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Lonely young adults in modern Britain: findings from an epidemiological cohort study

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Abstract

Background—The aim of this study was to build a detailed, integrative profile of the correlates of young adults' feelings of loneliness, in terms of their current health and functioning and their childhood experiences and circumstances.

Methods—Data were drawn from the Environmental Risk Longitudinal Twin Study, a birth cohort of 2,232 individuals born in England and Wales in 1994 and 1995. Loneliness was measured when participants were aged 18. Regression analyses were used to test concurrent associations between loneliness and health and functioning in young adulthood. Longitudinal analyses were conducted to examine childhood factors associated with young adult loneliness.

Results—Lonelier young adults were more likely to experience mental health problems, to engage in physical health risk behaviours, and to use more negative strategies to cope with stress. They were less confident in their employment prospects and were more likely to be out of work. Lonelier young adults were, as children, more likely to have had mental health difficulties, and to have experienced bullying and social isolation. Loneliness was evenly distributed across genders and socioeconomic backgrounds.

Conclusions—Young adults' experience of loneliness co-occurs with a diverse range of problems, with potential implications for health in later life. The findings underscore the

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importance of early intervention to prevent lonely young adults from being trapped in loneliness as they age.

Keywords

Loneliness; social isolation; mental health; young adulthood; public health; epidemiology

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Introduction

Loneliness is a distressing and pervasive experience, defined as the feeling that one's desired quantity or quality of social connection is unfulfilled (Peplau and Perlman, 1982). Among older people, it is associated with a diverse range of health outcomes, including cardiovascular disease and stroke (Valtorta *et al.* 2016), increases in blood pressure (Hawkley *et al.* 2010), changes in gene expression (Cole *et al.* 2007), elevated cortisol (Adam *et al.* 2006), cognitive impairments (Shankar *et al.* 2013) and physical decline (Perissinotto *et al.* 2012). A large body of epidemiological evidence has established loneliness as a strong predictor of premature death, with effect sizes similar to or greater than other well-established risk factors such as smoking and obesity (Elovainio *et al.* 2017; Holt-Lunstad *et al.* 2010; Luo *et al.* 2012). According to a cross-national study by the Office for National Statistics (2014), the percentage of the UK population with access to supportive social relationships is the third-lowest of all the 28 EU nations. This makes loneliness a public health concern of particular relevance to the UK.

Although widely studied from a gerontological perspective, loneliness is not confined to old age, and is particularly prevalent among young adults (Qualter *et al.* 2015; Victor and Yang, 2012). A survey by the Mental Health Foundation (2010) has indicated that the proportion of people in the UK who often feel lonely, worry about feeling lonely, and seek help for loneliness is highest among younger people (aged 18-34 years) compared to older age groups. More than half of young adults surveyed reported having felt depressed at some time because they felt alone, compared to one third of older respondents. Given this high prevalence, young adults today could be particularly at risk for loneliness-related health problems in later life. This high occurrence of loneliness among the young also underscores the need for greater understanding of how loneliness impacts young people's lives and the early factors that contribute to its emergence.

Feelings of loneliness have been shown to predict increases in depressive symptoms in both older and younger people (Cacioppo *et al.* 2010; Vanhalst *et al.* 2012). As well as being a risk factor for psychopathology, loneliness may co-occur with a broad variety of other health and lifestyle-related impairments, making it a risk marker of high clinical relevance. This could be particularly true for young adults, given the high prevalence of loneliness in this group and the life changes that take place at this age, such as entering the labour market and leaving the family home. The burden of loneliness may undermine young people's confidence in their employment prospects, or lead them to adopt maladaptive coping strategies and behaviours detrimental to later health. Wide-ranging descriptive research on loneliness is required to study its pervasiveness across different domains of health and functioning.

As well as examining the profile of loneliness in terms of its correlates in adulthood, it is important to consider individuals' childhood history and experiences that may shape individuals' vulnerability to loneliness. On the one hand, loneliness is likely to be an adversity that can befall people from a diverse range of socioeconomic and family backgrounds. On the other hand, emotional problems or difficulties with peer relationships in the childhood years may foreshadow greater feelings of loneliness in young adulthood. The investigation of these potential risk factors can help to identify groups of children who are particularly vulnerable to becoming lonely in adulthood, and to identify targets for preventative interventions.

The aim of the present study was to examine the profile of loneliness in a prospective, contemporary, nationally-representative cohort of 18 year-olds living in the UK. Cross-sectional data were used to investigate the functioning of lonely young adults in four domains: mental health, physical health and health risks, coping and functioning, and career prospects. Longitudinal data were used to examine the childhood history of lonely individuals, in terms of family environment, child characteristics, mental health, as well as victimisation and social relationships.

Methods

Participants

Participants were members of the Environmental Risk (E-Risk) Longitudinal Twin Study, which tracks the development of a birth cohort of 2,232 British children. The sample was drawn from a larger birth register of twins born in England and Wales in 1994-1995 (Trouton *et al.* 2002). Full details about the sample are reported elsewhere (Moffitt and E-Risk Study Team, 2002). Briefly, the E-Risk sample was constructed in 1999-2000, when 1,116 families (93% of those eligible) with same-sex 5-year-old twins participated in home-visit assessments. This sample comprised 56% monozygotic (MZ) and 44% dizygotic (DZ) twin pairs; sex was evenly distributed within zygosity (49% male).

Families were recruited to represent the UK population with newborns in the 1990s, to ensure adequate numbers of children in disadvantaged homes and to avoid an excess of twins born to well-educated women using assisted reproduction. The study sample represents the full range of socioeconomic conditions in Great Britain, as reflected in the families' distribution on a neighbourhood-level socioeconomic index (ACORN [A Classification of Residential Neighbourhoods], developed by CACI Inc. for commercial use) (Odgers *et al.* 2012a, 2012b). Specifically, E-Risk families' ACORN distribution matches that of households nation-wide: 25.6% of E-Risk families live in "wealthy achiever" neighbourhoods compared to 25.3% nationwide; 5.3% vs. 11.6% live in "urban prosperity" neighbourhoods; 29.6% vs. 26.9% live in "comfortably off" neighbourhoods; 13.4% vs. 13.9% live in "moderate means" neighbourhoods, and 26.1% vs. 20.7% live in "hard-pressed" neighbourhoods. E-Risk underrepresents "urban prosperity" neighbourhoods because such houses are likely to be childless.

Follow-up home visits were conducted when the children were aged 7 (98% participation), 10 (96%), 12 (96%), and at 18 years (93%). There were 2,066 children who participated in

the E-Risk assessments at age 18, and the proportions of MZ (55%) and male same-sex (47%) twins were almost identical to those found in the original sample at age 5. The average age of the twins at the time of the assessment was 18.4 years (SD = 0.36); all interviews were conducted after their 18th birthday. There were no differences between those who did and did not take part at age 18 in terms of socioeconomic status (SES) assessed when the cohort was initially defined ($\chi^2 = 0.86$, $p = 0.65$), age-5 IQ scores ($t = 0.98$, $p = 0.33$), or age-5 emotional or behavioural problems ($t = 0.40$, $p = 0.69$ and $t = 0.41$, $p = 0.68$, respectively). Home visits at ages 5, 7, 10, and 12 years included assessments with participants as well as their mother (or primary caretaker). The home visit at age 18 included interviews only with the participants. The Joint South London and Maudsley and the Institute of Psychiatry Research Ethics Committee approved each phase of the study. Parents gave informed consent and twins gave assent between 5-12 years and then informed consent at age 18.

Measures

Loneliness—Loneliness was assessed when participants were 18 using four items from the UCLA Loneliness Scale, Version 3 (Russell, 1996): “How often do you feel that you lack companionship?”, “How often do you feel left out?”, “How often do you feel isolated from others?” and “How often do you feel alone?” A very similar short form of the UCLA scale has previously been developed for use in large-scale surveys, and correlates strongly with the full 20-item version (Hughes *et al.* 2004). The scale was administered as part of a computer-based self-complete questionnaire. Interviewers were blind to participants’ responses. The items were rated “hardly ever” (0), “some of the time” (1) or “often” (2). Items were summed to produce a total loneliness score (Cronbach α = 0.83). The heritability of loneliness has been reported in a previous study of the E-Risk cohort (Matthews *et al.* 2016), in which 38% of the variance in loneliness was estimated to be explained by genetic influences.

Correlates of loneliness in young adulthood—Functioning in adulthood was measured in terms of mental health, physical health and health risks, coping and functioning, employment prospects. Mental health measures comprised past year diagnoses of depression, anxiety, attention-deficit hyperactivity disorder (ADHD), conduct disorder, alcohol dependence and cannabis dependence, as well as any instances of self-harm or suicide attempts between ages 12 and 18. Participants also reported whether they had seen a GP, psychiatrist, counsellor or psychotherapist for mental health problems in the past year. The physical health and health risk domain comprised measures of body mass index (BMI), C-reactive protein (CRP, a marker of inflammation), day-to-day physical activity and daily smoking. The coping and functioning domain included life satisfaction, coping with stress and problematic technology use. Participants were asked about their highest qualification level, and whether they were currently in employment or studying. Participants also completed questionnaires about their job search behaviour, their optimism about opportunities to succeed in their career, and their perceived job preparedness. Full details of measures are shown in Table 1.

Childhood predictors of loneliness in young adulthood—Childhood measures were collected between the ages of 5 and 12. Predictors were grouped in four domains: family environment, child characteristics, child mental health, experiences of victimisation and social relationships. Family environment variables included maternal warmth, maternal depression, parental antisocial behaviour and exposure to domestic violence. Child characteristics captured IQ, theory of mind, and personality traits such as openness to experience, conscientiousness, extraversion, agreeableness and neuroticism. Child mental health variables were symptom counts of depression, anxiety, ADHD, conduct disorder and substance use (alcohol, tobacco and other drugs). Victimisation comprised measures of physical maltreatment by an adult and bullying by peers, while social relationships were indexed by social isolation. Full details of measures are shown in Table 1.

Data analysis

Concurrent associations between loneliness and mental health diagnoses, self-harm, suicide attempts and service use in young adulthood were tested using logistic regressions. Associations between loneliness and measures of physical health and health risks, coping and functioning and employment prospects were tested using linear and logistic regressions. Loneliness was entered as the independent variable in each analysis.

Longitudinal analyses were conducted using linear regression with age-18 loneliness as the outcome variable. Childhood predictors were entered individually. As a further step, to test the independence of the associations, the variables that were significantly associated with loneliness were entered together in blocks by domain (family environment, child characteristics, child mental health, victimisation and social relationships). Significant predictors from each domain were then entered into a final model.

The proportion of participants with missing data from the interview assessments was <=10% for all variables except CRP (13%). Cases with incomplete data were excluded listwise in all regression analyses. Participants in this study were pairs of same-sex twins, and therefore each family contained data for two individuals, resulting in nonindependent observations. To correct for this, all regression analysis were based on the Huber-White or sandwich variance (Williams, 2000), which adjusts the estimated standard errors to account for the dependence in the data. Regression analyses were conducted in Stata, version 14 (StataCorp, 2015).

Results

Prevalence of loneliness

In response to the four items about feelings of loneliness, 23-31% of participants reported experiencing any of these feelings “some of the time”, and 5-7% reported feeling them “often” (Figure 1). These rates indicate that feelings of loneliness in the general population of young adults are not uncommon but their frequency is high only in a small group. All subsequent analyses were conducted using the summed scale of these items (M = 1.57, SD = 1.94). Mean levels of loneliness did not differ across genders (males M = 1.51, females M = 1.62; $p = 0.22$), nor across SES groups (low M = 1.69, middle M = 1.52, high M = 1.49; $p = 0.09$).

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Correlates of loneliness in young adulthood

Lonelier 18 year-olds were more likely to meet diagnostic criteria for depression, anxiety, ADHD, conduct disorder, alcohol and cannabis dependence, to have self-harmed, and to have attempted suicide (Table 2). Loneliness was most strongly associated with depression and anxiety, the odds of which more than doubled with a one standard deviation increase in loneliness. The overlap between loneliness and these two disorders is illustrated in Figure 2. Lonelier individuals were also more likely to have sought help for mental health problems from a GP, psychiatrist, counsellor or psychotherapist in the past year.

Loneliness was not associated cross-sectionally with indicators of poor physical health, such as BMI or CRP (Table 2). However, it was associated with risk behaviours that predict future ill health: lonelier individuals engaged in less day-to-day physical activity, and were more likely to be daily smokers. Lonelier young adults had lower overall life satisfaction, reported more problematic technology use, and used more negative strategies to cope with stress, such as withdrawing and obsessing about problems rather than seeking help or taking pragmatic steps to rectify the situation. Loneliness was unrelated to individuals' efforts to seek employment. Nonetheless, lonelier 18 year-olds were more likely to be out of work and education, and to have low educational qualifications. In terms of job market preparedness, lonelier individuals rated themselves lower in terms of their personal attributes (e.g. teamworking), but not their practical skills (e.g. computer programming). They also reported lower optimism about their ability to succeed in life.

Tests of robustness and independence

The associations between loneliness and each mental health disorder were tested further by controlling for prior symptoms of the disorder in childhood. All associations remained significant (Table 3). As a further step, to test the independence of each association, all comorbid mental health problems in young adulthood were additionally controlled for. Loneliness remained independently associated with depression, anxiety, ADHD, conduct disorder, self-harm and suicide attempts, but not with alcohol or cannabis dependence.

The independence of the associations between loneliness and life satisfaction, coping, problematic technology use, job market preparedness (personal attributes) and optimism were tested by controlling for mental health problems. All associations remained robust to these controls (life satisfaction $\beta = -0.29$, 95% CI = -0.34, -0.25; coping $\beta = -0.27$, 95% CI = -0.32, -0.22; problematic technology use $\beta = 0.17$, 95% CI = 0.12, 0.23; job market preparedness $\beta = -0.20$, 95% CI = -0.26, -0.14; optimism $\beta = -0.20$, 95% CI = -0.25, -0.15). Furthermore, the associations between loneliness and lower job market preparedness and optimism remained significant when controlling additionally for being not in employment, education or training, and for having low qualifications (job market preparedness $\beta = 0.19$, 95% CI = -0.26, -0.14; optimism $\beta = -0.19$, 95% CI = -0.24, -0.14)

Childhood predictors of loneliness in young adulthood

Loneliness was not associated with aspects of the early family environment, including maternal warmth, maternal depression, parental antisocial behaviour and domestic violence in the home (Table 4). However, children who had higher levels of neuroticism, depression

or anxiety, or who experienced bullying or social isolation in childhood were lonelier at age 18. When these predictors were considered together, they all remained independently associated with loneliness, although the effect sizes were small. IQ and theory of mind were associated with loneliness in the univariate analyses, but became non-significant when controlling for other variables. Childhood ADHD, conduct disorder and substance use did not predict loneliness when controlling for depression and anxiety. Physical maltreatment was not associated with loneliness after social isolation and bullying were accounted for.

Discussion

Loneliness is an important determinant of long-term health and functioning. Although often presumed to be an affliction of older age, this study demonstrates that loneliness is also a common experience in young people, occurring indiscriminately across genders and socioeconomic strata. The findings also show that loneliness is a marker of poor functioning across many different domains of well-being and health. To reduce the public health burden of loneliness in later life, the experience of feeling lonely in this age group merits particular consideration.

This study builds upon previous research showing that loneliness is robustly associated with depression (Cacioppo *et al.* 2010; Vanhalst *et al.* 2012) and extends these findings to a range of other mental health problems. Despite high comorbidity between the disorders under investigation, loneliness was independently associated with each one. The only exceptions to this were alcohol and cannabis dependence, possibly because substance abuse is a social activity among young adults (Borsari and Carey, 2001). This pervasiveness of loneliness across different mental health disorders could imply either that loneliness' effect on psychopathology is pleiotropic in nature or, conversely, that individuals with any mental health disorder are more likely to feel lonely and marginalised.

With regard to physical health, long-term outcomes of loneliness may not present until later adulthood, and this could explain why no differences were found in BMI in this young cohort, whereas such an association has been found in other samples of adults (Lauder *et al.* 2006). The null association with CRP, however, is consistent with other findings which suggest that objective social isolation, rather than feeling lonely, may be more strongly associated with inflammation (Shankar *et al.* 2011). Nonetheless, the finding that lonelier individuals were more likely to engage in physical health risk behaviours could signal cause for concern with regard to health outcomes later in adulthood. Furthermore, a previous study using the same cohort (Matthews *et al.* 2017) found that lonelier individuals had poorer sleep quality in young adulthood, which may further compromise health over time.

Feelings of loneliness co-occur with difficulties in other domains of functioning, beyond mental and physical health. For instance, lonelier individuals reported poorer global satisfaction with their lives, and adopted more negative ways of coping with stress. Regarding technology use, although social media and messaging apps could provide lonely individuals with opportunities to form and strengthen social connections with others (Nowland *et al.* 2018), lonelier young adults in this study reported using technology compulsively, at the expense of other activities and obligations. Excessive use of electronic

devices may in turn constitute an additional risk for impaired sleep quality (Carter *et al.* 2016).

School leavers in the UK today enter an economy still recovering from the fallout of the 2008 financial crisis. Low wage growth, decreased job security and rising house prices mean that young people face considerable challenges and uncertainty in their pursuit of financial stability (Belfield *et al.* 2014). Even though they were from similar socioeconomic backgrounds, lonelier young adults had lower educational attainment by age 18 than their non-lonely peers, and were more likely to be out of work and education. This suggests either that loneliness could be a force for downward social mobility, or alternatively that being unemployed could itself diminish individuals' sense of belonging. Although they were no less committed to job-seeking, lonelier young adults were less optimistic about their career prospects. Lonely individuals are characterised by shyness and lower self-esteem (Cacioppo *et al.* 2006), and these traits may undermine their confidence in their ability to compete in the labour market. Low income and unemployment may, in turn, contribute to feelings of loneliness (Luhmann and Hawkley, 2016).

The longitudinal findings indicate that young adults' propensity to feel lonely can be shaped by experiences earlier in life. Adversities in the family environment, though important for other emotional and behavioural outcomes (Caspi *et al.* 2004; Jaffee *et al.* 2007), do not appear to be associated specifically with loneliness. Instead, early risk factors for loneliness lie with children's own emotional health and experiences with their peers. It should be noted, however, that the effect sizes of these factors were small. Furthermore, while parental psychopathology and domestic violence did not predict loneliness, this does not rule out a potential role of other factors in the home, such as neglect or sibling relationship quality.

This study has some limitations. First, as loneliness was measured only at one time point, the directionality of the associations could not be tested. Further longitudinal research is needed to advance causal hypotheses about the observed associations. Second, it was not possible to investigate the stability of loneliness from childhood to adulthood. Different trajectories of loneliness during childhood and adolescence may predict different outcomes (Qualter *et al.* 2013). Third, because the sample consisted of twins, all participants had at least one sibling, which could mean that the correlates of loneliness are underestimated. Nonetheless, the prevalence of loneliness in this sample is similar to that found in other studies of young people (Mental Health Foundation, 2010; Victor and Yang, 2012). Fourth, this study focused on residents of one particular country, and the generalisability of these data to other regions of the world is not clear. Similar research in different populations is required to establish whether loneliness and its correlates differ across national and cultural demarcations.

Conclusion

The implications of chronic loneliness for longevity (Elovainio *et al.* 2017; Holt-Lunstad *et al.* 2010; Luo *et al.* 2012) attest to the importance of intervening early to prevent loneliness persisting across time. However, simply increasing individuals' amount of contact with others is unlikely to be sufficient, for two reasons. First, loneliness can be experienced even

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in the company of others. Second, if loneliness shapes individuals' social interactions in ways that evoke negative perceptions from others, opportunities to escape loneliness may be thwarted. A meta-analysis of interventions to reduce loneliness indicates that the most successful strategies involve addressing destructive patterns of social cognition in a counselling or psychotherapeutic setting (Masi *et al.* 2011). Furthermore, the findings of this study indicate that strategies to prevent the emergence of loneliness in young people should devote particular attention to children who experience problems of an internalising nature, or who are bullied or isolated by their peers.

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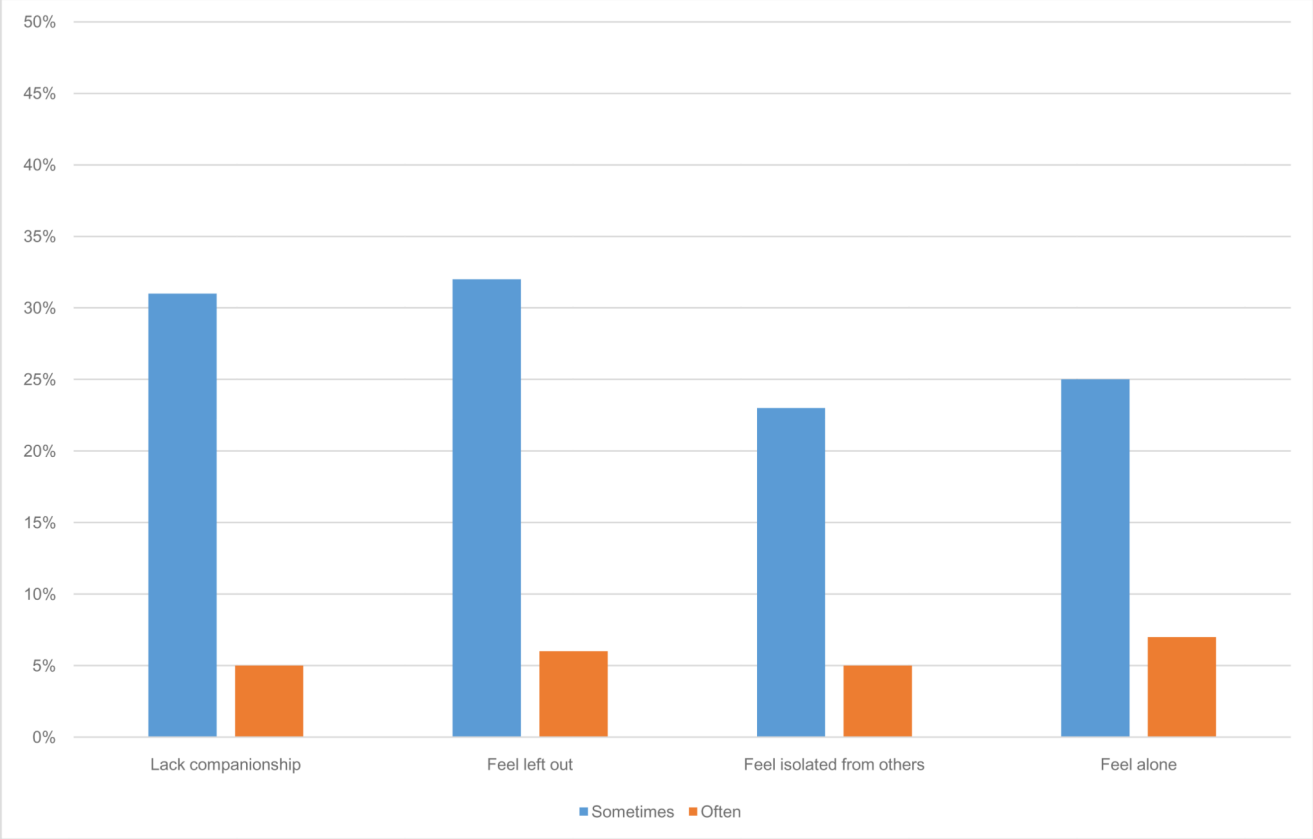

Figure 1.
Prevalence of reported feelings of loneliness among young adults

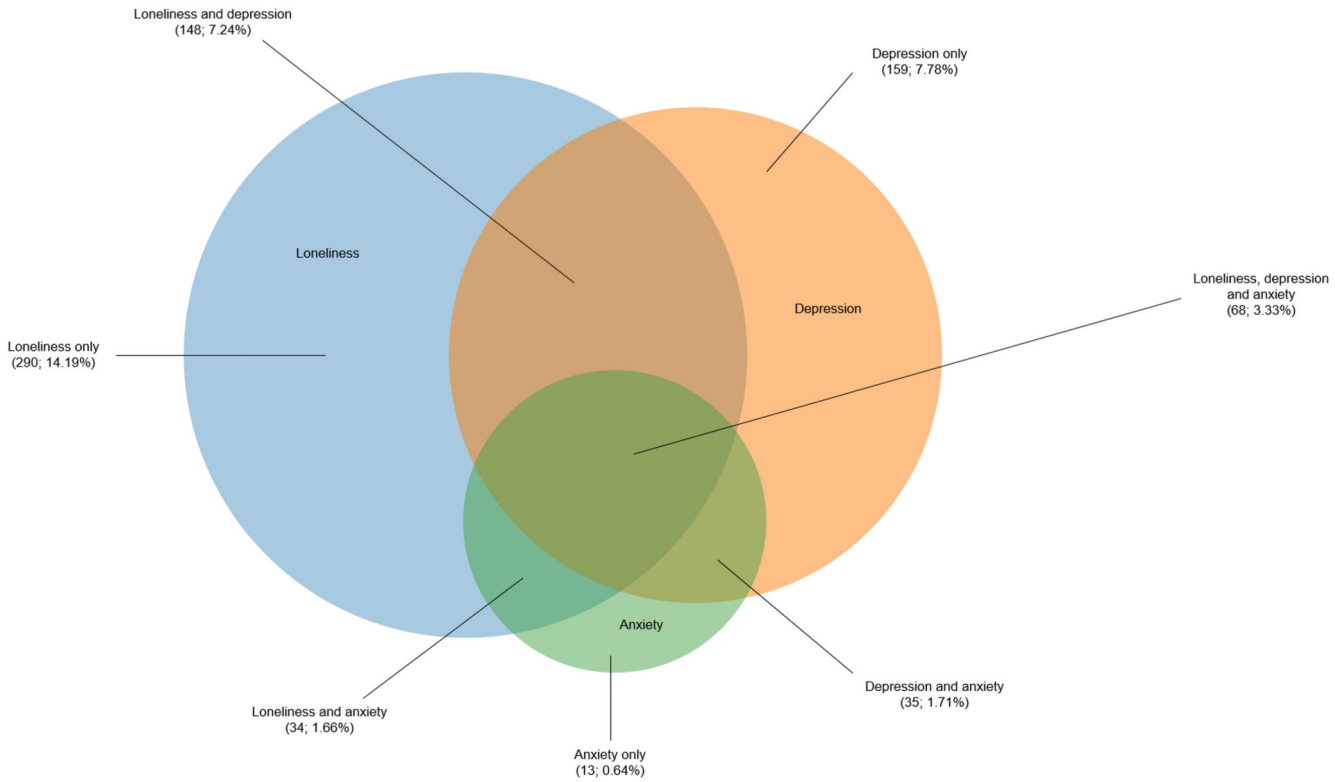

Figure 2.

Overlap in prevalence of loneliness, depression and anxiety. For illustrative purposes, the loneliness scale was dichotomised by taking the top quartile.

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Table 1

Summary of measures

	Participant's age at measurement	Description
Correlates in young adulthood		
Mental health and service use		
Depression diagnosis	18	Past-year diagnoses according to DSM-IV or DSM-V criteria, assessed via structured clinical interview (American Psychiatric Association, 1994; 2013).
Anxiety diagnosis	18	
ADHD diagnosis	18	
Conduct disorder diagnosis	18	
Alcohol dependence diagnosis	18	
Cannabis dependence diagnosis	18	
Self-harm	18	Reports of at least one instance of self-harm or suicide attempt between ages 12 and 18.
Suicide attempt	18	
Service use	18	Any visit to a GP, psychiatrist or counsellor/psychotherapist for mental health problems in past year.
Physical health and health risks		
BMI	18	Calculated from height and weight measurements taken by interviewers at the home visit.
CRP	18	Collected via dried blood spots. mg/L values were log-transformed prior to analysis (Danese *et al.* 2011).
Physical activity	18	Daily physical activity during work/college or leisure time, measured using the Stanford Brief Activity Survey (Taylor-Piliae *et al.* 2010).
Daily smoking	18	At least 1 cigarette smoked daily.
Coping and functioning		
Life satisfaction	18	Global life satisfaction measured via the Satisfaction With Life Scale (Diener *et al.* 1985).
Coping with stress	18	Count of strategies used when experiencing stress in relation to finances, relationships, college or work. Four positively-coded items (e.g. "talk with other people about it", "take steps to solve the problem") and four negatively-coded items ("withdraw or spend more time alone", "obsess about problems") were combined, with higher scores reflecting more negative positive coping strategies.
Problematic technology use	18	Compulsive use of digital technology such as internet, email, social networking, mobile phones and text messaging. Measured using an adapted version of the Compulsive Internet Use Scale (Meerkerk *et al.* 2009).
Employment prospects		
Not in employment, education or training	18	Participants' report of whether they were currently employed or studying (Goldman-Mellor *et al.* 2016).
Low qualifications	18	Based on attainment on the General Certificate of Secondary Education (GCSE), taken by UK students at age 14-15. Participants with either no qualifications or GCSE's at grades D-G were coded as having low qualifications.
Job preparedness (skills)	18	Self-rating of professional and technical skills, e.g. writing and computer programming (Goldman-Mellor *et al.* 2016).

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	Participant's age at measurement	Description
Job preparedness (attributes)	18	Self rating of 'soft' skills, e.g. communication and teamwork (Goldman-Mellor *et al.* 2016).
Optimism	18	Self-rated perceptions of participants' ability to get ahead in their careers (Goldman-Mellor *et al.* 2016).
Job search activities	18	Total number of job-seeking activities participants have undertaken, e.g. applied for a job or looked at job vacancies pages (Goldman-Mellor *et al.* 2016).
Childhood predictors		
Family environment		
Maternal warmth	5	Maternal expressed emotion (Caspi *et al.* 2004).
Maternal depression	5	Lifetime history of a major depressive episode based on DSM-IV criteria (American Psychiatric Association, 1994).
Parental antisocial behaviour	5	Lifetime presence of symptoms of conduct disorder or antisocial personality disorder in either parent, based on DSM-IV criteria (American Psychiatric Association, 1994).
Domestic violence	5	Any domestic violence in the first 5 years since participants' birth (Strauss, 1990).
Low SES	5	Lowest tertile of a standardised composite of income, parents' education and social class.
Child characteristics		
Female gender	5	
IQ	5	Assessed using a short form of the Wechsler Preschool and Primary Scale of Intelligence-Revised (Wechsler, 1990).
Theory of mind	5	Summed score across eight false-belief tasks completed when participants were aged 5 (Hughes *et al.* 2000).
Openness to experience	12	Child version of the Big Five Inventory, rated by study interviewers after the home visits (John & Srivastava, 1999)
Conscientiousness	12	
Extraversion	12	
Agreeableness	12	
Neuroticism	12	
Child mental health		
Depression symptoms	12	Symptom score on the Children's Depression Inventory (Kovacs, 1992).
Anxiety symptoms	12	Symptom score on the Multidimensional Anxiety Scale for Children (March, 1997).
Substance use	12	Mothers' report of any alcohol, tobacco or other drug use by participants (Achenbach, 1991).
ADHD diagnoses	5, 7, 10, 12	DSM-IV criteria for ADHD or Conduct disorder (American Psychiatric Association, 1994).
Conduct disorder diagnoses	5, 7, 10, 12	
Victimisation and social relationships		
Physical maltreatment	5, 7, 10, 12	Mothers report of any physical maltreatment of participants by an adult in the 12 years since participants' birth (Jaffee *et al.* 2007)
Bullying	7, 10, 12	Mother- and self-report of any bullying (occasional or frequent) experienced by participants between the ages of 5 and 12 (Shakoor *et al.* 2011).

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	Participant's age at measurement	Description
Social isolation	5, 7, 10, 12	Mother and teacher reports of participants' social isolation (Matthews *et al.* 2015).

ADHD = Attention-deficit hyperactivity disorder. BMI = Body mass index. CRP = C-reactive protein. SES = Socioeconomic status. IQ = Intelligence quotient.

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Table 2

Characteristics of lonely young adults

	Distribution	Association with loneliness
Mental health and service use	% (N)	OR (95% CI)
Depression diagnosis	20.07 (414)	2.22 (1.98, 2.48)
Anxiety diagnosis	7.43 (153)	2.45 (2.12, 2.84)
ADHD diagnosis	7.86 (162)	1.66 (1.46, 1.89)
Conduct disorder diagnosis	15.05 (309)	1.56 (1.40, 1.74)
Alcohol dependence diagnosis	12.75 (263)	1.29 (1.15, 1.45)
Cannabis dependence diagnosis	4.31 (89)	1.71 (1.42, 2.05)
Self-harm	13.57 (280)	2.22 (1.97, 2.50)
Suicide attempt	3.83 (79)	2.27 (1.90, 2.72)
Service use	12.89 (266)	1.88 (1.68, 2.11)
Physical health and health risks	M (SD)	β (95% CI)
BMI	23.08 (4.86)	0.02 (-0.03, 0.06)
CRP (log)	-2.54 (1.51)	-0.04 (-0.08, 0.01)
Physical activity	2.76 (1.06)	-0.11 (-0.15, -0.07)
	% (N)	OR (95% CI)
Daily smoking	22.34 (461)	1.23 (1.10, 1.38)
Coping and functioning	M (SD)	β (95% CI)
Life satisfaction	3.87 (0.73)	-0.44 (-0.48, -0.39)
Coping with stress	8.95 (2.61)	-0.36 (-0.41, -0.32)
Problematic technology use	4.54 (3.91)	0.28 (0.23, 0.33)
Employment prospects	% (N)	OR (95% CI)
Not in employment, education or training	11.57 (239)	1.38 (1.21, 1.57)
Low qualifications	21.88 (451)	1.22 (1.09, 1.37)
	M (SD)	β (95% CI)
Job preparedness (skills)	4.97 (1.82)	0.00 (-0.04, 0.05)
Job preparedness (attributes)	16.98 (2.64)	-0.22 (-0.27, -0.17)
Optimism	16.10 (3.20)	-0.29 (-0.35, -0.24)
Job search activities	5.03 (2.43)	0.03 (-0.01, 0.08)

M = Mean. SD = Standard deviation. β = Standardised regression coefficient (interpretable as equivalent to a correlation). OR = Odds Ratio. CI = Confidence interval. ADHD = Attention-deficit hyperactivity disorder. BMI = Body mass index. CRP = C-reactive protein. All associations adjusted for gender and socioeconomic status. In logistic regression analyses, loneliness scores were standardised to obtain ORs based on a 1 SD increase in loneliness. Note: for sleep quality and coping with stress, higher scores reflect worse sleep and more negative coping strategies, respectively.

Table 3
Associations between loneliness and mental health problems in young adulthood

	Prevalence	Loneliness		Controlling incrementally for:		
		Diagnosis	No diagnosis	Gender and SES	Prior symptoms	Comorbid mental health problems
	% (N)	M (SD)		OR (95% CI)		
Depression	20.07 (414)	2.95 (2.35)	1.22 (1.65)	2.22 (1.98, 2.48)	2.15 (1.91, 2.42)	1.67 (1.46, 1.92)
Anxiety	7.43 (153)	3.70 (2.42)	1.40 (1.80)	2.45 (2.12, 2.84)	2.45 (2.10, 2.85)	1.87 (1.55, 2.26)
ADHD	7.86 (162)	2.71 (2.28)	1.47 (1.88)	1.66 (1.46, 1.89)	1.62 (1.42, 1.85)	1.32 (1.12, 1.55)
Conduct disorder	15.05 (309)	2.34 (2.24)	1.43 (1.85)	1.56 (1.40, 1.74)	1.53 (1.36, 1.71)	1.23 (1.06, 1.42)
Alcohol dependence	12.75 (263)	2.04 (2.07)	1.50 (1.91)	1.29 (1.15, 1.45)	1.29 (1.15, 1.44)	0.98 (0.84, 1.12)
Cannabis dependence	4.31 (89)	2.81 (2.46)	1.51 (1.90)	1.71 (1.42, 2.05)	1.73 (1.44, 2.08)	1.24 (0.97, 1.58)
Self-harm	13.57 (280)	3.18 (2.26)	1.32 (1.76)	2.22 (1.97, 2.50)	2.19 (1.94, 2.48)	1.60 (1.39, 1.85)
Suicide attempt	3.83 (79)	3.72 (2.48)	1.48 (1.86)	2.27 (1.90, 2.72)	2.20 (1.83, 2.65)	1.37 (1.06, 1.78)

N = Number. M = Mean. SD = Standard deviation. OR = Odds ratio. CI = Confidence interval. ADHD = Attention-deficit hyperactivity disorder. Loneliness scores were standardised to obtain ORs based on a 1 SD increase in loneliness. All associations adjusted for gender and socioeconomic status.

Table 4
Childhood predictors of loneliness in young adulthood

	Distribution	Association with age-18 loneliness β (95% CI)		
		Baseline	Adjusted within domain	Final model
Family environment	M (SD)			
Maternal warmth	3.27 (1.00)	-0.03 (-0.08, 0.02)		
	% (N)			
Maternal depression	35.01 (780)	0.05 (-0.00, 0.10)		
Parental antisocial behaviour	27.58 (614)	-0.01 (-0.06, 0.04)		
Domestic violence	42.29 (938)	-0.02 (-0.07, 0.04)		
Child characteristics	M (SD)			
IQ	100 (15.00)	-0.04 (-0.09, 0.01)		
Theory of mind	4.52 (3.28)	-0.08 (-0.13, -0.04)	-0.08 (-0.12, -0.03)	-0.04 (-0.08, 0.01)
Openness to experience	4.31 (2.76)	0.03 (-0.02, 0.08)		
Conscientiousness	8.52 (3.23)	-0.01 (-0.06, 0.05)		
Extraversion	8.28 (3.54)	-0.03 (-0.08, 0.02)		
Agreeableness	8.94 (1.70)	-0.03 (-0.09, 0.03)		
Neuroticism	2.08 (1.84)	0.13 (0.08, 0.18)	0.13 (0.08, 0.18)	0.07 (0.02, 0.12)
Child mental health				
Depression symptoms	3.11 (5.32)	0.23 (0.18, 0.29)	0.19 (0.13, 0.25)	0.16 (0.10, 0.22)
Anxiety symptoms	7.62 (3.04)	0.17 (0.13, 0.22)	0.11 (0.07, 0.16)	0.08 (0.03, 0.13)
Substance use	0.04 (0.24)	0.03 (-0.02, 0.08)		
	% (N)			
ADHD diagnosis	12.12 (266)	0.07 (0.02, 0.11)	0.03 (-0.02, 0.08)	
Conduct disorder diagnosis	15.76 (349)	0.08 (0.03, 0.13)	0.03 (-0.02, 0.08)	
Victimisation and social relationships				
Physical maltreatment	5.73 (128)	0.07 (0.02, 0.12)	0.03 (-0.02, 0.09)	
Bullying	44.49 (985)	0.15 (0.11, 0.20)	0.12 (0.07, 0.17)	0.08 (0.03, 0.13)
Social isolation	33.67 (700)	0.15 (0.11, 0.20)	0.12 (0.07, 0.17)	0.08 (0.03, 0.12)

β = Standardised regression coefficient (interpretable as equivalent to a correlation). CI = Confidence interval. IQ = Intelligence quotient. ADHD = Attention-deficit hyperactivity disorder. All analyses adjusted for gender and socioeconomic status.