneliness between T1 and T2 indicated considerable stability of loneliness across 5 years between the two data collection waves. Correlations between loneliness and register data were generally small, with the exception of marriage/cohabitation for which married or cohabitating participants reported less loneliness than those with no spouse or cohabitating partner. Self-reported contact with friends was significantly related to all loneliness measures, but associations were substantially higher for indirect than for direct measures of loneliness. For personality, the highest correlations were observed for loneliness with emotional stability and extraversion, indicating that being more emotionally stable and more extraverted were each associated with reporting being less lonely.

Development of Loneliness Across the Second Half of Life

Next, two latent change score models were estimated, based on direct and indirect measures of loneliness, respectively. Figure 1B depicts the model for the indirect measure of loneliness, and model fit was adequate ($\chi^2[7] = 124.78$; CFI = .97, TLI = .95, RMSEA = .048). Model fit for the direct measure of loneliness was not an issue, because the model was just identified, yielding as such a perfect fit. As defined by the models, the mean level of loneliness was 0, with a standard deviation (*SD*) of 1 for both direct and indirect measures. The mean change in loneliness was estimated to be -0.25 *SD* units ($p < .001$; $SD = 0.86$, $p < .001$) and –

0.06 *SD* units ($p < .01$; $SD = 0.71$, $p < .001$), for the direct and indirect measure of loneliness, respectively.

Next, we included age and gender as predictors of initial level of loneliness and change in loneliness from T1 to T2 in the models. Quadratic and cubic terms for age were included as well as predictors to examine non-linear age trends (see Figure 1C). Table 3 shows the results of these analyses for direct and indirect measures of loneliness. Concerning the direct loneliness measure, age, age³, and gender significantly predicted the initial level of loneliness. Additionally, a significant age \times gender interaction effect emerged. Interactions of gender with higher polynomials of age were not significant and thus not included in the final model. Figure 2, Panel A, shows the results, where black lines represent level of loneliness across age. The figure shows that men and women had comparable levels of loneliness at age 40. With age, however, women's loneliness level increased steadily especially in older ages, whereas men showed a U-shaped age trend, with decreasing loneliness until about age 70 and an increase thereafter. Age and gender significantly predicted changes in the direct measure of loneliness and estimates of change in loneliness from T1 to T2 are represented by gray lines in Figure 2, Panel A (for ease of presentation, estimated change is only presented in 5-year intervals). The figure shows an overall decrease in loneliness across the 5-year time span from T1 to T2; however, the decrease abated with increasing age. Moreover, at all ages the rate of decline in loneliness from the first to the second time point was steeper in men than in women. In follow-up analyses, we used a dichotomized direct measure of loneliness. The analyses revealed similar results, thereby indicating that estimates of age trends and gender differences in loneliness were not affected by whether dichotomous measures of loneliness were used or not.

For the indirect loneliness measure, age, age², and an age × gender interaction were found to predict levels of loneliness. As Figure 2, Panel B, shows, age trends for the indirect measure were similar to those for the direct measure of loneliness, with cross-sectional age-related increases in levels of loneliness for women and slightly U-shaped age trends for men. However, compared to direct measures of loneliness, men reported higher average loneliness scores, so that no significant gender differences in the overall level of loneliness were found. Moreover, as for the direct loneliness measure, age was significantly related to changes in loneliness. More specifically, loneliness decreased among the youngest participants in our sample (aged 40 years) between T1 and T2; however, the decrease abated with increasing age, and rates of change at age 60 were not statistically significant. From about age 60 and older, loneliness gradually increased from T1 to T2 (see gray lines in Figure 2, Panel B). In contrast to the direct measure of loneliness, no significant gender differences in changes in loneliness were found for the indirect measure.

We note an apparent difference between the trajectories reported in Figures 2A and 2B. In Figure 2A, longitudinal within-person decreases in the direct measure of loneliness were considerably larger in size than corresponding between-person age differences. In Figure 2B in contrast, estimates of within-person change and between-person age differences in the indirect measure of loneliness corresponded more closely. One possible explanation for the divergence may be that direct loneliness measures are more vulnerable to instrumentation effects than indirect measures. More specifically, the direct measure of loneliness may be influenced to a greater degree than indirect measures by repeated measurement of loneliness or repeated participation in the NorLAG study in general. To provide indications of such potential instrumentation effects, we conducted follow-up analyses to examine whether loneliness at T2

differed between those who had also participated at T1 ($N = 3,774$) and those who had not participated at T1 ($N = 737$). Results of these follow-up analyses were indeed consistent with a possible instrumentation effect interpretation. More specifically, significant differences were found for the direct loneliness measure, with lower loneliness scores for those who had participated at both T1 and T2 ($M = 1.81$) than for those who had participated at T2 only ($M = 1.90$; $t = 2.18$, $p = .03$), even when controlling for potential gender and age differences among groups. In contrast, results revealed no significant difference on the indirect measure of loneliness for the two groups (persons participating at both T1 and T2: $M = 1.95$, persons participating at T2 only: $M = 1.97$; $t = 0.03$, $p = .98$).

Predictors of Loneliness

Next, we included all predictor variables together with gender, age, and polynomials of age simultaneously into our models (see Table 4). To begin with register data, analyses revealed that having a disability, not having a spouse/cohabitating partner, and having experienced widowhood were each associated with reporting higher levels of loneliness on both the direct and the indirect measure. Moreover, people in high-income categories experienced steeper declines in loneliness over time for both measures. Findings specific to a particular type of assessment were also obtained in that people with higher education levels reported more loneliness on the direct measure, and people who had a history of divorce or who did not have a spouse/cohabitating partner experienced steeper increases in loneliness on the direct measure. With the indirect measure, being unemployed and having a history of divorce were associated with reporting more loneliness. Because previous studies indicated that indicators of physical health prospectively predicted loneliness (Cohen-Mansfield et al., 2009; Luo, Hawkey, Waite, & Cacioppo, 2012), we conducted follow-up analyses to examine whether disability or sick leave

were related to change in loneliness when not controlling for the remaining covariates. The results indeed revealed significant associations between disability and change for both the direct ($\beta = 0.04, p = .02$) and indirect ($\beta = 0.05, p = .04$) measure of loneliness, whereas no associations were found for sick leave ($p > .05$). Further examinations showed that both for indirect and direct measures of loneliness, the inclusion of neuroticism as covariate was the primary driver of reducing the association between disability and change in loneliness into non-significance when covariates were included. Income was also important for the reduced association of the direct measure of loneliness.

For the self-report measures, a high frequency of contact with friends was associated with reporting lower levels of loneliness on both types of measures and related to steeper declines in loneliness over time on the indirect measure. For personality, we found that people high in emotional stability reported fewer feelings of loneliness at age 60 and experienced steeper loneliness declines over time, when measured both directly and indirectly. Similarly, being high in extraversion was associated with lower levels of loneliness on both types of measures and with steeper declines on the direct measure. People high in conscientiousness reported lower levels of loneliness on the direct measure.

We also tested for interactions of all potential predictor variables with gender and age in predicting level of or change in loneliness. Only one statistically significant interaction effect was identified: Gender and having a spouse/cohabitating partner interacted in predicting change in loneliness when using the indirect measure. The interaction effect indicated that loneliness decreased less or even increased among women with no spouse/cohabitating partner compared to women with a partner. No such differences were found for men. A possible explanation of the interaction effect could be that a higher proportion of men than women without a spouse or

cohabitating partner at baseline re-partnered during the five year follow-up period. Such gender differences could, in turn, lead to gender differences in the development of loneliness. Follow up-analyses showed that men without a spouse/cohabitating partner, in fact, were more prone to establish a new live-in relationship or to marry than women (14.2% of men versus 9.1% of women); however, such differences could not explain the interaction effect as the interaction term remained almost unchanged when including partnership status at T2 as predictor in the analyses ($\beta = .07, p < .01$)

Finally, we examined how the reported age trends and gender differences in level of and change in loneliness changed when including all covariates in the model. Figure 3 (Panel A) shows that the shape of age trends with the direct loneliness measure virtually did not change for men whereas women's estimated scores became similar to men's. As a result, gender and the gender \times age interaction term ceased to be significantly related to loneliness (see Table 4). Also for the indirect measure of loneliness, women's estimated age trends in the level of loneliness changed to a larger degree than men's, indicating as such that the increasing level of loneliness with increasing age among women can be explained primarily by covariates (see Figure 3, Panel B). Interestingly, the estimated level of the indirect measure of loneliness was significantly higher for men than women after adjusting for covariates. Including covariates in the model did not lead to substantial change in the shape of age trends for changes in loneliness (see gray lines in Figure 3).

Discussion

Combining self-reports and register data from the two-wave population-based NorLAG study in Norway, this study provided three main findings about loneliness in the second half of life. First, the results showed substantial gender differences in age trends in loneliness, with

steadily increasing loneliness from age 40 to 80 for women, whereas men's level of loneliness followed a U-shaped curve, with highest loneliness levels at age 40 and 80 and lower levels in between. Second, indirect and direct measures of loneliness provided similar results for age trends and predictors of loneliness; however, gender differences in loneliness varied according to assessment. More specifically, men reported feeling less lonely than women when using direct measures, whereas we found no overall gender differences on indirect measures. When adjusting for a variety of covariates, gender differences still varied according to how loneliness was assessed. Assessment mode also influenced longitudinal changes in loneliness, as direct measures showed greater decreases in loneliness during the study span of five years than indirect measures. Third, a multitude of factors such as indicators of SES, physical health, social relationships, and personality traits, uniquely predicted higher levels of and changes in loneliness. The results thus show the importance of examining the unique contribution of a variety of factors—including broad personality traits—as predictors of the development of loneliness in the second half of life.

Development of Loneliness Across the Second Half of Life

In agreement with most other studies on age differences in loneliness (e.g., Gerstorf et al., 2013; Luhmann & Hawkey, 2016), our report shows increasing levels of loneliness among older adults, particularly among those aged 75 and older. This holds for both men and women and both indirect and direct assessments of loneliness. Our study thus supports the findings from other empirical research suggesting that levels of loneliness are higher in old age. New in our study is the emphasis on potential gender differences in loneliness age trends, with consistent increases in women's loneliness with higher age, whereas men's loneliness mean scores were distributed in a U-shaped fashion across age. Even though some studies examined the age distributions of

loneliness for women and men separately (e.g., Demakakos et al., 2006; Victor & Yang, 2012), research explicitly testing for gender differences in age trends of loneliness is sparse. An exception is Luhmann and Hawkley's (2016) large-scale population-based study, which found mixed findings in that some analyses showed significant gender differences, whereas others did not. The present study is thus one of the first to provide indications of age trends that are contingent on gender.

Mode of assessment (i.e., direct versus indirect measures) seemed to be of rather minor importance for the shape of the age patterns in loneliness. Although age trends were most appropriately modeled by a cubic function for the direct measure of loneliness and by a quadratic function for the indirect measure, the resulting trajectories were similar for direct and indirect measures. Direct and indirect measures thus provide congruent information about age-related trends in loneliness. In contrast, mode of assessment seemed to make a difference for estimates of change in loneliness: When measuring loneliness indirectly, loneliness decreased between the two data waves for those in their early 40s. However, the decrease abated gradually with increasing age, with no mean change in loneliness observed at age late 50s and early 60s, whereas loneliness increased steadily for those being older. These changes corresponded well with age trends in the level of loneliness. In contrast, when loneliness was measured directly, loneliness decreased over 5 years at all ages, even though the decreases abated with increasing age. Moreover, estimates of change in the direct measure did not converge with age trends in levels of the direct measure of loneliness because longitudinal decreases were considerably larger in size than corresponding age trends in the level of loneliness. Post-hoc analyses provided some indication of a specific instrumentation effect for the direct loneliness measure because individuals who were asked about their loneliness the second time reported lower loneliness

scores on the direct measure than those who were asked the first time. In contrast, no such effect was found for the indirect measure of loneliness. The notion of instrumentation or testing effect is well-known in the methodological literature and says that negatively toned self-reports, and particularly self-reports on negative mental states, are substantially reduced when measured repeatedly (Baird, Lucas, & Donnellan, 2010). One potential explanation for these instrumentation effects may be that participants realize at T1 that they have been assessed for socially undesirable conditions, and that they attempt to present themselves more favorably in later assessments (Sharpe & Gilbert, 1998; Shrout et al., 2018). These effects may be particularly potent for direct measures of loneliness because these measures are thought to be particularly prone to social desirability biases due to the negative connotations associated with the term loneliness (de Jong Gierveld et al., 2006). In contrast, instrumentation effects may be weaker for indirect measures because affirmative responses to such measures may not to the same degree be perceived as socially undesirable. However, it may also be possible that differences between first-time responders and second-time responders are due to initial differences in loneliness between those who could not be reached at T1 and those who participated.

Likewise, gender differences in loneliness seemed to be influenced by mode of assessment: Analyses examining levels of loneliness without controlling for covariates showed women to report more loneliness than men when loneliness was measured directly, whereas no overall gender differences were found on indirect measures. The results seem to be in line with notions according to which loneliness is less socially accepted among men (Borys & Perlman, 1985), thereby leading men to be more reluctant to disclose that they are feeling lonely when asked directly about it. However, gender differences in direct measures of loneliness vanished when controlling for covariates. The results indicate that gender differences in direct measures of

loneliness may not only be a result of a gendered response bias, but at least in part due to gender differences in psychosocial factors and socio-demographic conditions. More specifically, in our study, as in the population in general, women more frequently were widowed, had no spouse/cohabitating partner, and they reported higher levels of neuroticism—factors that all were associated with higher levels of loneliness. Female disadvantages in several psychosocial and socio-demographic areas, leading to more frequent reports of loneliness among women, may thus be important sources of gender differences in direct measures of loneliness. Interestingly, for the indirect measure of loneliness, gender differences only emerged when controlling for covariates, with men reporting to feel more lonely than women. Thus, for the indirect measure of loneliness, the inclusion of covariates yielded not only reduced levels of female loneliness, but even resulted in significantly lower loneliness estimates among women than men. This suggests that if men and women were to not differ on socioeconomic, physical health, and social factors, men would indirectly admit feeling more lonely than women. In reality, however, gender differences in these factors exist and overshadow these gender differences in indirect measures of loneliness.

In conclusion, our study indicates gender differences in loneliness to be highly dependent on both assessment mode (with direct measures resulting in higher loneliness scores for women, relative to indirect measures) and whether one takes into account demographic and psychosocial differences between men and women (with adjustments for such differences resulting in higher loneliness scores for men, relative to no adjustments). Moreover, our study supports the notion that assessment mode is crucial for estimates of change in loneliness, whereas assessment mode seems to have only modest effects on the overall shape of the loneliness distribution across age.

Predictors of Loneliness

Socioeconomic status. Our study included a comprehensive set of potential predictors of loneliness in the areas of SES, physical health, social factors, and personality. For SES, high income predicted a reduction in loneliness between the two data collection waves for both the direct and indirect measure. Moreover, unemployment was related to higher levels of indirect loneliness measures. These results are in accordance with findings from reviews showing associations between loneliness and income and indicators of labor market inclusion (Cohen-Mansfield et al., 2016; Pinquart & Sörensen, 2001b). Sufficient financial resources may increase people's opportunities to participate in social activities and may increase mobility, particularly among older people, thereby reducing the risk of feeling lonely (Pinquart & Sörensen, 2001b). Surprisingly, our study showed high education level to be related to increased levels of direct measures of loneliness when controlling for all other potential predictors. Similar findings were obtained in a recent study showing that people with higher education levels reported more loneliness after but not before controlling for relevant covariates (Luhmann & Hawkey, 2016). Even though high education level is related to a variety of positive life outcomes—such as higher income and lower risk of labor market marginalization—high education level in itself may not necessarily protect against loneliness. On the contrary, highly educated persons may acknowledge their own situation and feelings to a greater extent, including negative ones such as loneliness and they may be more likely to communicate to others how they are feeling.

Physical health. In line with recent reviews providing evidence for cross-sectional associations between poor physical health and loneliness (Cohen-Mansfield et al., 2016; Ong et al., 2016), our study found that a history of receiving a disability pension was related to higher levels of loneliness, even when controlling for a large range of potential covariates. Recent sick leaves were not related to either the level of or change in loneliness. One interpretation of the

divergence is that short-term variations in physical health (proxied here by recent histories of sick leave) are not associated with loneliness, whereas far-reaching, long-term health conditions (proxied here by receiving disability pensions) in fact show associations with loneliness levels. Earlier studies have explained associations between poor physical health and loneliness primarily as the adverse effects of loneliness on health (e.g., Cacioppo et al., 2015; Ong et al., 2016), whereas reverse temporal directions have been studied less frequently. We examined reverse directionality in our study but did not find indications of any, because none of the measures of physical health examined were found to show significant predictive effects for changes in loneliness. Our findings are in contrast with one longitudinal study showing that self-rated health and functional limitations were both prospectively related to changes in loneliness over 6 years, a time frame that is similar to the time frame used in our study (Luo et al., 2012). Possibly, our measure of receiving disability pension may represent a chronic state that has been accommodated by the individual and would therefore not be expected to be related to subsequent changes in loneliness. It is also possible that parts of the effects seen in earlier studies were driven by some of the variables that we have controlled for in our comprehensive approach to take a variety of individual characteristics into account. Indeed, follow-up analyses indicated that disability was associated with less favorable changes in loneliness when other covariates were excluded from the model, with neuroticism as a primary source for a reduced association. This result underscores the importance of including personality variables in research on sources of loneliness.

Social relationships. In accordance with the notion that a lack of social ties—and particularly a lack of close social relationships—is one of the main sources of loneliness (Peplau & Perlman, 1982; Pinqart, 2003), this study provides support that close relationships are related

to both level of and change in loneliness. More specifically, having a spouse/cohabitating partner and more frequent contact with friends were both associated with lower levels of loneliness and decreases in loneliness across the two measurement points. Close social relationships are thus not only related to concurrent levels of loneliness but also may be an important asset and may provide encouragement to maintain one's social connections and thereby reduce feelings of loneliness. Interestingly, a history of widowhood or divorce (for the indirect measure only) was related to higher levels of loneliness even when accounting for other relationship factors such as current partnership status, thereby indicating that loss of a partner may have long-lasting effects even when widowed and divorced persons have found a new partner. These negative effects may possibly be driven by changes in one's social relationships after a loss of a partner because a meta-analysis found that loss of a spouse was related to impaired personal and family networks (Wrzus et al., 2013). The losses in social networks, and particularly when this applies to family members and one's own children, may persist even when a person remarries and may thus lead to increased feelings of loneliness.

Personality. Little research has been available on personality antecedents of loneliness. To our knowledge, this study is the first to examine links between Big Five personality traits and loneliness in a large-scale longitudinal study of adults in midlife and old age. Higher levels of both extraversion and emotional stability were associated with feeling less lonely and experiencing more favorable changes in loneliness (less pronounced increases, stronger decrease). High levels of extraversion may constitute a buffer to feelings of loneliness because extraverted people both tend to obtain higher social status and tend to have a more positive outlook on life. On the other side, low levels of emotional stability may be detrimental for satisfaction in close social relationships and are generally related to negative emotionality

(Larsen & Ketelaar, 1991), which in turn may increase feelings of loneliness. Our study adds to the existing literature by showing that links between personality and loneliness are not only found among adolescents (Asendorpf & van Aken, 2003; Vanhalst et al., 2012), young adults (Cacioppo et al., 2006; Stokes, 1985), or the oldest-old (Hensley et al., 2012; Long & Martin, 2000), but also among middle-aged and old adults. Moreover, in line with the only previous longitudinal study on personality predictors of loneliness (Mund & Neyer, 2016), the present study supports the importance of emotional stability as a source of individual changes in loneliness. Our study is the first to demonstrate that extraversion also promotes changes towards experiencing less loneliness.

Age, Gender, and Measurement of Loneliness as Moderators

A third aim of this study was to examine whether the relevance of predictors was moderated by age, gender, and mode of assessment of loneliness. For age, no significant interactions with the predictors were found. These findings are somewhat in contrast to the expectations that we had formulated based on socioemotional selectivity theory (Carstensen et al., 1999) and theoretical accounts emphasizing the importance of normative expectations about social relationships for feelings of loneliness (Luhmann & Hawkey, 2016). Possibly, forces from both perspectives are important but shape the age-differential relevance of predictors for loneliness in opposite directions. For example, applying socioemotional selectivity theory (Carstensen et al., 1999), emotionally rewarding social experiences, as provided through close friendships and intimate relationships, would become increasingly important for loneliness with increasing age, as the theory predicts the quality of network relationships to gain in importance with increasing age. In contrast, theoretical accounts emphasizing normative expectations predict close friendships and intimate relationships to become less relevant for loneliness from midlife

into old age (Luhmann & Hawkley, 2016). Opposing effects of these forces may conjointly nullify possible underlying age differences in the relevance of predictors.

For gender, only one significant interaction with the predictors examined was found, indicating that gender moderates the association between marital/cohabitation status and change in the indirect measure of loneliness. More specifically, partner status did not predict changes in loneliness for men, whereas among women without a partner loneliness decreased less (or even increased) over time than among women with a partner. This result is somewhat surprising because other studies found that risks of loneliness were much higher for non-married men than for non-married women, whereas no differences were found for married persons (Pinquart, 2003). Future research needs to examine whether partnership variables predict longitudinal patterns in loneliness also in other data sets and how such patterns may be explained.

Patterns of predictors were rather similar when comparing indirect and direct measures of loneliness. Even though there were some differences concerning SES as a predictor, both modes of assessment showed rather consistent associations of disability, social factors, and personality with loneliness. Mode of assessment may thus be of minor importance when examining the association between most predictors and loneliness. However, as previously discussed, it is worth noting that mode of assessment seems to be of crucial importance when examining gender differences and longitudinal changes in loneliness.

Strengths and Limitations

By using long-term longitudinal register and self-report data from a large and representative national sample, this study provides unique insights into age trends in loneliness in midlife and old age and on predictors of indirect and direct measures of loneliness. However, the results have to be interpreted in light of several limitations. Beginning with limitations of our

measures, our strategy of treating loneliness measures as continuous variables was guided by recommendations in the methodological literature, clearly advising against dichotomization (MacCallum et al., 2002; Royston et al., 2006). However, by focusing on mean levels of loneliness instead of prevalence rates of loneliness above a certain cut-off, the present study highlights only to a limited degree serious and problematic levels of loneliness, age variations, and risks thereof. However, the fact that similar results were obtained when dichotomizing the direct loneliness measure shows that our findings are robust. Moreover, although the items assessing loneliness indirectly were taken from one of the most frequently used measures of loneliness, the internal consistency of the three items was somewhat low. Even though comparable short measures of loneliness have been used extensively (Hughes, Waite, Hawkey, & Cacioppo, 2004; Luhmann & Hawkey, 2016) and the short measure used in this study correlates highly with longer versions of the De Jong Gierveld Loneliness Scale (Hansen et al., 2013), a more comprehensive scale with higher internal reliability would have been preferable.

We also note that model fit was significantly reduced when imposing strong measurement invariance across time on the indirect loneliness measure, thereby indicating slight inconsistencies in how participants responded to the instrument at the two time points. However, model fit still remained good, and patterns of results did not change when models imposing strong measurement invariance were compared with those partly relaxing the assumptions. Strong measurement invariance was thus not a critical issue for interpretation of the results. Also, we measured Big Five personality traits with an instrument that has been used in Norway only, and the measure of extraversion had low internal consistency. Even though the scale has been shown to have good validity (Engvik, 1993) and reliability for most personality traits is comparable to other Big Five scales with a similar number of items (Donnellan et al., 2006), a

more widely used instrument assessing the Big Five personality traits would have been an advantage by allowing comparison of the findings directly with reports from other studies.

As a major limitation of our study design, we acknowledge the lack of more than two available waves of data. As a result, it was not possible to examine complex longitudinal change patterns in loneliness. Indeed, results from this study have to be corroborated by large-scale longitudinal studies across the lifespan including several data waves. We consider longitudinal designs capable of disentangling cohort and longitudinal effects—such as large-scale cohort sequential designs—as particularly promising in moving the field of loneliness further. This notion is in accordance with a recent review stating that large-scale longitudinal studies covering the whole lifespan as they have been conducted in other fields—such as personality and self-esteem—are still lacking in the field of loneliness (Mund et al., 2017). As another major limitation of our study design, most predictors of loneliness were assessed at the first time point only. Longitudinal analyses were thus limited to examining how predictors at the first time point were associated with change in loneliness, whereas it was not possible to examine how changes in predictors were related to changes in loneliness. For example, because the personality measures used at T1 were not included at T2, it was not possible to examine how changes in personality were related to changes in loneliness, even though such analyses would provide valuable information about the longitudinal associations with loneliness. Moreover, we note that the size and strength of associations found for the socioeconomic, physical health, social relationship, and personality factors reported here may be specific to the 5-year time interval. It is quite possible that the relevance of these variables is different or that other factors may emerge to be important when associations are considered over shorter time intervals, such as fluctuations from one situation to the next or one day to the next (Gerstorf, Hoppmann, & Ram, 2014). For

example, although in our study sick leaves were not related to changes in loneliness over a long time span of 5 years, it is quite possible that shorter-term sick leaves may predict temporary increases in loneliness. Further, the NorLAG study did not recruit a refreshment sample at T2 that was drawn in the same manner as the original sample at T1. We had thus to rely on non-responders at T1 who were interviewed at T2 to examine potential instrumentation effects, thereby opening up the possibility of alternative explanations other than instrumentation effects because non-responders at T1 may have differed in loneliness from those who participated.

Finally, as limitations of the sample, we acknowledge that our results may not generalize to less positively select segments of the population because no institutionalized older adults were included in our sample and persons with low educational level were underrepresented. Moreover, the nature and correlates of loneliness may have been shaped by the specific culture and historical time monitored. For example, empirical reports comparing levels of loneliness in several European countries show that persons living in Northern European countries (including Norway) report lower levels of loneliness than those in Southern and particularly Eastern Europe (Hansen & Slagsvold, 2016; Yang & Victor, 2011). Possibly, the shape of age trends and the relevance of predictors may also vary with the economic and cultural background. Our results therefore have to be replicated in other countries.

Conclusion

This study provides novel information on the nature and predictors of how loneliness develops in the second half of life. The findings indicate that using indirect and direct measures of loneliness provides similar results for age trends and predictors of loneliness, but the results differ strongly for changes in loneliness and gender differences. It is thus particularly important to consider mode of assessment when examining longitudinal change and gender differences in

loneliness. Our report is one of the first studies that demonstrates the importance of broad personality traits for the development of loneliness in the second half of life. Our study shows that emotional stability and extraversion are not only cross-sectionally related to levels of loneliness but also predict subsequent change in loneliness. Our study also provides support for the notion that social factors and physical health are important for loneliness even when accounting for personality and other relevant covariates. The results thus indicate that sources of loneliness are multifaceted and comprise SES factors, physical health, social relationships, and personality traits. Future research efforts need to corroborate and replicate our initial findings using well-characterized study samples representing other, preferably more heterogeneous and less well-functioning population segments.

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Table 1

Fit Indices for Measurement Models of Indirect Loneliness Measure with Increasing Degree of Invariance Across Time

	χ^2	<i>df</i>	BIC	CFI	TLI	RMSEA	90% CI RMSEA
Configural invariance	22.93	5	86550.29	1.00	.99	.025	.015 – .036
Weak invariance	27.60	7	86538.61	1.00	.99	.023	.014 – .032
Strong invariance	135.39	10	86637.77	.97	.95	.048	.041 – .055
Partial strong invariance*	37.80	9	86532.08	.99	.99	.024	.016 – .032

Note. $N = 5,555$. *df* = degrees of freedom; BIC = Bayesian information criterion; CFI = Comparative Fit Index; TLI = Tucker-Lewis Index; RMSEA = root mean square error of approximation. 90% CI RMSEA = 90% confidence interval of RMSEA.

*Intercept for item “There are many people I can trust completely” was not constraint to be equal across time points, whereas the intercepts for the two other items were set time invariant.

Table 2

Descriptive Statistics and Correlations Among Key Study Variables

Parameter	<i>M</i>	<i>SD</i>	<i>N</i>	Intercorrelations																			
				(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
Loneliness																							
(1) Direct loneliness measure T1 (1–4)	2.04	0.89	5,532																				
(2) Direct loneliness measure T2 (1–4)	1.81	0.85	3,752	.50																			
(3) Indirect loneliness measure T1* (1–5)	2.04	1.01	5,534	.47	.35																		
(4) Indirect loneliness measure T2* (1–5)	1.95	0.92	3,748	.35	.49	.53																	
Socio-demographics																							
(5) Age (40–80)	57.91	11.11	5,555	-.02	.06	-.04	-.03																
(6) % women	51.4		5,555	.08	.14	-.03	-.02	-.01															
Register data																							
(7) Education in years	11.62	2.76	5,508	-.01	-.01	-.04	-.03	.01	-.07														
(8) Income	293.53	269.67	5,555	-.03	-.06	-.02	-.05	.01	-.27	.38													
(9) % unemployment	6.7		4,101	.06	.05	.08	.07	-.06	-.02	-.07	-.10												
(10) % sick leave	19.5		4,101	.00	.00	-.01	.00	-.03	.01	-.07	-.02	.03											
(11) % history disability	15.4		5,555	.09	.08	.06	.07	.02	.07	-.18	-.22	-.03	-.08										
(12) % spouse/cohabitating partner	70.4		5,514	-.27	-.24	-.22	-.21	-.16	-.14	.02	-.01	-.10	.00	-.04									
(13) % history divorce	24.4		3,562	.08	.08	.10	.07	-.07	.04	.01	.04	.06	.02	.08	-.32								
(14) % history widowhood	4.0		3,559	.14	.13	.12	.11	.35	.13	-.06	.04	-.01	-.02	-.04	-.39	-.09							
(15) % having children	84.0		5,555	-.08	-.07	-.06	-.08	.02	.06	-.02	-.01	-.03	.02	.01	.23	.10	.03						
Self-report data																							
(16) Contact with friends (1–5)	3.69	0.82	5,500	-.07	-.06	-.23	-.22	-.14	-.02	-.04	.00	.01	.05	-.03	-.08	.01	.02	.00					
(17) Emotional stability (1–7)	4.77	1.26	4,100	-.30	-.28	-.22	-.21	-.02	-.15	.01	.09	-.03	-.04	-.10	.06	-.01	-.01	.08	.15				
(18) Extraversion (1–7)	4.87	1.17	4,107	-.17	-.16	-.22	-.19	-.03	.12	-.01	.01	-.06	.00	.02	.01	.03	.01	.07	.08	.28			
(19) Conscientiousness (1–7)	5.02	1.01	4,093	-.11	-.08	-.07	-.08	-.02	.04	.08	.10	-.06	-.01	-.05	.03	.01	.01	.03	.11	.22	.25		
(20) Agreeableness (1–7)	5.65	0.94	4,109	-.06	-.03	-.10	-.11	.01	.23	-.06	-.11	-.03	.01	.05	-.05	.03	.08	.01	.02	.21	.40	.32	
(21) Openness (1–7)	4.87	0.87	4,096	-.09	-.07	-.09	-.08	-.04	-.01	-.01	.03	-.02	-.01	.04	.02	.04	-.01	.03	.09	.26	.36	.32	.36

Notes. Intercorrelations of $r = |.06|$ or above are statistically significantly different from zero at $p < .001$. Continuous measures are presented in their original metric. Income in 1,000 Norwegian kroner. *Descriptive statistics of the indirect measure of loneliness are based on mean scores of all three items. However, all other analyses in this paper are based on latent scores for the indirect loneliness measure.

Table 3

Standardized Beta Coefficients from Regression Analyses with Age, Polynomials of Age, and Gender Predicting Initial Status and Subsequent Change in Loneliness

Parameter	Direct measure of loneliness		Indirect measure of loneliness	
	Initial status	Change	Initial status	Change
Intercepts (adjusted means)	-0.03	-0.23***	0.00	-0.01
Age	-0.08*	0.07***	0.06***	0.15***
Age ²	0.02	--	0.05**	--
Age ³	0.07*	--	--	--
Women	0.09***	0.09***	-0.03	0.00
Age × women	0.05***	--	0.06**	--

Note. $N = 5,555$. Age was centered at 60 years (near the average age of the sample) and divided by 10, so as to express the rate of change by decade. * $p < .05$; ** $p < .01$; *** $p < .001$.

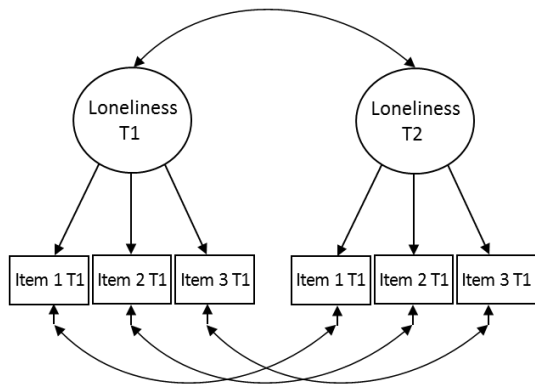
Table 4

Standardized Beta Coefficients from Regression Analyses with all Potential Predictors Predicting Initial Status and Subsequent Change in Loneliness

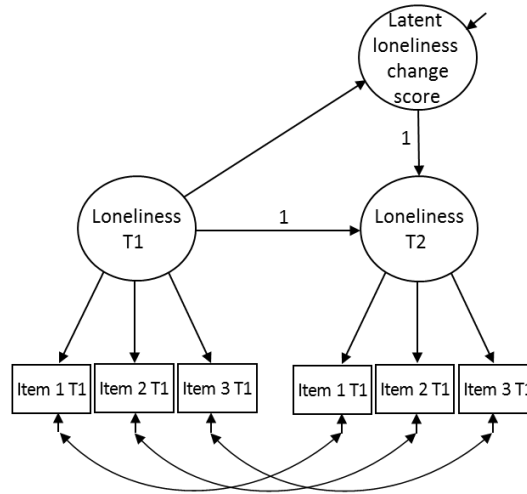
Parameter	Direct measure of loneliness		Indirect measure of loneliness	
	Initial status	Change	Initial status	Change
Intercepts (adjusted means)	-0.03	-0.23***	0.00	0.00
Socio-demographic variables				
Age	-0.15***	0.04*	-0.05**	0.15***
Age ²	-0.01	--	0.02	--
Age ³	0.06	--	--	--
Women	0.01	0.07***	-0.10***	-0.02
Age × women	0.02	--	0.02	--
Register data				
Education	0.04**	0.02	-0.01	0.01
Income	0.00	-0.03*	-0.01	-0.06**
Unemployment	0.02	0.01	0.04**	0.02
Sick leave	-0.01	0.00	-0.01	0.00
Disability	0.07***	0.02	0.05**	0.02
Spouse/cohabitating partner	-0.23***	-0.07***	-0.25***	-0.05
History of divorce	0.00	0.03*	0.05*	0.00
History of widowhood	0.09***	0.03	0.10***	-0.03
Having children	-0.01	-0.02	0.01	-0.05
Self-report data				
Contact with friends	-0.06***	0.00	-0.26***	-0.07**
Emotional stability	-0.24***	-0.12***	-0.18***	-0.08**
Extraversion	-0.10***	-0.08***	-0.18***	-0.03
Conscientiousness	-0.04*	0.00	0.01	0.00
Agreeableness	0.02	0.02	0.00	-0.03
Openness	0.01	0.03	0.03	0.02
Women × cohabitating partner	--	--	--	-0.07**

Note. $N = 5,555$. Age was centered at 60 years (near the average age of the sample) and divided by 10, so as to express the rate of change by decade. * $p < .05$; ** $p < .01$; *** $p < .001$.

A. Basic Model



B. Unconditional Latent Change Score Model



C. Conditional Latent Change Score Model

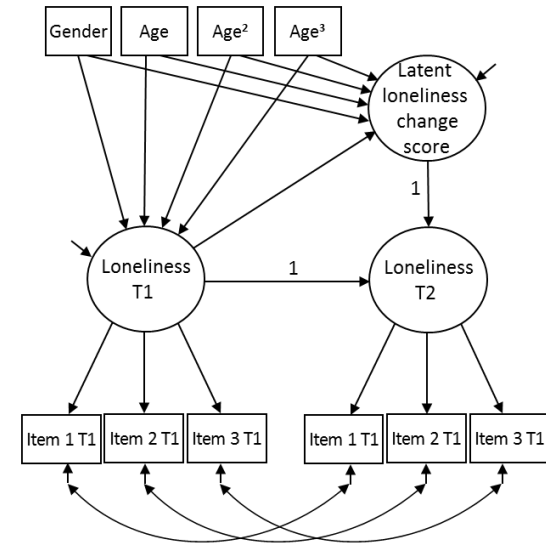


Figure 1. Latent change score models for indirect measure of loneliness. Latent change score models were also used for the direct measure of loneliness; however, the model was based on manifest and not on latent indicators.

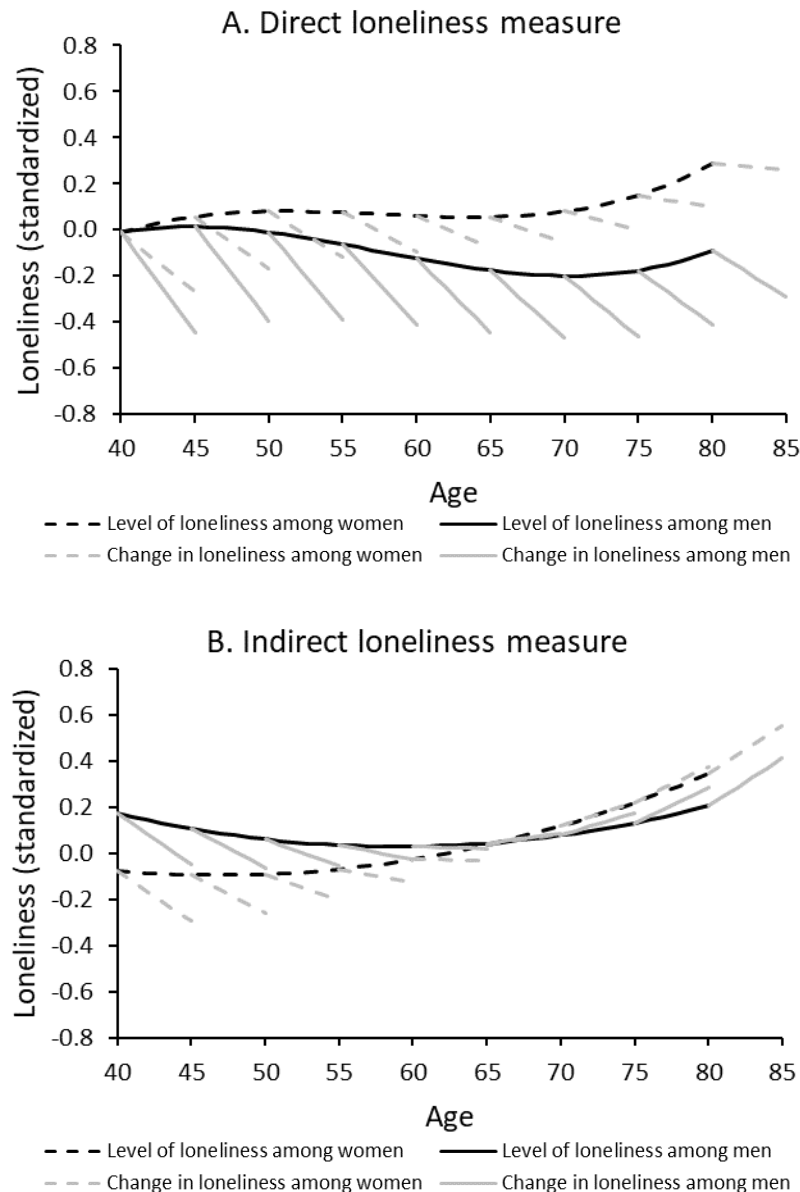


Figure 2. Initial level of and change in loneliness by age and gender with loneliness measured directly (A) and indirectly (B). Black lines represent estimated levels of loneliness at T1, and gray lines represent estimated change of loneliness in 5-year intervals from T1 to T2. The figures show that levels of loneliness increased steadily for women especially after age 70, whereas men's level of loneliness followed a U-shaped curve, with highest loneliness levels at ages 40 and 80. When loneliness was measured directly, men reported less loneliness than women, particularly in old age, but we found no overall gender differences on indirect measures. The direct measure of loneliness decreased considerably from T1 to T2 for both genders, but the decrease was smaller with higher age. By contrast, the indirect measure of loneliness decreased only among the youngest participants in our sample (aged 40 years) between T1 and T2. That decrease abated with increasing age such that rates of change at age 60 were not statistically significant. From about age 60 and thereon, loneliness gradually increased between T1 to T2 with increasing age.

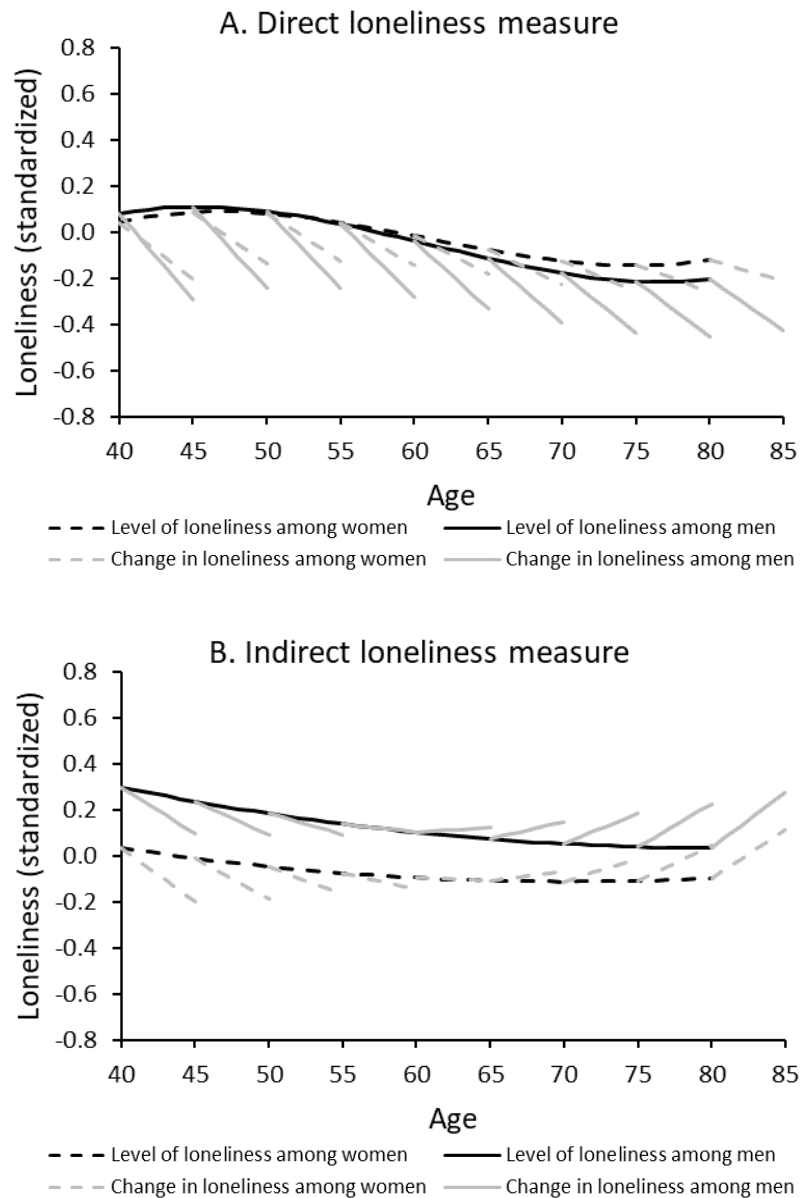


Figure 3. Initial level of and change in loneliness by age and gender when controlling for all predictors with loneliness measured directly (A) and indirectly (B). Black lines represent estimated levels of loneliness at T1, and gray lines represent estimated change of loneliness in 5-year intervals from T1 to T2. The figure shows that gender differences in the shape of age trends for the level of loneliness were reduced when controlling for predictors, but gender differences in the level of loneliness on the indirect measure emerged with higher estimated loneliness scores for men than women. When including covariates, women's level of loneliness did not any longer increase with increasing age. Estimates of change in loneliness did not change substantially when controlling for predictors.