1 **Temporal patterns of loneliness and their associations with mental health outcomes:**

2 **Observations from a longitudinal study**

3 *Short title: Temporal patterns of loneliness and mental health*

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25 **Abstract**

26 **Background:** Loneliness is a global public health concern. Investigating loneliness in the

27 general population offers a greater generalizability over various levels of health-related

28 impairments, identification of at-risk individuals, detection of various loneliness severity

29 levels, and broader insights into social determinants. Previous studies have shown that

30 loneliness might be a transient or chronic experience depending on how consistently it is

31 reported across at least two timepoints. This study aimed to assess differential associations of

32 chronic and transient with various domains of psychopathology.

33 **Methods:** Participants were enrolled from the general population and assessed at two

34 timepoints spanning 6-7 months. Depressive symptoms, generalized anxiety, social anxiety,

35 and paranoid thoughts were measured using self-reports. The data were analysed using binary

36 logistic regressions.

37 **Results:** Altogether, 3,275 completed both assessments with the retention rate of 64.2%.

38 Chronic loneliness was associated with higher baseline and follow-up scores across all

39 symptom domains. The strongest association was observed for social anxiety. Transient

40 loneliness was not robustly associated with symptom scores. It was not significantly associated

41 with depressive symptoms (at neither of timepoints) and paranoid ideation (at baseline). The

42 strongest association was observed for generalized anxiety. Chronic loneliness, compared to

43 transient loneliness, was associated with significantly higher odds of social anxiety, depressive

44 symptoms, and paranoid ideation, but not generalized anxiety.

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45 **Conclusions:** Both transient and chronic loneliness are associated with mental health

46 outcomes with the latter one showing generally stronger associations. Risk stratification and

47 early intervention among individuals experiencing loneliness might be needed to prevent the

48 development of more severe psychopathology.

49 **Keywords:** perceived social isolation; social disconnection; depression; anxiety disorder;

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73   **Introduction**

74   The perception of social bonds has evolved significantly over time and was shaped by

75   cultural, social, and historical contexts [1]. Pre-modern perspectives posited social isolation

76   (currently conceptualized as an objective measure denoting that individual social bonds are

77   lower than average) as a choiceful or even esteemed experience associated with spiritual

78   reflection, creativity, or even philosophical inquiry [2, 3]. The term "loneliness", understood

79   today as a painful self-perception of social disconnection or the discrepancy between actual

80   and desired social [4], was not commonly used or conceptualized by ancient and medieval

81   societies [3]. The concept of loneliness, as a distressing experience, emerged more

82   prominently in the 20th century and appeared to be influenced by societal shifts related to

83   industrialization, urbanization, and the rise of individualism [5]. According to the Bauman's

84   "liquid modernity" concept, these processes are largely unpredictable and coincide with the

85   "virtualization of reality" manifesting in an ongoing digitalization of daily life and social

86   interactions [6, 7]. The 20th century brought a growing academic interest in the psychological

87   aspects of loneliness with early studies that began to link loneliness with depression and

88   anxiety [8, 9].

89   Currently, loneliness is perceived as a global public health concern due to high

90   prevalence rates and a negative impact on all aspects of health, wellbeing, and development

91   [10, 11]. Experiencing loneliness has been associated with 26% increased risk of mortality over

92   time [12]. Taking into account the mental health perspective, it is needed to note bidirectional

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93   associations of loneliness with symptoms across a variety of mental health outcomes,

94   including mood and anxiety disorders [13-15], psychosis [16, 17], substance use disorders [18,

95   19], and problematic internet use [20]. It is also important to note that contextual factors

96   underlying the emergence of loneliness might show some interindividual variability [21]. For

97   instance, factors related to social identity formation, social rejection, life transition, and digital

98   overconnectivity might be of greater importance in younger populations [22-24]. In turn,

99   contexts related to the loss of significant social connections, retirement, institutional care,

100   physical illness and related disability might play important roles in older adults [25-27].

101   Studying loneliness in the general population offers several advantages over focusing

102   on clinical samples. Although clinical samples provide valuable insights into loneliness among

103   people with poor health status, population-based studies allow for a more comprehensive

104   understanding of loneliness as a public health concern. Studies based on the general

105   population include a wide range of participants providing the opportunity to apply the findings

106   to the whole society. Given that these studies offer to study loneliness alongside a variety of

107   demographic, social, behavioural, and environmental factors, potential risk and protective

108   factors might be identified. Another benefit is related to the whole spectrum of loneliness

109   severity and thus the opportunity for risk stratification. At this point, it is needed to note that

110   population-based studies hold the potential to detect at-risk individuals who show a lower

111   severity of loneliness. Therefore, it might be foreseen that these studies hold the potential to

112   contribute to the development of early intervention strategies applicable to primary care.

113   Finally, existing evidence indicates that the effects of psychotherapeutic interventions on

114   loneliness might be limited as reported effect size estimates are mostly small-to-medium [28,

115   29]. These observations might indicate the necessity to adopt more comprehensive

116   approaches that also cover top-down strategies at the level of public health interventions.

117   However, their development might require broader insights into population-wide processes.

118   Following the considerations about the spectrum of loneliness severity that might be

119   covered by population-based studies, it is needed to note that previous studies have found

120   loneliness to be either a transient or chronic experience [30-36]. Although the exact threshold

121   duration of loneliness defining its chronic temporal pattern has not been established so far,

122   previous studies have conceptualized chronic loneliness as its occurrence across at least two

123   timepoints spanning between 1 and 6 years [30-36]. Investigating differences between chronic

124   and transient loneliness might be of importance to understand interindividual variability of

125   underlying mechanisms and outcomes. According to the cognitive and evolutionary model [4,

126   37, 38], the experience of loneliness might be adaptive as it triggers cognitions and behaviours

127   that aim to restore social connections. However, some individuals, especially those remaining

128   lonely over time, focus on threats related to social interactions and thus remain socially

129   disconnected [39]. In agreement with this model, it has been observed that transient

130   loneliness is associated with a smaller interpersonal distance while chronic loneliness is related

131   to a greater interpersonal distance [40]. A recent population-based study further

132   demonstrated that chronic and transient loneliness show important differences in terms of

133   underlying risk factors [41]. In this study, female gender, not being married, poor educational

134   attainment, poor mental and physical health, being limited in activities, poor social network,

135   and living in a culturally individualistic country are risk factors for chronic loneliness. For

136   transient loneliness, the effects of some risk factors including gender, physical health, the level

137   of education, and social network size were either not significant or not robust. It has also been

138   suggested that transient loneliness tends to occur after stressful events (e.g., retirement and

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139   loss of close social interactions), while chronic loneliness is more closely related to poor social

140   cognition, low social support, and a lack of intimate relationships [42].

141   Little is known about the differential associations of chronic and transient loneliness

142   with mental health outcomes. To date, temporal patterns of loneliness have not been tested

143   with respect to mental health outcomes beyond those related to depressive symptoms. It has

144   recently been observed that both chronic and transient loneliness, assessed over the course

145   of one year, are significantly associated with a higher likelihood of reporting a history of

146   depression diagnosis and psychiatric distress [30]. However, stronger associations were found

147   for chronic loneliness. Similar observations have been obtained in older populations [33, 36,

148   43, 44] and college students [45]. To bridge existing research gaps, the present study aimed to

149   assess differential associations of chronic and transient loneliness with a variety of mental

150   health outcomes represented by depressive symptoms, generalized anxiety, social anxiety, and

151   paranoid thoughts in a large, general population sample. The hypothesis behind the present

152   study was that both temporal patterns are associated with poor mental health outcomes;

153   however, these associations might be stronger for chronic loneliness.

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155   **Methods**

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157   *Recruitment procedures*

158   The cohort reported in this study was developed using the quota sampling method to

159   provide sample representativeness with respect to age, gender, education, employment

160   status, and place of residence. All assessments were carried out using self-reports

161   implemented in an internet-based survey. Baseline data were collected between July and

162   August, 2024. The follow-up assessment took place in February, 2025. At both timepoints, after

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163   the first invitation, potential participants received up to two reminders. Participants were

164   enrolled by a research company using its own online access panel of registered and verified

165   participants. The panel includes over 70,000 participants residing all administrative regions of

166   Poland. It is continuously being developed by means of regular campaigns. Individuals with

167   underrepresented backgrounds (e.g., ethnic and social minorities) are continuously invited to

168   register by additional campaigns initiated through trusted channels (e.g., ethnic media,

169   cultural festivals, and local events). These campaigns are implemented by the staff trained on

170   cultural sensitivity that approaches community leaders and organizations, and disseminates

171   culturally appropriate contents (in terms of language, imagery, and messaging) with

172   transparent information about research activities. In this study, the panel members aged at

173   least 18 years were eligible for participation. For completing both surveys, the participants

174   received incentives equivalent to 10 EUR. To optimize the reliability of responses, the accuracy

175   checks were used. Specifically, respondents were excluded while violating any of the following

176   accuracy checks: (1) short survey completion time (i.e., below 30% of the median completion

177   time); (2) failure to pass attention checks (i.e., participants were asked to respond to items

178   requesting them to select a specific answer); (3) inconsistent responses to repeated items, and

179   (4) responses with random strings of characters. The study received approval from the

180   Bioethics Committee at Wroclaw Medical University, Wroclaw, Poland (approval number:

181   553/2024) and all participants provided the online version of informed consent.

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183   *Measures*

184   *Depressive symptoms:* The Patient Health Questionnaire-9 (PHQ-9) was administered

185   to measure depressive symptoms [46]. It is a 9-item questionnaire measuring the frequency

186   of various depressive symptoms over preceding two weeks with a 4-point scale (0 - "not at all"

187   to 3 - "nearly every day"). The total PHQ-9 score are between 0 and 27 (higher scores reflect a

188   greater level of depressive symptoms). The PHQ-9 total score of $\geq$ 10 has optimal sensitivity

189   and specificity in detecting depression and was used in this study [47]. The Cronbach's alpha

190   of the PHQ-9 was 0.897 in this study.

191   *Generalized anxiety:* Anxiety symptoms were recorded using the Generalized Anxiety

192   Disorder-7 (GAD-7) [48]. It is a 7-item questionnaire (rated on 4-point scale: 0 - "not at all", 3 -

193   "nearly every day") that refers to generalized anxiety symptoms in the preceding 2 weeks (a 4-

194   point scale; 0 - "not at all", 3 - "nearly every day"). The total score is 0 - 21, where higher scores

195   indicate a greater level of anxiety symptoms. The optimal cut-off score of GAD-7 to detect

196   generalized anxiety disorder has been estimated at $\geq$ 10 and thus it was used in our study [48].

197   The Cronbach's alpha of GAD-7 was 0.944 in this study.

198   *Social anxiety:* The Social Interaction Anxiety Scale (SIAS) was used [49]. It is a 20-item

199   questionnaire that covers various of social anxiety. Respondents are instructed to rate the level

200   each item is typical for them on a 5-point scale (0 – "not at all", 4 – "extremely"). The cut-off

201   score of $\geq$ 36 was used [50]. The Cronbach's alpha was 0.947 in this study.

202   *Paranoid ideation:* Participants were asked to fill in the Revised Green et al. Paranoid

203   Thoughts Scale (R-GPTS) [51]. It is based on two subscales measuring ideas of reference (part

204   A, 8 items) and ideas of persecution (part B, 10 items) over the period of preceding month.

205   Items are rated on a 5-point scale (0 – "not at all", 4 – "totally"). Respondents are asked to

206   assess experiences that did not appear as the consequence of substance use. For the

207   persecution scale, the recommended cut-off to detect clinical levels of persecutory ideation

208   was estimated at $\geq$ 11 [51]. This cut-off corresponds with moderately severe levels of ideas of

209   reference (part A, $\geq$ 16 points). Therefore, in our study, the participants showing threshold

210   scores reaching at least one of these cut-offs were classified as those showing paranoid

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211 ideation. In this study, the Cronbach's alphas for parts A and B were 0.930 and 0.964,

212 respectively.

213 *Social network size:* To measure the social network size, the 6-item version of Lubben

214 Social Network Scale (LSNS-6) was used [52]. The LSNS-6 items record the number of family

215 members and friends who are seen or heard at least once a month, with whom the respondent

216 can talk about private matters, and who can be called on for help (a 6-point scale). The total

217 LSNS-6 score is 0 - 20. Higher scores correspond with a greater social network size. The

218 Cronbach's alpha of the LSNS-6 was 0.876 in this study.

219 *Loneliness:* To record the level of loneliness, the 11-item version of the De Jong Gierveld

220 Loneliness Scale (DJGLS) was used [53, 54]. Each item is rated using a 5-point scale (potential

221 responses are as follows: "yes!", "yes", "more or less", "no", and "no!"). There are two DJGLS

222 subscales: the first one measures emotional loneliness (6 items) and the second one refers to

223 social loneliness (5 items). The total score is estimated by counting positive and neutral

224 responses ("yes!", "yes", and "more or less") to items for emotional loneliness as well as

225 negative and neutral responses ("no!", "no", and "more or less") to items developed for social

226 loneliness. The total DJGLS score ranges between 0 and 11 (higher scores reflect a greater level

227 of loneliness). We used the cut-off proposed by the authors of DJGLS of > 2 to classify

228 participants as those experiencing loneliness [53]. In the present study, the Cronbach's alphas

229 for emotional loneliness subscale and social loneliness subscale were 0.874 and 0.810,

230 respectively.

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232 *Data analysis*

233 In the first step, descriptive characteristics of participants who completed assessments

234 at both timepoints and follow-up non-completers were compared using the chi-square test

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235 (categorical variables) and t-tests (continuous variables). Next, participants who completed

236 assessments at both timepoints were divided into three groups according to threshold scores

237 of the DJGLS [53] as proposed by previous studies [30, 32-36, 43, 55]. These groups were as

238 follows: (1) individuals with the DJGLS score of < 3 at both time points (i.e., participants

239 without loneliness at neither of timepoints); (2) individuals with the DJGLS score of ≥ 3 at one

240 timepoint (i.e., participants with transient loneliness), and (3) individuals with the DJGLS score

241 of ≥ 3 at both timepoints (i.e., participants with chronic loneliness). Finally, binary logistic

242 regression models were analysed to assess differential associations of loneliness temporal

243 patterns with symptom scores. Separate models were analysed for baseline and follow-up

244 symptoms taking into consideration three specific comparisons (i.e., chronic loneliness vs. no

245 loneliness, transient loneliness vs. no loneliness, and chronic loneliness vs. transient

246 loneliness). Covariates included age, gender, the level of education, place of residence,

247 employment status, mean monthly income, social network size, substance use in the

248 preceding month (except for alcohol and nicotine), and psychiatric treatment history (in the

249 preceding month). There were no missing data among individuals who completed assessments

250 at both timepoints. Results were interpreted as significant while obtaining the p-value lower

251 than 0.05. All analyses were carried out in the SPSS software, version 28.

252

253 **Results**

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255 *Descriptive characteristics of the sample*

256 Altogether, 10,985 individuals were approached for participation (Supplementary

257 Figure 1). Baseline assessment was completed by 5,099 individuals (aged 44.9 ± 15.4 years,

258 47.7% men, 46.4% of individuals invited to participate) while the follow-up assessment

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259   included 3,275 individuals resulting the retention rate of 64.2%. Individuals who completed

260   both assessments did not differ significantly from individuals who did not participate in the

261   follow-up assessment with respect to sociodemographic and clinical characteristics (Table 1).

262   Chronic loneliness was observed in 58.1% participants while transient loneliness was found in

263   16.2% individuals.

264

265   *Baseline symptoms and temporal patterns of loneliness*

266   Transient loneliness was associated with significantly higher odds of baseline

267   generalized anxiety, social anxiety, and paranoid ideation, but not depressive symptoms. This

268   observation remained significant after adjustment for covariates (Table 2, Figure 1A). The

269   highest effect size estimate was found for generalized anxiety (unadjusted analysis: OR = 1.94,

270   95%CI: 1.16 – 3.27, p = 0.012; adjusted analysis: OR = 1.92, 95%CI: 1.11 – 3.33, p = 0.020).

271   Among all tested covariates, only a lower social network size at baseline was significantly

272   associated with transient loneliness.

273   Chronic loneliness was associated with significantly higher baseline levels of all

274   symptom scores before and after adjustment for covariates (Table 2, Figure 1B). The highest

275   effect size estimate was observed for social anxiety (unadjusted analysis: OR = 4.29, 95%CI:

276   3.35 – 5.50, p < 0.001; adjusted analysis: OR = 3.18, 95%CI: 3.18, 95%CI: 2.38 – 4.24, p < 0.001).

277   Chronic loneliness was also significantly associated with female gender, higher levels of

278   education, higher odds of substance use, and a lower social network size.

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280   *Follow-up symptoms and temporal patterns of loneliness*

281   Transient loneliness was associated with significantly higher odds of follow-up

282   generalized anxiety and social anxiety. This observation was significant before and after

283   adjustment for covariates (Table 3, Figure 1C). The highest effect size estimate was found for

284   generalized anxiety (unadjusted analysis: OR = 2.57, 95%CI: 1.46 – 4.53, p = 0.001; adjusted

285   analysis: OR = 2.51, 95%CI: 1.39 – 4.53, p = 0.002). Among all tested covariates, only a lower

286   social network size at the follow-up was significantly associated with transient loneliness.

287   Chronic loneliness was associated with significantly higher odds of all symptoms before

288   and after adjustment for covariates (Table 3, Figure 1D). The highest effect size estimate was

289   found for social anxiety (unadjusted analysis: OR = 4.29, 95%CI: 3.35 – 5.50, p < 0.001; adjusted

290   analysis: OR = 3.18, 95%CI: 2.38 – 4.24, p < 0.001). Chronic loneliness was also significantly

291   associated with female gender, higher levels of education, higher odds of substance use, and

292   a lower social network size.

293

294   *Differences between temporal patterns of loneliness in their associations with mental health*

295   *outcomes*

296   Chronic loneliness, compared to transient loneliness, showed stronger associations

297   with baseline and follow-up symptoms of depression, social anxiety, and paranoid thoughts,

298   but not generalized anxiety (Table 4, Figure 2). These differences remained significant after

299   adjustment for covariates. With respect to baseline symptoms, the highest effect size estimate

300   was found for depressive symptoms (unadjusted analysis: OR = 2.46, 95%CI: 1.74 – 3.49, p <

301   0.001; adjusted analysis: OR = 2.20, 95%CI: 1.53 – 3.16, p < 0.001). In turn, for follow-up

302   symptoms, the highest effect size estimate was observed for social anxiety (unadjusted

303   analysis: OR = 2.68, 95%CI: 2.10 – 3.44, p < 0.001; adjusted analysis: OR: 2.30, 95%CI: 1.77 –

304   2.99, p < 0.001).

305

306   **Discussion**

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308 *Main findings*

309   Findings from the present study indicate that chronic loneliness, compared to its

310 transient temporal pattern, shows stronger and robust associations with the symptoms of

311 social anxiety, generalized anxiety, depression, and paranoia that are likely to be observed in

312 a short-term perspective. In case of chronic loneliness, these associations are likely to be

313 bidirectional with the largest effect size estimates observed for social anxiety. In case of

314 transient loneliness, the associations with psychopathological symptoms might be more

315 complex. First, it is important to note that our study did not demonstrate any significant

316 associations of transient loneliness with depressive symptoms. Second, transient loneliness

317 was significantly associated with higher baseline, but not follow-up odds of paranoid ideation.

318 Third, the strongest effect driven by transient loneliness was found for generalized anxiety and

319 this effect was comparable to the one found for chronic loneliness.

320   In general, the findings about quantitative differences in the strength of associations

321 with symptom domains between chronic and transient loneliness are in agreement with our

322 expectations and observations from previous studies measuring the level of depressive

323 symptoms [30, 33, 36, 43-45]. Various processes might explain observed associations between

324 loneliness and mental health outcomes. There is evidence that individuals experiencing

325 loneliness tend to show a number of social information processing biases that might increase

326 the risk of developing mental disorders. These include attention for threat bias, negative and

327 hostile intent attributions, increased rejection sensitivity, negative evaluation of self and

328 others, endorsement of less promotion- and more prevention-oriented goals, and low

329 perceived self-efficacy [39]. These cognitive biases might be bidirectionally associated with

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330   depression [56], generalized anxiety disorder [57], social anxiety disorder [58], and psychosis

331   [59].

332   It is also important to discuss some discrepancies between our findings and previous

333   observations. Indeed, our findings, to some extent, contradict the evolutionary model of

334   loneliness positing its transient temporal pattern as an adaptive experience that signals the

335   need to reconnect with others and indicating a lack of unfavourable associations with mental

336   health. However, observations from previous studies also do not support these considerations.

337   For instance, a longitudinal study of adolescents with the observation period of 12 years

338   identified three trajectories of loneliness, i.e., "stable low", "high decreasing", and "low

339   increasing" [60]. Both "high decreasing" and "low increasing" temporal patterns were

340   associated with elevated risk of depression. In addition, the "low increasing" pattern was

341   associated with a higher risk of anxiety. Another study, based on a 14-year observation period

342   of older adults revealed two frequency patterns of loneliness (i.e., moderate and high

343   frequency) and both of them were associated with increased risk of depression [61]. Also, the

344   study which spanned one year and included two waves of data demonstrated that both

345   chronic and transient loneliness are related to a higher risk of depression [30]. Notably, the

346   present study did not demonstrate any significant associations of transient loneliness with

347   depressive symptoms while observing significant associations with social and generalized

348   anxiety as well as follow-up paranoid ideation. This difference might originate from the fact

349   that our study, as opposed to previous studies, analysed the associations with depressive

350   symptoms while accounting for co-occurring psychopathology.

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352   *Methodological considerations*

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353   To our knowledge, this study has various strengths related to broad insights into

354   symptom domains associated with loneliness, a relatively large sample size, and a longitudinal

355   design. However, the findings also need to be interpreted in light of some limitations.

356   Recruitment procedures were implemented among the online panel users. While this

357   approach provided representativeness of the sample in terms of sociodemographic

358   characteristics, the risk of selection bias should be considered. Indeed, the study was

359   performed among internet users and initiated during the summer period when many people

360   spend holidays. Moreover, we did not use any measures of problematic internet use that has

361   been associated with loneliness [20]. Following these considerations, it cannot be excluded

362   that individuals with problematic internet use and those with higher levels of loneliness were

363   overrepresented in the present cohort. Another limitation is that we did not record the

364   information about the social or ethnic minority status. Also, the response and retention rates

365   (46.4% and 64.2%, respectively) were relatively low. However, a recent meta-analysis

366   estimated the mean response rate across online surveys at 44.1% [62]. Moreover, response

367   rates are not always directly related to the validity of findings [63]. For instance, it has been

368   found that studies with low response rate, even those with the response rate of 20%, are able

369   to provide more accurate results than those with the response rate of 60 – 70% [64].

370   Another limitation is related to a lack of the general consensus on how loneliness

371   should be operationalized as a categorical construct. Therefore, prevalence rates of loneliness

372   show relatively high variability across previous studies that is further influenced by the use of

373   specific questionnaires. In general, studies using single-item measures tend to report lower

374   prevalence rates and some authors argue that simple measures may not thoroughly capture

375   the construct of loneliness [65, 66]. A recent meta-analysis estimated the prevalence of

376   loneliness at 55.4% in community-dwelling older adults while pooling the studies using DJGLS

377   [65]. For studies based on single-item questions, the prevalence rate was found to be 21.2%.

378   Single-item measures often use direct indicators of loneliness (e.g., "I feel lonely" and "how

379   often do you feel lonely?"). Indirect indicators, represented by the DJGLS that was used in the

380   present study, are not based on the reference to loneliness. Therefore, they do not evoke

381   negative stereotypes and limit socially desirable responses [66, 67]. Indeed, individuals

382   experiencing loneliness are likely to hold self-stigmatizing perceptions that might be defined

383   as "the shame for being lonely and inclination to conceal loneliness" [68]. In this regard, the

384   use of single-item and direct indicators might lead to underreporting of loneliness. Findings

385   from our study may also provide limited insights into the temporal patterns of loneliness due

386   to a low number of assessments over time and a relatively short observation period. However,

387   we believe that approaching shorter observation periods may also be important as it informs

388   about early consequences of loneliness and processes that directly precede its occurrence.

389   Considering our approach to data analysis, it is needed to note that while we controlled for

390   the effects of various sociodemographic characteristics, we did not assess as to whether these

391   variables moderate the associations of loneliness with mental health outcomes.

392   It should also be noted that while the general population provides opportunities for

393   studying loneliness as a public health concern taking into consideration the heterogeneity of

394   social determinants, this approach limits the potential to translate findings over individuals

395   with mental disorders. At this point, it is also important to highlight that the measures of

396   mental health outcomes were based on screening questionnaires and a comprehensive clinical

397   validation was not performed. Finally, it should be noted that the study does enable to draw

398   conclusions about causality due to observational design.

399

400   *Directions for future studies*

401   The most important direction for future studies is related to the need of a consensus-

402   driven operationalization of loneliness temporal patterns. In this regard, two research

403   directions need to be discussed. First, it should be considered to develop questionnaires

404   recording duration of loneliness. Second, it might be needed to perform intensive longitudinal

405   studies that record the experience of loneliness and mental health characteristics over

406   multiple timepoints in order to find the threshold duration defining temporal patterns of

407   loneliness. Another important direction is related to the need of better understanding of

408   factors moderating the associations of loneliness with mental health in order to define

409   populations with the highest vulnerability. For instance, it has consistently been shown that

410   the prevalence of loneliness is the highest in young adulthood (up to 30 years of age),

411   decreases in middle adulthood and early old age, and then increases during the oldest old age

412   [69-71]. To date, it has been suggested that contextual factors underlying loneliness in various

413   age groups might differ [22-27]. However, as shown by a recent meta-analysis, interventions

414   targeting loneliness in various age groups might show comparable efficacy [29].

415   Finally, with an ongoing digitalization and frequent involvement in remote social

416   interactions, it might be needed to better understand on how various problematic online

417   behaviours are interrelated with loneliness. A recent meta-analysis demonstrated that

418   problematic internet use is bidirectionally associated with loneliness [20]. This association was

419   found to be stronger in samples from Eastern countries, with more men and young adults, and

420   those studied over recent years. On one side, problematic internet use might be perceived as

421   the strategy to cope with social disconnection (either loneliness or social isolation) and

422   boredom [72-74]. On the other side, problematic internet use may increase the level of

423   loneliness through the mechanisms related to social displacement, a lack of adequate sensory

424   cues and bodily feedback [75, 76]. However, it is needed to point out that problematic internet

425   use is now believed to serve as the spectrum of various problematic online behaviours that

426   show differential associations with mental health outcomes [77]. Addressing their differential

427   associations with loneliness is warranted. Also, the need to explore on how digital

428   advancements might be reframed to tackle loneliness should be highlighted. For instance,

429   there is some evidence that enhancing video communication between care home residents

430   and family members might be feasible in supporting person-centred care, social interactions,

431   and wellbeing [78].

432

433   *Clinical implications*

434   Although the present study was carried out in the general population, some

435   implications for public health and clinical practice might be formulated. The findings imply the

436   necessity to consider early intervention and risk stratification taking into consideration the

437   temporal pattern of loneliness. It should also be considered which interventions need to be

438   prioritized among individuals showing specific temporal patterns of loneliness. According to

439   the cognitive-evolutionary model, transient loneliness might motivate individuals to seek

440   social interactions [4, 37, 38]. A recent study revealed that while transient loneliness is

441   associated with a smaller preferred interpersonal distance, chronic loneliness was found to be

442   linked with a greater preferred interpersonal distance [40]. In this regard, it might be

443   concluded that specific therapeutic interventions targeting transient loneliness, especially

444   those related to motivating social involvement, may not be necessary. In this group, awareness

445   of transition to chronicity of loneliness, improvement of social skills maintaining close

446   relationships, community engagement, and clinical assessment should be considered [79]. In

447   turn, the initiation of therapeutic interventions might be the priority for individuals with

448   chronic loneliness. To date, a variety of approaches targeting chronic loneliness have been

19

449   developed. A recent meta-analysis revealed that the priority should be given to the

450   reminiscence intervention, interventions promoting social identity formation, and cognitive-

451   behavioural therapy [29]. Another meta-analysis revealed the greatest effect size for cognitive

452   interventions and a lack of benefits related to the interventions enhancing social skills [80].

453

454   *Conclusions*

455   Taken together, the findings indicate that chronic and transient loneliness show

456   qualitative and quantitative differences in their associations with psychopathological

457   symptoms that might already be observed in a short-term perspective. Chronic loneliness

458   shows robust and bidirectional associations across various domains of psychopathology

459   covering depressive symptoms, social anxiety, generalized anxiety, and paranoid ideation. In

460   turn, transient loneliness shows bidirectional associations with generalized and social anxiety.

461   These observations hold some implications referring to the public health and clinical

462   perspectives by indicating the rationale to detect loneliness in its early development. However,

463   additional studies approaching longer observation periods and a thorough clinical assessment

464   are also needed to provide broader insights into the mechanisms, consequences, and

465   temporal patterns of loneliness.

466

467   **Figure legend**

468

469   **Figure 1.** Temporal patterns of loneliness and their associations with mental health outcomes.

470   The associations with baseline symptoms are shown in Figure 1A (transient loneliness vs. no

471   loneliness) and Figure 1B (chronic loneliness vs. no loneliness), while the associations with

472   follow-up symptoms are visualized in Figure 1C (transient loneliness vs. no loneliness) and

20

473 Figure 1D (chronic loneliness vs. no loneliness). Results are adjusted for age, gender,

474 education, place of residence, employment status, monthly income, social network size,

475 substance use (preceding month), and psychiatric treatment history (preceding month).

476

477 **Figure 2.** Differences between temporal patterns of loneliness in their associations with

478 baseline (A) and follow-up (B) symptoms. Chronic loneliness is a reference category. Results

479 are adjusted for age, gender, education, place of residence, employment status, monthly

480 income, social network size, substance use (preceding month), and psychiatric treatment

481 history (preceding month).

482

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488

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490

491 **Data availability statement.** Due to sensitivity reasons, the data supporting the present study

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493

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740 **Table 1.** The general characteristics of the cohort.

	Total sample (*n* = 5,099)	Completers (*n* = 3,275)	Non-completers (*n* = 1,824)	*p*
Age, years	44.9 ± 15.4	45.2 ± 15.7	44.8 ± 15.2	0.189
Gender, men	2431 (47.7)	1568 (47.9)	863 (47.3)	0.718
Education				
Primary	94 (1.8)	53 (1.6)	41 (2.2)	0.858
Vocational	411 (8.1)	273 (8.3)	138 (7.6)	
Secondary	2098 (41.1)	1345 (41.1)	753 (41.3)	
Higher	2496 (49.0)	1604 (49.0)	892 (48.9)	
Employment				
Unemployed	435 (8.5)	265 (8.1)	170 (9.3)	0.406
Retired/disability pension	1002 (19.6)	632 (19.3)	370 (20.3)	
Student	234 (4.6)	156 (4.8)	78 (4.3)	
Part-time work	482 (9.5)	317 (9.7)	165 (9.0)	
Full-time work	2946 (57.8)	1905 (58.1)	1041 (57.1)	
Place of residence				
Rural	1650 (32.4)	1065 (32.5)	585 (32.1)	0.991
Urban, < 50,000 inhabitants	1166 (22.9)	750 (22.9)	416 (22.8)	
Urban, 50,000 – 150,000 inhabitants	816 (16.0)	525 (16.0)	291 (16.0)	
Urban, 150,000 – 500,000 inhabitants	714 (14.0)	457 (14.0)	257 (14.0)	
Urban, > 500,000 inhabitants	753 (14.7)	478 (14.6)	275 (15.1)	
Monthly income				
< 750 USD	1082 (21.1)	695 (21.2)	387 (21.2)	0.170
750 – 1500 USD	2485 (48.7)	1621 (49.6)	864 (47.4)	
1,500 – 2,500 USD	722 (14.2)	468 (14.3)	254 (13.9)	
2,500 – 3,750 USD	133 (2.6)	80 (2.4)	53 (2.9)	
> 3,750 USD	44 (0.9)	31 (0.9)	13 (0.7)	
Refused to answer	633 (12.4)	380 (11.6)	253 (13.9)	
Social network size, baseline	15.9 ± 6.0	16.0 ± 6.0	15.8 ± 5.8	0.222
Social network size, follow-up	–	15.7 ± 5.9	–	–
Psychiatric treatment				
Lifetime	1108 (21.7)	705 (21.5)	403 (22.1)	0.638
Preceding month	539 (10.6)	327 (10.0)	512 (28.1)	0.068
Substance use, preceding month[*]	353 (6.9)	213 (6.5)	140 (7.7)	0.353
Depression, baseline	1362 (26.7)	860 (26.3)	502 (27.5)	0.329
Depression, follow-up	–	823 (25.1)	–	–
Generalized anxiety, baseline	1084 (21.3)	683 (20.9)	401 (22.0)	0.345
Generalized anxiety, follow-up	–	664 (20.3)	–	–
Social anxiety, baseline	1890 (37.1)	1206 (36.8)	684 (37.5)	0.632
Social anxiety, follow-up	–	1219 (37.2)	–	–
Paranoid ideation, baseline	1618 (31.7)	1017 (31.1)	601 (32.9)	0.163
Paranoid ideation, follow-up	–	1018 (31.1)	–	–
Loneliness				
Chronic	–	1904 (58.1)	–	–
Transient	–	532 (16.2)	–	
None	–	839 (25.6)	–	

741 Data are reported as mean ± SD or n (%)
742 [*]Except for nicotine and alcohol
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744 **Table 2.** The associations of baseline mental health measures with temporal patterns of loneliness.

Model	Independent variable	Analysis					
		Unadjusted			Adjusted		
		OR	95%CI	p	OR	95%CI	p
Transient loneliness vs. no loneliness	Depressive symptoms	1.20	0.74 − 1.94	0.455	1.16	0.69 − 1.92	0.578
	Generalized anxiety	1.94	1.16 − 3.27	**0.012**	1.92	1.11 − 3.33	**0.020**
	Social anxiety	1.87	1.36 − 2.56	**< 0.001**	1.65	1.18 − 2.31	**0.004**
	Paranoid ideation	1.62	1.16 − 2.24	**0.004**	1.64	1.16 − 2.32	**0.005**
	Age	−	−	−	0.99	0.98 − 1.00	0.134
	Gender (women)	−	−	−	1.26	0.97 − 1.62	0.084
	Education	−	−	−	1.18	0.98 − 1.43	0.081
	Urbanicity	−	−	−	0.96	0.87 − 1.04	0.311
	Unemployment[a]	−	−	−	1.01	0.76 − 1.34	0.967
	Income	−	−	−	1.04	0.88 − 1.23	0.626
	Psychiatric treatment[b]	−	−	−	1.54	0.82 − 2.90	0.176
	Substance use[c]	−	−	−	1.87	0.90 − 3.89	0.094
	Social network size	−	−	−	0.89	0.87 − 0.92	**< 0.001**
Chronic loneliness vs. no loneliness	Depressive symptoms	3.39	2.35 − 4.90	**< 0.001**	2.96	1.94 − 4.50	**< 0.001**
	Generalized anxiety	1.85	1.20 − 2.86	**0.006**	1.86	1.14 − 3.03	**0.013**
	Social anxiety	4.29	3.35 − 5.50	**< 0.001**	3.18	2.38 − 4.24	**< 0.001**
	Paranoid ideation	2.17	1.67 − 2.82	**< 0.001**	2.14	1.59 − 2.89	**< 0.001**
	Age	−	−	−	0.99	0.98 − 1.05	0.326
	Gender (women)	−	−	−	1.39	1.10 − 1.76	**0.005**
	Education	−	−	−	1.26	1.07 − 1.49	**0.007**
	Urbanicity	−	−	−	0.95	0.88 − 1.03	0.252
	Unemployment[a]	−	−	−	0.93	0.72 − 1.20	0.569
	Income	−	−	−	0.97	0.83 − 1.13	0.661
	Psychiatric treatment[b]	−	−	−	1.02	0.62 − 1.66	0.950
	Substance use[c]	−	−	−	2.27	1.22 − 4.22	**0.009**
	Social network size	−	−	−	0.80	0.78 − 0.82	**< 0.001**

745 Significant associations (p < 0.05) are bolded
746 [a]Refers to the lack of any employment and student status
747 [b]Refers to the prior-month history
748 [c]Refers to the prior-month history; nicotine and alcohol use were not assessed
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752 **Table 3.** The associations of follow-up mental health measures with temporal patterns of loneliness.

Model	Independent variable	Analysis					
		Unadjusted			Adjusted		
		OR	95%CI	p	OR	95%CI	p
Transient loneliness vs. no loneliness	Depressive symptoms	1.12	0.69 – 1.82	0.656	1.11	0.67 – 1.85	0.690
	Generalized anxiety	2.57	1.46 – 4.53	**0.001**	2.51	1.39 – 4.53	**0.002**
	Social anxiety	1.77	1.28 – 2.45	**< 0.001**	1.52	1.08 – 2.15	**0.017**
	Paranoid ideation	1.30	0.93 – 1.81	0.126	1.37	0.96 – 1.94	0.081
	Age	–	–	–	0.99	0.98 – 1.00	0.147
	Gender (women)	–	–	–	1.26	0.97 – 1.63	0.080
	Education	–	–	–	1.21	1.00 – 1.46	0.050
	Urbanicity	–	–	–	0.97	0.89 – 1.06	0.485
	Unemployment[a]	–	–	–	0.99	0.74 – 1.31	0.929
	Income	–	–	–	1.06	0.90 – 1.24	0.517
	Psychiatric treatment[b]	–	–	–	1.39	0.74 – 2.60	0.303
	Substance use[c]	–	–	–	2.03	0.98 – 4.23	0.058
	Social network size	–	–	–	0.89	0.86 – 0.91	**< 0.001**
Chronic loneliness vs. no loneliness	Depressive symptoms	2.26	1.57 – 3.24	**< 0.001**	2.11	1.39 – 3.21	**< 0.001**
	Generalized anxiety	2.92	1.84 – 4.62	**< 0.001**	2.38	1.43 – 3.95	**< 0.001**
	Social anxiety	5.00	3.89 – 6.41	**< 0.001**	3.39	2.56 – 4.50	**< 0.001**
	Paranoid ideation	2.34	1.81 – 3.03	**< 0.001**	2.58	1.92 – 3.47	**< 0.001**
	Age	–	–	–	0.99	0.98 – 1.01	0.639
	Gender (women)	–	–	–	1.36	1.08 – 1.72	**0.009**
	Education	–	–	–	1.25	1.05 – 1.48	**0.010**
	Urbanicity	–	–	–	0.97	0.90 – 1.05	0.475
	Unemployment[a]	–	–	–	0.90	0.70 – 1.16	0.422
	Income	–	–	–	0.97	0.83 – 1.13	0.690
	Psychiatric treatment[b]	–	–	–	0.97	0.60 – 1.58	0.915
	Substance use[c]	–	–	–	2.42	1.31 – 4.47	**0.005**
	Social network size	–	–	–	0.79	0.77 – 0.81	**< 0.001**

753 Significant associations (p < 0.05) are bolded

754 [a]Refers to the lack of any employment and student status

755 [b]Refers to the prior-month history

756 [c]Refers to the prior-month history; nicotine and alcohol use were not assessed
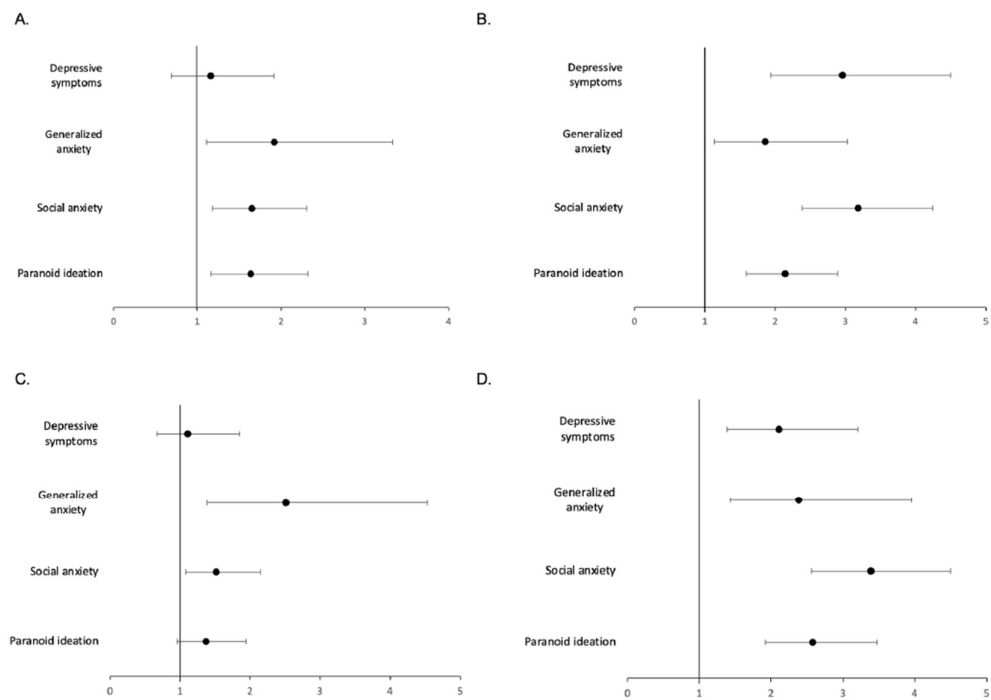
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759 **Table 4.** Differences between chronic and transient loneliness with respect to mental health measures.

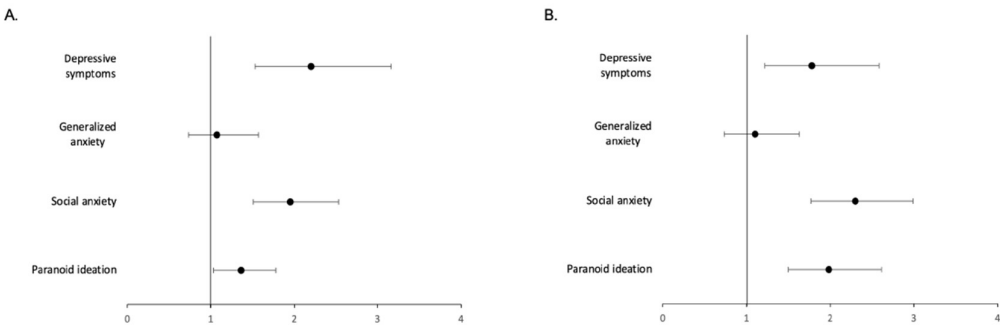| Model	Independent variable	Analysis					
		Unadjusted			Adjusted		
		OR	95%CI	p	OR	95%CI	p
Baseline measures of mental health	Depressive symptoms	2.46	1.74 – 3.49	**< 0.001**	2.20	1.53 – 3.16	**< 0.001**
	Generalized anxiety	1.05	0.72 – 1.52	0.808	1.07	0.73 – 1.57	0.731
	Social anxiety	2.29	1.80 – 2.91	**< 0.001**	1.95	1.51 – 2.53	**< 0.001**
	Paranoid ideation	1.33	1.03 – 1.72	**0.030**	1.36	1.03 – 1.78	**0.028**
	Age	–	–	–	1.00	0.99 – 1.01	0.718
	Gender (women)	–	–	–	1.21	0.96 – 1.53	0.111
	Education	–	–	–	1.06	0.89 – 1.25	0.520
	Urbanicity	–	–	–	0.98	0.90 – 1.06	0.566
	Unemployment[a]	–	–	–	0.95	0.73 – 1.22	0.675
	Income	–	–	–	0.94	0.82 – 1.09	0.440
	Psychiatric treatment[b]	–	–	–	0.74	0.46 – 1.19	0.215
	Substance use[c]	–	–	–	0.85	0.51 – 1.42	0.536
	Social network size	–	–	–	0.89	0.87 – 0.91	**< 0.001**
Follow-up measures of mental health	Depressive symptoms	1.82	1.28 – 2.59	**< 0.001**	1.78	1.22 – 2.58	**0.003**
	Generalized anxiety	1.16	0.79 – 1.70	0.444	1.10	0.73 – 1.63	0.657
	Social anxiety	2.68	2.10 – 3.44	**< 0.001**	2.30	1.77 – 2.99	**< 0.001**
	Paranoid ideation	1.78	1.37 – 2.32	**< 0.001**	1.98	1.50 – 2.61	**< 0.001**
	Age	–	–	–	1.00	0.99 – 1.01	0.727
	Gender (women)	–	–	–	1.18	0.93 – 1.50	0.166
	Education	–	–	–	1.06	0.89 – 1.26	0.495
	Urbanicity	–	–	–	0.98	0.91 – 1.07	0.668
	Unemployment[a]	–	–	–	0.95	0.74 – 1.23	0.695
	Income	–	–	–	0.95	0.82 – 1.10	0.481
	Psychiatric treatment[b]	–	–	–	0.73	0.46 – 1.17	0.195
	Substance use[c]	–	–	–	0.83	0.49 – 1.39	0.474
	Social network size	–	–	–	0.88	0.86 – 0.90	< 0.001

760 Chronic loneliness was included as reference

761 Significant associations (p < 0.05) are bolded

762 [a]Refers to the lack of any employment and student status

763 [b]Refers to the prior-month history

764 [c]Refers to the prior-month history; nicotine and alcohol use were not assessed

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766   Figure 1
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770   Figure 2

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