


Fluctuations in loneliness due to changes in frequency of social interactions among older adults: a weekly based diary study

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ABSTRACT

Objectives: *Loneliness* functionally varies and is determined by the degree of interaction with others. We examined weekly fluctuations in reported loneliness as a function of frequency of social interactions in old age. We hypothesized that emotional and social components of loneliness would be related to different types of social relationships.

Design: Participants reported their feeling of loneliness and their social interaction quantity (frequency of meetings) via a weekly based diary, over 6 weeks.

Setting: Diary study.

Participants: The study included 55 older adults with different dwelling arrangements ($M = 73.4$, $SD = 6.97$).

Measurements: Measures of *Loneliness* (the De Jong-Gierveld Loneliness Scale), *Social Interaction and Contact*, and *sociodemographic* parameters were used.

Results: Social and emotional loneliness fluctuated over the course of the 6-week study. Frequency of meeting friends was related to emotional loneliness and total feelings of loneliness. Frequency of meeting close/trusted figures was related to emotional loneliness which appeared the following week. Other variables were not associated with either changes in loneliness or its dimensions.

Conclusions: Loneliness in old age is changeable. The emotional component of loneliness seems to be dominant in determining overall feelings of loneliness and is more sensitive to externally chosen social interaction.

Key words: loneliness, social loneliness, emotional loneliness, fluctuation, social interactions, weekly-based diary, older adults

Introduction

Loneliness is often attributed to the discrepancy between desired and actual social interactions and relationships (Cacioppo and Hawkley, 2009; Perlman and Peplau, 1981). Its levels may be functionally determined via the frequency and degree of social interaction and contact (Chen and Feeley, 2014; Kuczynski *et al.*, 2022). Respectively, it was reported that a low frequency of social activity and contact with others were associated with high levels of loneliness among older adults (Gibney *et al.*, 2019).

While loneliness might be chronic, stable, or continuous over months or years, it might also be situational, infrequent, or transient and often occurs temporarily, after facing stressful life events or losses in one's social network (De Jong-Gierveld and Raadschelders, 1982; Young, 1982). Loneliness has been consistently related to old age (Dykstra, 2009; Heylen, 2010), due to the ongoing changes and losses in the social network of older adults (Dahlberg *et al.*, 2015).

Recent studies have indicated that this approach might be stereotypical. *Level of loneliness* was found to be the lowest during one's 60s, compared to one's 20s and mid-40s (Nguyen *et al.*, 2020). Moreover, it has been argued that older adults do not always feel lonely (Brittain *et al.*, 2017).

Another typology of loneliness points to its dual dimensional feature – the emotional and social

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dimensions – which were found to be empirically evident in old age (Dahlberg and McKee, 2014; van Baarsen *et al.*, 2001). These dimensions may be relevant, especially as regards the temporal feeling of loneliness, and may contribute to its changeable levels. The *emotional* dimension of loneliness refers to the feeling of absence of close or intimate contact with significant figures such as family members, while the *social* dimension stems from the absence of a wider spectrum of social interactions such as friends, colleagues, neighbors, and people with common satisfying interests and activities (Liu and Rook, 2013; Weiss, 1973). Individuals may suffer from emotional loneliness but not social loneliness, and vice versa, since each dimension is linked to different types of social interactions.

Accordingly, due to the changes that characterize one's emotional and social life in old age (loss of a spouse, loss of friends, restricted social life, etc.), older adults may also experience fluctuations in loneliness as a function of the quality or amount of their emotional or social ties and connections.

Previous studies evaluated loneliness duration among older adults, targeting different methodologies, questionnaires, and various contexts; and exploring different and common social predictors and risk factors for chronic and situational loneliness (Hector-Taylor and Adams, 1996; Newall *et al.*, 2014; Shiovitz-Ezra and Ayalon, 2010). Generally, participants were asked to report their feelings of loneliness in two to three waves or timepoints over a period of years or months, or in a one-time report.

However, examining loneliness using this method may not capture short-term fluctuations in loneliness levels, especially in old age. Individuals may continuously deal with variability in their social network. In addition, they may experience different levels of loneliness within a time period that is shorter than months or years. Evidence of this can be seen in the fluctuating levels of loneliness among young adults, as a function of daily social situations and events (Larson, 1981, 1990). A recent study not only indicates relative stability in loneliness from 1 day to the next among young adults (Kuczynski *et al.*, 2022), but also shows that interacting with others more frequently than one usually does may prevent depression and loneliness. Another study conducted among young students revealed that as the quality of interaction with others increased during the week, feelings of loneliness decreased (Gonzalez, 2018). During the COVID-19 pandemic, which altered people's social lives due to social restrictions, several studies applied (mostly daily) diary study to examine feelings of loneliness and found that daily loneliness increased over time due to linearly decreased interactions (Buecker and

Horstmann, 2021). This was especially true regarding older people who voluntarily reduced their interaction with family members, friends, and colleagues during the pandemic, compared to younger people (Chou *et al.*, 2020).

Older adults may not necessarily experience fluctuations in their level of loneliness on a daily basis, but may rather experience changes over a longer period of time. For example, being ill and suffering from functional limitation may take several days, which in turn may affect one's social activity, leading to increasingly distressful feelings of loneliness. Alternatively, the positive effects of a visit from grandchildren, for example, may also last more than one day and serve to mitigate one's level of loneliness.

In light of this, we hypothesized that older adults may report fluctuations in loneliness levels, if examined at several points in time, ranging from week to week.

We expected that the variability in the emotional and social components of loneliness would depend on the type of social interaction and contact experienced by the individual in the same week. To test this hypothesis, we systematically examined reported loneliness by using the diary research procedure, in an attempt to evaluate loneliness and degree of sociability on a weekly basis, over the course of several weeks.

To date, there is very little research on loneliness that employs this type of methodology. The few studies that have been conducted examined loneliness in indirect contexts, while real or actual social interactions were not explored. For example, in one study, a 4-week diary research was conducted among individuals between the ages of 18–68, examining loneliness in the context of social media abstinence, and no effect on loneliness levels was observed (Hall *et al.*, 2019). Another 2-day diary study linked loneliness to mobility and the surrounding environment among older adults (van den Berg *et al.*, 2016).

In the current study, we aimed to identify how changes in older people's social life – such as interaction and contact with family, friends, and close/trusted figures and neighbors, as well as participating in social activities may affect fluctuations in loneliness via a weekly based diary. We expected the emotional and social components to be affected differently by these changes. Specifically, we hypothesized that the frequency of meeting with family and close/trusted figures will have a negative effect on the emotional component of loneliness, while the frequency of meeting with friends and neighbors, and participating in social activities will have a positive effect on the social component of loneliness.

Method

Participants

A total of 55 subjects (37 female and 18 male subjects) without cognitive impairment were recruited to participate in the study from January to November 2018. Informed consent was obtained from the participants after ethical approval was granted from the Ethics Committee (IRB) at the University of Haifa.

The participants' mean age was $M=73.4$, $SD=6.97$, range = 65–89. Half ($n=29$; 52.27%) of the participants were cohabiting. Most of the participants ($n=55$; 87.30%) defined their health as “good” or “very good”, and most reported a “good” – “very good” financial status ($n=47$; 85.45%).

Note: For the convenience of presenting data and findings, Greek and Latin statistic characters were used.

Measures and procedure

Emotional and social loneliness were assessed using the De Jong-Gierveld Loneliness Scale (De Jong-Gierveld and Kamphuls, 1985). This scale consists of 11 items; answers were given on a 5-point Likert scale, ranging from (1) none of the time, to (5) all of the time. Six items were used to assess emotional loneliness ($\alpha = .72$), e.g.: “I miss having a really close friend” and “I often feel rejected”; 5 items were used to evaluate social loneliness ($\alpha = .72$), e.g.: “There is always someone I can talk to about my day-to-day problems” and “There are enough people I feel close to”. Following the instructions (De Jong-Gierveld and Kamphuls, 1985), the score for *emotional loneliness* was computed by counting the neutral and positive answers (“more or less”, “yes”, or “yes!”) for items 2, 3, 5, 6, 9, and 10. The *missing emotional loneliness score* was computed by counting the missing values (i.e., no answer) for items 2, 3, 5, 6, 9, and 10. In addition, the *social loneliness score* was computed by counting the neutral and negative (“no!”, “no”, or “more or less”) answers for items 1, 4, 7, 8, and 11. The *missing social loneliness score* was computed by counting the missing values (i.e., no answer) for items 1, 4, 7, 8, and 11. The *total loneliness score* was computed by adding the sum of the *emotional loneliness score* to the *social loneliness score*. The *total loneliness score* is valid only if the sum of the *missing emotional loneliness score* and the *missing social loneliness score* equals 0 or 1. The internal reliability for the total scale was good ($\alpha = .80$). In this study, we relied on the authors suggestion of cut-scores, total loneliness score was divided into four levels: not lonely (a score of 0, 1, or 2), moderately lonely (a score ranging from 3 to 8),

severely lonely (a score of 9 or 10), and very severely lonely (a score of 11). It is important to note that this cut-scores division, was previously used in this form (see Uysal-Bozkir *et al.*, 2017), but was not validated.

First, participants were asked to report their total feeling of loneliness, to determine their base level. In the next step, they were asked to answer the questionnaire each week, for 6 weeks in a diary form. The mean of the base total loneliness of all participants was $M=3.80$, $SD=2.81$, Range = 0–10. For emotional loneliness, the average level was $M=2.23$, $SD=1.64$, Range = 0–5; and for social loneliness the average level was $M=1.56$, $SD=1.69$, Range = 0–5.

Social interactions and contacts (SIC) were assessed by five items derived from a questionnaire used previously (Dahlberg and McKee, 2014). Social interaction quantity (frequency of meetings) was measured on a weekly basis, using four items designed specifically for this study, which aimed to examine defined social relationships. The items used in this study were: “How often do you meet and spend time with family members?”; “How often do you meet and spend time with close/trusted individuals?”; “How often do you meet and spend time with friends?”; “How often do you meet and spend time with neighbors?”; and “How often do you participate in social activities?”. Since we aimed to capture weekly changes, our response scale ranged from: (1) never, (2) once a week, (3) twice a week, and (4) every day.

Sociodemographic characteristics such as age, gender, marital status, self-rated health, and financial status were also measured. In addition, depression was assessed using the Geriatric Depression Scale (GDS 15; Yesavage and Sheikh, 1986). This scale consists of 15 items with a dichromic answer: yes, or no, $\rho_{KR20} = .82$. Depressive symptoms were correlated with total loneliness, and with emotional and social loneliness, separately ($r_p = .46, .29, .46$; $p < .01$; respectively).

Data analysis

Data analyses were conducted with the Statistical Package for the Social Sciences (SPSS-25; IBM) software, using SPSS MIXED procedures. Six repeated, measured data points with a 1-week interval for each participant were included in the multi-level database file.

Statistical analyses were conducted in two steps. In the first step, we aimed to identify change in reported loneliness and its social and emotional components over the 6-week study period. For this purpose, we used an unconditional means model (a one-way ANOVA with random effects

and with no predictors) to calculate the within- and between-person variances in *Loneliness* level, which was parameterized as follows: Combined Levels 1 and Level 2: $Y_{ij} = \gamma_{00} + u_{0j} + r_{ij}$ (see Heck et al., 2013; Peugh and Enders, 2005).

The model's variance components provide the proportion of variability in the weekly reports of loneliness for each participant ($r_{ij} \setminus \sigma^2$) and the variance between all participants ($u_{0j} \setminus \tau_{00}$). These values provide the information to create an intraclass correlation coefficient that is computed by $(\tau_{00} \setminus \tau_{00} + \sigma_2)$ and represents the variances of the individual within-subject variance, which may indicate changes in reported loneliness at the individual level. Therefore, we used the intercept-only model procedure. The *Loneliness* variable was added following the MIXED command; we added the *Intercept* (e.g., *Loneliness* grand mean) at the /FIXED and at the /RANDOM sub-commands.

In the next step, we tested whether the variables of *social interaction and contact with others (SIC)* predicted weekly fluctuations in reported loneliness over the 6-week period. We aimed to test the effect of *SIC* variables (e.g., spending time with family members, close/trusted individuals/friends/neighbors, and participating in social activity), with controlling the effect of other variables on the *loneliness* level such as *sociodemographic* variables and depression, which were found to be significantly associated with loneliness. We used a mixed-effects model of repeated measures (MMRM), with random intercepts and slopes, assuming that every participant had a different *intercept* and *slope* (see McCulloch and Searle, 2004). *Loneliness* and its social and emotional components were the dependent variables (a separate analysis for each), while the *SIC* variables were the independent variables (a separate analysis for each). The model included the main effects covariates that might affect *loneliness* level such as *Time* (weeks), time-dependent variable (*SIC* variable), and main effects of baseline covariate such as sociodemographic variables, and depression. Fixed effects included the *Intercept*, *Time*, *SIC* variable, sociodemographic variables, depression, and two-way interactions of the *SIC* variable with *Time*. The random effects included only *Intercept* and *Time*, respectively; while the covariates were omitted because their effects on the intercepts and slopes were not allowed to randomly vary across individuals.

Results

Loneliness level showed a fluctuating nature among most of the participants in the study (see Figure 1). For example, some participants reported severe

loneliness ($n = 2$) at the beginning of the study, but reported no loneliness the following week/s. Other participants reported no loneliness ($n = 10$) in the first week and diverse levels of loneliness in the following week/s.

The data analysis showed that the grand mean of loneliness was statistically significant ($Y_{00} = 3.43$, $p < .01$), rejecting the null hypothesis that this parameter is zero (meaning all participants reported no loneliness at baseline). The within-subject and between-subject variances were also significant ($\sigma^2 = 1.75$, $\tau_{00} = 5.56$, $p < .001$), which enabled us to calculate the intra-class correlation. Moreover, variation across subjects in their mean loneliness indicated that regardless of the value of the overall mean, subject varied significantly by their loneliness mean. The intra-class correlation (.76) indicated that 24% of the variance in loneliness was within-subject variance, pointing to fluctuations in reporting loneliness over time. Applying hierarchical regression, after adding demographic and covariate variables in the first step, emotional loneliness in the next step, and finally adding social loneliness in the third step, revealed that emotional loneliness explained 22% (Δ *pseudo-R*² = .22, $p < .001$) of the variance in the fluctuation of loneliness, while social loneliness explained 19% (Δ *pseudo-R*² = .19, $p < .001$).

Examining the emotional and social components of loneliness indicated that both dimensions had a fluctuating nature (emotional loneliness mean: $Y_{00} = 2.01$, $p < .01$; social loneliness mean: $Y_{00} = 1.32$, $p < .01$). The within- and between-subject variances were also significant ($\sigma^2 = .82, .67$; $\tau_{00} = 1.35, 2.41$; $p < .001$; respectively). For emotional loneliness, 37.7% of the variance was within-subject; for social loneliness, 21.75% of the variance was within-subject.

Examining the effects of *social interaction and contact with others (SIC)* variables on weekly fluctuations in reported loneliness showed that only *frequency of meeting friends* was associated with fluctuation in the total feeling of loneliness. The two-way interaction was significant (*SIC* * *Time* = -0.15 , $p < .001$) with effect size of .24, explaining 31% of the variance. Contrary to our hypothesis, *frequency of meeting friends* was related to the emotional component of loneliness, but not to the social component. The effect of *frequency of meeting friends* on the emotional component over time was *SIC* * *Time* = -0.8 , $p < .01$, accounting for 40% of the within-subject variance and with effect size of .19 (see Table 1).

The effects of other *SIC* variables – e.g., frequency of meeting family, frequency of meeting close/trusted figures, frequency of meeting neighbors, and participating in social activities – on

Table 1. Multilevel Model for weekly frequency of meeting with friends

	LONELINESS			SOCIAL LONELINESS			EMOTIONAL LONELINESS		
	ESTIMATOR	S.E.	E.S.	ESTIMATOR	S.E.	E.S.	ESTIMATOR	S.E.	E.S.
<i>Fixed effects</i>									
Intercept	-.55	.71		-.20	.48	.03	-.27	.43	
Age	.03	.04	.02	.04	.02	.20	-.01	.02	.01
Gender	.97	.60	.65	.32	.41	.20	.51	.35	.41
Depression	.32**	.10	.21	.21**	.06	.13	.08	.05	.07
Marital status	-.18	.60	.12	.06	.40	.04	-.20	.35	.16
Health	-.21	.33	.14	0	.22	0	-.17	.20	.14
Economic status	-.02	.33	.01	-.15	.22	.09	.01	.20	.01
Frequency of meeting friends	-.12	.08	.19	-.10	.05	.19	-.02	.05	.05
Time	.37**	.12	.59	.16*	.08	.42	.16 ⁺	.08	.38
Time × frequency of meeting friends	-.15***	.03	.24	-.05	.02	.13	-.08**	.02	.19
<i>Random effects</i>									
Within-person variance	1.55***	.15		.59***	.05		.70***	.07	
Between-person variance	3.44***	.72		1.51***	.31		1.06***	.23	
AIC		1239.6			951.69			972.45	
BIC		1292.44			1004.54			1025.3	

Notes: AIC = Akaike’s Information Criterion, BIC = Schwarz’s Bayesian Criterion, E.S. = Effect size. *N* = 55 respondents who provided 330 observations. Unstandardized estimates and standard errors are presented. ⁺*p* < .10, **p* < .05, ***p* < .01, ****p* < .001.

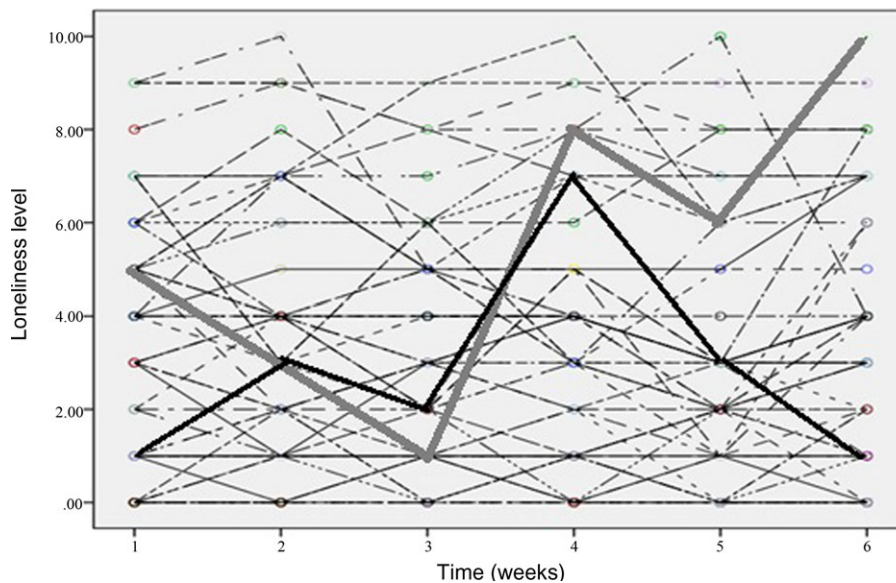


Figure 1. The weekly fluctuation in reported total loneliness level over the 6-week research period. The black and the grey lines describe two participants with different fluctuation trajectories in loneliness level during the 6-week research period.

fluctuation of loneliness and its emotional and social components over time were not significant.

Probing the interaction between *Time* and meeting friends revealed that the level of total loneliness was significantly lower over the course of the 6 weeks, when the frequency of meeting friends was +1 SD above the average ($\beta = -.30$, 95% CI [-.51, -.09], $t = -2.83$, $p < .01$), but not when it was on the average or -1 SD below the average. For emotional loneliness, the interaction between

Time and meeting friends was significant when the frequency of meeting friends was on the average ($\beta = -.10$, 95% CI [-.18, -.01], $t = -2.22$, $p < .05$) and +1 SD above the average ($\beta = -.22$, 95% CI [-.35, -.09], $t = -3.43$, $p < .001$) (see Figures 2 and 3).

As presented in the Figures 2 and 3, a high frequency of meeting friends over the weeks was related to low levels of total loneliness and emotional loneliness.

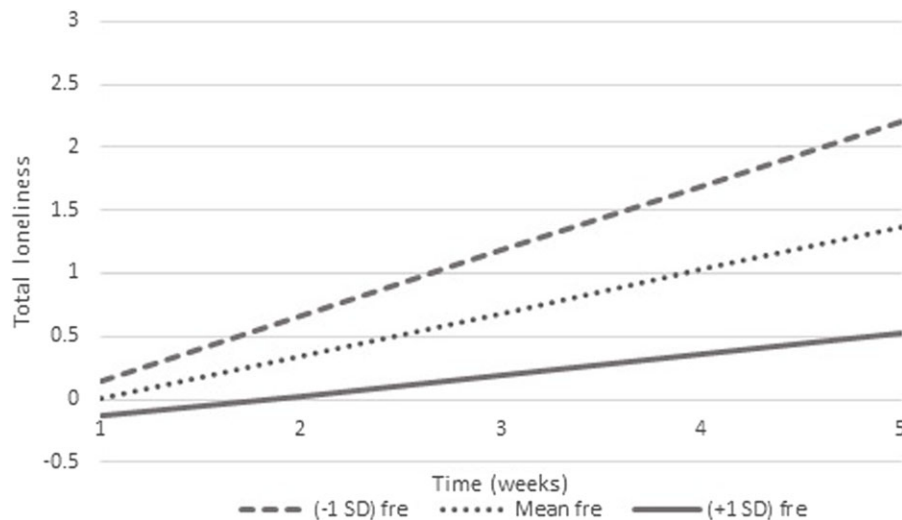


Figure 2. The relationship between time (weeks) and total loneliness, as a function of the frequency of meeting friends. *Note:* The figure shows the centered values of total loneliness. *Fre* = frequency of meeting friends.

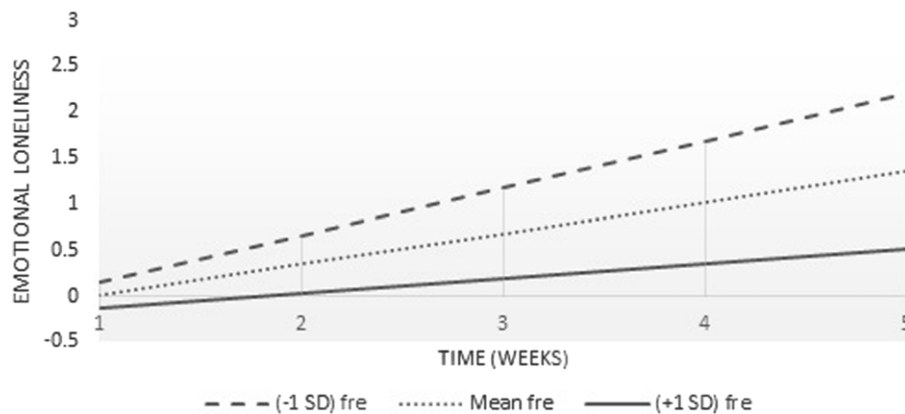


Figure 3. The relationship between time (in weeks) and emotional loneliness as a function of the frequency of meeting friends. *Note:* The figure shows the centered values of emotional loneliness. *Fre* = frequency of meeting friends.

Additional analysis

Unexpectedly, no relationship was found between frequency of meeting close/trusted figures and frequency of meeting family with total loneliness and its dimensions in the same week. Hence, a set of time-lagged analyses was conducted to test the sequential order of relationships between the *SIC* and loneliness dimensions. We tested whether *SIC* at measurement point t predicted a change in loneliness from t to $t + 1$ (a week later), controlling for age, gender, marital status, self-rated health, financial status, and depression. The findings revealed that only frequency of meeting close/trusted figures in the previous week was significantly related to total loneliness and emotional loneliness in the following week ($-.26, p < .001$; $-.12, p < .01$, respectively). However, the effect of frequency of meeting close/trusted figures in the previous week on social loneliness in the following week ($-.16, p > .05$) was not

significant. These findings indicate that the effect of meeting close/trusted figures contributed to diminishing the level of total loneliness and emotional loneliness the following week.

Gender differences were also examined in the study. Men reported about .82 points, $p < .015$, less than women for the weekly average of emotional loneliness ($-.82, p < .05$), and about 1.64 points, $p < .015$ less than women on the total loneliness scale. The effect of gender on social loneliness was not significant, $-.82, p > .05$. These findings will now be discussed.

Discussion

The current study examines the association between social contact with others and its effects on total, emotional, and social loneliness. In line with our

hypothesis, the findings revealed that levels of loneliness among older adults may fluctuate on a weekly basis – a pattern that was found in both the emotional and social components of loneliness.

Interestingly, our findings indicated that only the frequency of meeting friends was related to changes in the total levels of loneliness and emotional loneliness over the weeks. Contrary to our hypothesis, the frequency of meeting family and close/trusted figures or participating in social activities were not related to any of the loneliness dimensions or to the total feeling of loneliness. However, the time-lagged analyses revealed that the effect of the frequency of meeting close/trusted figures was evident in diminishing emotional loneliness and total loneliness levels the following week.

Our findings were collected from a sample of older adults (>65) and are in line with previous evidence on fluctuations in loneliness among older adults aged 85+, but loneliness levels were evaluated in three waves with an 18-month difference between each wave (Brittain *et al.*, 2017). Another study that used 11 items from the De Jong-Gierveld scale that examined loneliness in three waves, with a 5-year difference between each wave (Julsing *et al.*, 2016), showed that loneliness increased over the years, due to the increase in the emotional component over time.

In our weekly diary study, loneliness was found to be unstable, even among those who reported feeling lonely at base level (during the first week). Participants, who reported moderate-to-high levels of loneliness at least during 1 week, also reported lower levels of loneliness in the following weeks more than once, indicating that older individuals may feel moderate-to-severe levels of loneliness in a certain week, but may then recover and not feel lonely at all after a very short time.

The fluctuating nature of loneliness as presented in this study is in line with Young's definition of *transient loneliness* (Young, 1982). This definition describes temporary and infrequent feelings of loneliness. If transient loneliness is compared with situational loneliness – which usually occurs after stressful events or changes in the social network, such as the death of a close person or retirement (De Jong-Gierveld and Raadschelders, 1982) – the latter might take more than a week to recover from, and might be more severe and stressful, even compared to chronic loneliness (Beck and Young, 1978).

Our outcomes indicated that levels of loneliness might be changeable on a weekly basis. Indeed, a previous qualitative study showed that loneliness can fluctuate on a daily basis, and indicated that people mainly feel lonely in the evening hours and on the weekends, when distracting activities are not available (Cohen-Mansfield and Eisner, 2019).

However, while the time needed to detect changes in loneliness levels is still controversial, our weekly based study may capture minor changes in sociability and loneliness, indicating that loneliness may undergo rapid fluctuations over shorter periods of time.

Weekly SIC variables and fluctuations in loneliness

Our study highlights that loneliness might be affected by small changes in the frequency of social interactions. Previous studies support our findings, especially during the COVID-19 pandemic, indicating an increase in loneliness resulting from the decreased frequency of social interaction during the pandemic (Buecker and Horstmann, 2021). However, very few prior studies have examined loneliness in the context of defined social interactions, using the De Jong Gierveld Loneliness scale (De Jong-Gierveld and Kamphuis, 1985), in order to explore loneliness via its social and emotional components, and the types of interaction that affect its levels.

Our findings suggested a complex picture concerning the effect of different social interactions on both dimensions of loneliness, with social loneliness seeming to be less sensitive than emotional loneliness to changes in social interaction. Contrary to our expectations, the *friends'* variable has low to intermediate effect size, and was the most relevant in affecting the long-term fluctuations in loneliness levels – mostly due to its effect on emotional loneliness, rather than social loneliness.

Previous studies indicated that the effect of family on loneliness may not be conclusive. Some studies suggested the protective role of family in attenuating loneliness (De Jong Gierveld and Van Tilburg, 2006; De Jong-Gierveld *et al.*, 2009). In addition, it was found that those individuals who had few or no children were at a higher risk of suffering from social loneliness (De Jong Gierveld and Van Tilburg, 2010), while the lack of a spouse or partner in one's life tended to predict emotional loneliness (Drennan *et al.*, 2008). Other studies indicated that relationships with family members can be both complex and ambivalent (Bengtson *et al.*, 2002; Silverstein and Bengtson, 1997). Stressful and conflicting relationships, especially when there is a high frequency of meetings, may even increase loneliness (Chen and Feeley, 2014; Shiovitz-Ezra and Leitsch, 2010).

Feeling a sense of loneliness mainly depends on one's desired level of sociability compared to the actual existing level, as well as the ability to choose our relationships. People can choose their friends, for example, but not their family members

(Shiovitz-Ezra and Leitsch, 2010). Furthermore, one can choose whether or not to meet one's friends, but friends may not always be around or meet one's expectations. The same is true regarding our partner in relation to participation in social activities. Emotional and physical efforts are a part of any type of social activity that older people are likely to participate in (Fredrickson and Carstensen, 1990). Hence, older adults tend to reduce interaction with unfamiliar social partners. Therefore, attempts to get older people together to take part in social activities in their environment – like in their nursing home or day center – will not necessarily contribute to reducing social loneliness as is generally expected.

It is important to mention that in this study we did not examine either the quality or the nature of these relationships. However, as was presented earlier, the frequency of meeting friends, for example, might be an indicator of the quality of the relationship (Heylen, 2010), which may serve to explain the link between relationships and the fluctuation in emotional loneliness. In some cases, friends can even replace family members and contribute to diminished feelings of loneliness among older adults, especially among those who have no children or partners (Cacioppo and Patrick, 2009; Russell *et al.*, 2012).

Interestingly, contrary to what was expected, the frequency of meeting close/trusted figures was not related to fluctuations in emotional loneliness. Some prior studies proposed that emotional loneliness is related to intimate relationships, rather than general relationships with others (Green *et al.*, 2001). Others suggested that the link between relationships and loneliness is still not clear (Drennan *et al.*, 2008). Our findings may explain this controversy, as the frequency of meeting close/trusted figures the previous week was found to be related to diminished emotional loneliness levels the following week, but not to have an influence on longer periods of time.

The delayed effect of frequency of meeting close/trusted figures, which affects loneliness 1 week later, might possibly be explained by the socioemotional selectivity theory that may be unique to old age – a period in which time is perceived as limited and death is approaching (Carstensen, 1995; Carstensen *et al.*, 2003). In light of this sense of limited time, socioemotional regulation contributes to motivational changes that include increased investment in close social relationships that are more satisfying, and which meet the individual's emotional needs, and compensate for the shrinking social network which often accompanies this time of life. Accordingly, meeting close/trusted figures can compensate for social needs and reduce emotional loneliness. The close or trusted person can be a family member

or neighbor, and this relationship can replace and compensate for the lack of other relationships.

In light of our results, we should also take the gender difference into account regarding social and emotional loneliness. According to previous studies (Drennan *et al.*, 2008; Green *et al.*, 2001), older women reported more emotional loneliness and total loneliness than men. In contrast, gender differences regarding social loneliness were not statistically evident. This may be attributed to the fact that men are less expressive, and therefore less likely to express and report their loneliness compared to women (Pinquart and Sörensen, 2001; Victor and Yang, 2012). These differences should not be ignored and may indicate that women are more sensitive to changes in sociability related to interactions with friends and close/trusted figures. This is especially true as women often live more years alone (as widows) and suffer more from poor health and disability compared to men (Brittain *et al.*, 2017; Chipperfield and Havens, 2001).

Our findings are in line with recommendations to increase opportunities for social interaction – particularly in old age (Jeste *et al.*, 2020) and highlight the important contribution of the chosen interaction. For example, choosing to interact with friends and close/trusted figures has only low to moderate effect, but it is more effective in reducing loneliness than engaging in other interactions and pursuing other relationships within the existing social network.

This study has some limitations that should be taken in account. It is important to mention that the study examined the effect of weekly interaction with family, friends, and close/trusted figures, and participating in social activity on reported loneliness, regardless of other factors that were previously reported to affect loneliness, such as trait-related factors, personal characteristics, or a lack of social skills (Heinrich and Gullone, 2006; Peplau and Perlman, 1982). Moreover, 14 participants filled out the questionnaires independently, and their answers might be biased as a result of the probability of seeing their reports from the previous weeks. Finally, the weekly text message or phone call to remind participants to fill out the questionnaires might have been perceived as social interaction for some, and therefore might have also affected their loneliness level.

It is also important to mention that using the De-Jong Gierveld Loneliness scale in order to explore loneliness via its social and emotional components is still questioned and should be used in caution. Although evidence indicated that the two subscales of the De-Jong Gierveld Loneliness scale measure different aspects of loneliness among old

people (van Baarsen *et al.*, 2001), it has been indicated that the scale was found as reliable and was validated in several countries, but some still argued that the scale's items may be biased under certain social or cultural conditions and may be affected by the gender of the participant (see Buz and Pérez-Arechaederra, 2014; De Jong Gierveld and Van Tilburg, 2010).

Alongside these limitations, the outcomes may present a new perspective on the nature of loneliness in old age and address an important topic that has been relatively neglected in the empirical literature on loneliness. The study examines, for the first time, questions like stability and fluctuations in loneliness among older adults, and the temporal relationships of social and emotional loneliness with social interaction and contact. Furthermore, this study is the first to use a lagged-time analysis to examine loneliness among older adults, and showed the lasting effect of a certain kind of social interaction, which may serve an important role in attenuating loneliness in old age.

Therefore, future interventions should take into account the notion that loneliness levels may vary over the span of several days, rather than months or years. Additionally, the study findings may indicate that emotional loneliness could be the dominant component affecting one's total feeling of loneliness, and may be more sensitive to changes in the close social network. In contrast, while social loneliness also seems to be important, it is less sensitive to external interaction with others. Understanding these points may lead to developing better solutions and interventions to reduce loneliness among older adults.

Conflict of interest

None.

Description of authors' roles

All authors contributed to study conceptualization, design and methodology, data curation, statistical analysis, and interpretation of data. Awad was involved in the conduction of the study and drafting the manuscript. Palgi and Shamay-Tsoory were involved in reviewing, editing, and supervision. Additionally, authors have given final approval of the version to be published.

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