REVIEW ARTICLE

Loneliness in youth during COVID-19: A narrative review

Tiffany Field*

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For this narrative review, only a couple dozen publications could be found on loneliness of youth during COVID-19. They are limited to research on prevalence, effects and risk factors. The prevalence has widely ranged from 8%-68% across different countries. Loneliness has increased from pre-COVID to COVID and especially across lockdowns. Increases in loneliness-related depression and anxiety have ranged from 15-25% which has been comorbid with excessive use of social media, physical inactivity, sleep disturbances and inflammation markers including increased C-reactive protein and neutrophil-to-lymphocyte ratios. Only a few buffers have been noted for the stressful effects of loneliness including peer and parent relationships, meditation and exercise. Despite methodological limitations including that causality cannot be determined from cross-sectional data, this research highlights the importance of further research on the relatively unknown underlying mechanisms for loneliness as well as effective interventions for reducing loneliness in youth.

Key Words: *Loneliness; Youth; COVID-19; C-reactive protein*

INTRODUCTION

A search on PubMed on loneliness during COVID-19 yielded two hundred fourteen papers. Eighty percent of those were on loneliness in older adults. Only twenty-three studies focused on loneliness experienced by youth during the pandemic. This narrative review summarizes those papers on loneliness in youth during COVID-19. Only peer-reviewed, English-language papers were included. The research can be classified as studies on the prevalence, effects, risk factors and interventions for loneliness as well as methodological limitations of this literature. This narrative review is accordingly organized by those topics.

Loneliness in adults during COVID-19

Loneliness has been defined as a "painful, subjective emotional state that arises from the discrepancy between desired and achieved patterns of social interaction". Loneliness has been associated with negative mood states, sleep disturbances and health problems in adults during COVID-19 lockdowns. For example, in a Survey Monkey study conducted during a COVID-19 lockdown (N=260 respondents), 68% reported feeling lonely. Correlation analyses suggested that feeling lonely was negatively related to healthy practices scale scores and positively related to scores on measures of stress, negative mood states including anxiety and depression, fatigue, sleep disturbances, and posttraumatic stress symptoms. Analyses of variance revealed significant differences between lonely and non-lonely groups on these measures. Only a weak correlation was noted between living alone and loneliness, suggesting that feelings of loneliness were also experienced by those living with others. Positive correlations between both feeling lonely and time on Facebook and gaming suggested that these activities did not compensate for feelings of loneliness. Feelings of loneliness and associated problems also increased across the lockdown survey period. The lack of touch and exercise suggested that those activities might have alleviated the negative feelings and associated problems. The results of this COVID lockdown survey are limited by the self-reported data from a non-representative sample that is cross-sectional. Nonetheless, they highlight the negative effects of isolation and loneliness during a COVID-19 lockdown. This research is characteristic of hundreds of studies on adult loneliness that have appeared in the COVID-19 literature. By comparison, only a couple dozen studies have been published on loneliness of youth during COVID-19. And, they are limited to a few studies on prevalence and effects and to several studies on risk factors that could also be considered as research on effects because causality cannot be determined from cross-sectional data. And only a few studies have appeared in this literature on buffers for the stressful effects of loneliness [1,2].

Prevalence of loneliness among youth

The prevalence of loneliness among youth during COVID-19 has varied widely across different countries (Table 1). For example, the prevalence has been as low as 8% in a study from Canada has been noted at 19% in France, and a significantly greater prevalence has been reported in the US at 68%. This variability has been discussed in the context of confounding variables including age, gender and timing of the data collection, with the prevalence being greater later in the pandemic and during a lockdown. And the definitions of loneliness have varied across studies. For example, the prevalence of loneliness at 8% in the Canadian study was based on an extreme criterion of "being lonely 5 or more days during the last week". And, loneliness has been noted to increase from the middle to the end of a one-month lockdown (47% to 68%, a 45% increase). Further, the prevalence has been greater when all levels of severity have been combined. In longitudinal studies, significant increases have been noted from pre to during COVID in the Midwest, by the end of a US COVID lockdown and with a sharp increase during the winter months of a lockdown based on growth curve modeling [3-7].

TABLE 1

Prevalence of loneliness in youth across different countries during COVID19 and first authors

Country	Prevalence	First author
Canada	8%	Wickens
France	19%	Megalakaki
U.S.	68%	Field

Effects of loneliness

A variety of effects have been noted for loneliness during COVID-19 including excessive use of social media and symptoms of anxiety, depression and sleep disturbances as well as biological effects (Table 2). Of course, it's

Department of Pediatrics, University of Miami/Miller School of Medicine and Fielding Graduate University, 2889 McFarlane Rd, Miami, FL 33133, USA

Correspondence: *Tiffany Field, Department of Pediatrics, University of Miami/Miller School of Medicine and Fielding Graduate University, 2889 McFarlane Rd, Miami, FL 33133, USA, Tel: (305) 243-6781; E-mail: tfield@med.miami.edu*

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not clear whether these are effects of loneliness or risk factors for loneliness or bi-directional/reciprocal effects given that most of the studies are cross-sectional rather than longitudinal.

TABLE 2

Effects of loneliness on youth during COVID-19 and first authors

Country	Effect	First author
China	problematic mobile phone use	Li
UK	increased texting	Cooper
Greece	increased time on social media	Galemis
Belgium	increased time on social media	Cauberghe
Hong Kong	increased gaming	Zhu
UK	increased depression and anxiety	Cooper
France	increased depression and anxiety	Megalakaki
U.S	increased depression and anxiety	Mayorga
U.S	increased sleep disturbance	Becker
Japan	chronic inflammation	Koyama

The loneliness effects on social media use include excessive phone use, texting, and gaming. In a study on problematic mobile phone use in adolescents from China (N=1034), for example, loneliness was associated with problematic mobile phone use. This was attributed to greater "escape motivation" by the authors although it could also be interpreted as a coping mechanism for missing relationships. However, in a longitudinal study on texting that involved data collection during the first 11 weeks of a UK lockdown and one month later, increased texting was associated with greater loneliness as well as mental health problems in a sample of 894 eleven-sixteen-year-old adolescents [8,9].

In a study on loneliness in youth from Greece (N=1559), those who were lonely were noted to spend more time on social media at more than five hours per day and on new social media accounts. This was especially noted for female youth. In a similar study on 13 to 19-year-old adolescents from Belgium (N=2165), those who were more lonely were more likely to use social media to cope with less social contact. In this structural equation modeling study, loneliness had the most negative effect on happiness [10].

Excessive gaming has also been associated with loneliness. In this study on children and adolescents from Hong Kong (N=2863), a multinomial logistic regression showed that feeling lonely was associated with problematic gaming behavior and that the association was stronger for older females. As many as 83% played video games, with the prevalence being 21% for excessive game-playing and 5% for pathological game-playing. Game-playing in general was noted more frequently in male children and adolescents [11].

LITERATURE REVIEW

Depression and anxiety are perhaps the worst effects of loneliness. In a longitudinal study during COVID-19, the odds of loneliness leading to an increase in depression were 2.43 and to an increase in anxiety were 2.02. But the odds were even greater for the development of new depression at 14.83 and new anxiety at 24.74. In another longitudinal study during a UK lockdown, participants reported loneliness during the first 11 weeks of the lockdown and mental health problems one month later. Greater loneliness led to greater depression and anxiety. This effect was compounded by greater texting which also led to greater depression and anxiety. In a study from France, hierarchical linear regression suggested that loneliness accounted for 29% of the variance in anxiety and 34% of the variance in depression [4,9,12,13].

Others have looked at specific types of loneliness and interactions with other variables. For example, in a meta-analysis on 63 studies including 51,576 children and adolescents (mean age=15), the duration of loneliness versus the intensity of loneliness was more related to mental health symptoms including depression and anxiety. In this meta-analysis, the odds ratios for loneliness leading to depression ranged from 5.8 to 40 times. Loneliness was moderately to strongly correlated with social anxiety (r=.33-.72) as well as with suicidal ideation, self-harm and eating disorders. This meta-analysis and systematic review revealed problems with the studies including that most were cross-sectional surveys with no controls for potential confounding variables [14,15].

A significant interaction between worry and loneliness has also predicted depression, anxiety and stress in a study on Texas college students (N=209). The COVID-19 Worry Index was created by these authors and the Depression, Anxiety and Stress Scales were used to tap the mental health conditions. Worry was more strongly related to each of the mental health conditions in those who were lonelier. And, in still another study, depression and anxiety were comorbid pathological effects of loneliness along with unhealthy eating habits, physical inactivity, and sleep disturbances, highlighting the complexity of relationships between loneliness and mental health variables [13,16].

Sleep disturbances were not only reported as being a comorbid condition of depression and anxiety but were also identified as an effect of loneliness. In this longitudinal study on 122 eighth graders from schools in Ohio, Kentucky and Virginia, loneliness was predictive of difficulties both initiating and maintaining sleep. But, in the study from France, a hierarchical linear regression suggested that loneliness accounted for only 15% of the variance in insomnia, suggesting that other salient factors need to be considered [4,13,17].

Pre-existing chronic illness has also accompanied loneliness, in turn, leading to psychological distress in a study from Israel (N=204). Illness-related inflammation has been related to anxiety, depression and sleep disturbances but has also been related to loneliness and has been cited as the worst physiological effect of loneliness. In this study from Japan (N=624), feeling lonely (based on the UCLA Loneliness Scale scores) was associated with chronic inflammation (high neutrophil-to-lymphocyte ratios) and other inflammatory markers including IL-6, TNF, fibrinogen, ferritin and C-reactive protein. Being lonely was especially associated with greater neutrophil-to-lymphocyte ratios in men. Surprisingly, C- reactive protein was lower in women who were not isolated but lonely. These were said to derive from loneliness and associated changes in health behaviors (decreased physical activity and sleep problems) and altered autonomic and neuroendocrine system activity. Although these data were reflective of chronic stress, the authors referred to "stress response hormesis" as low levels of stress are being beneficial but high levels of stress being harmful. Another research group referred to a similar phenomenon as the "conserved transcriptional response to adversity" that was suggested to promote inflammation and diminish the anti-viral response leading to inadequate protection against viral disease [1,13,14].

Risk factors for loneliness

Of course, the most presumed risk factor for loneliness is isolation or being alone. Isolation and loneliness are often studied together (Table 3). Social isolation has alternately been referred to as loneliness, and loneliness has been defined as the perception of social isolation. In some studies, loneliness has been correlated with isolation and in others it has only been weakly correlated. Some people living alone may not feel lonely and those living with others may feel lonely. Nonetheless, those mood states have been used interchangeably in the literature that preceded COVID-19. Other risk factors for loneliness are highly variable. They could be classified as demographic variables, previously existing conditions and behaviors/activities. The demographic variables have included gender, age, extraversion, living conditions and employment. And, the previously existing conditions include physical and psychological problems. The

behaviors/activities that have been risk factors include inactivity, excessive social media use and sleep disturbances [18-20].

TABLE 3

Risk factors for loneliness in youth during COVID-19 and first autbr

Country	Risk factor	First author
Canada	being female	Wickens
Peru	female	Magis-Weinberg
Hong Kong	being male	Zhu
Canada	being younger	Wickens
Israel	younger	Horesh
Japan	younger	Khan
Germany	being older	Landmann
Germany	extraversion	Alt
Germany	extraversion	Landmann
Japan	living alone	Khan
UK	not in school	Hu
UK	physical health problems	Hu
Japan	health status	Khan
France	medical and psychological problems	Megalakaki
Germany	physical inactivity	Lippke

Gender effects on loneliness have been mixed. In at least three studies, females have been said to have greater odds for being lonely. In one of these studies the odds of greater loneliness in females were 3.53. In another study, Peruvian adolescents between 11 and 17 years-old (N=735) were noted to experience constant loneliness between weeks six and eleven of the study. Although loneliness of females was more prevalent than that of males in the study from Peru, the females were also noted to have more negative online experiences, a potential confounding variable. In contrast, loneliness was more frequently noted in male children and adolescents from Hong Kong. However, the research group from Hong Kong also reported an interaction effect suggesting that a stronger association between loneliness and being older, female adolescents [3,11,21,22].

Age effects on loneliness also appear to be mixed. In at least two studies, younger students were experiencing greater loneliness during this pandemic including a study from Canada that reported an interaction between being female and younger and experiencing greater loneliness. The interaction between being female and younger was also reported for the Israeli sample. Similarly, an interaction effect was noted between being young and living alone which was moderately related to all the negative mental health conditions including anxiety, depression, fatigue, sleep disturbances and PTSD symptoms [2,3,14].

The relationship between loneliness and age has been further clarified by still other interaction effects. For example, in a study from Japan, loneliness was more pervasive among young people, but the increase in loneliness during the pandemic was greater for older people. In this longitudinal study (N=6103), loneliness was greater in the younger participants both before and during the pandemic. However, several confounding risk factors included health status, depression, low income and living alone as well as several virus-mitigating measures including social distancing, self-isolation, sheltering in place and working from home. And, as in the other research reviewed here, no data were provided on whether the participants suffered from the virus and/or grief from the loss of someone to the pandemic. Further clarification comes from a study that distinguished emotional, social and physical loneliness. In that study from Germany, age was negatively related to physical loneliness (lack of physical contact) but positively associated with social loneliness (lack of a broader network) [21,23].

Extraversion has been implicated as a risk factor for loneliness in at least two studies. In a longitudinal data set from Germany(N=843), latent change modeling showed that extraverted adolescents experienced a greater increase in depression during the pandemic, but a third of that effect was mediated by increased loneliness. The authors suggested that this result challenged the notion that extraversion was a protective factor for loneliness. In another study from Germany, but by different authors, extraversion was positively associated with physical loneliness but negatively associated with emotional and social loneliness [23,24].

Several living conditions have been considered risk factors for loneliness during COVID-19. These include marital status, living alone, being unemployed and not in school. In a study from Japan, living alone and being unmarried were risk factors for greater loneliness which were, of course, confounded with being younger. In a study from the U.S. being young and living alone was the group that suffered the most loneliness. In a UK study (N=419), those who were unemployed and not in school experienced greater loneliness [7,21].

Both physical and mental health problems have been considered pre-existing conditions for loneliness. For example, those with long-standing physical and mental health problems reported experiencing greater loneliness in the sample from the U.K. In a logistic regression analysis on the database from Japan, health status both before and during the pandemic explained a significant amount of the variance in loneliness. And, a hierarchical linear regression and mediation analysis of the French database suggested that loneliness predicted insomnia but that relationship was moderated by a history of medical and psychological problems [4,7,21].

Several behaviors/activities have been risk factors for loneliness including sedentary behavior, texting, being a victim of cyber bullying, excessive gaming and sleep problems. Although these have been studied in the context of loneliness, they are likely related behaviors/activities with, for example, texting contributing to sedentary behavior and physical inactivity leading to sleep disturbances. However, they have rarely been studied as a group of confounding behaviors in a multivariate analysis, probably because researchers typically focus on the variables that most interest them (sometimes called "pet variables").

Sedentary behavior has contributed to the pathological effects of loneliness along with unhealthy eating habits and sleep disturbances. And in a study on university students from Germany (N=363), a stronger negative correlation was noted between physical activity and loneliness during the pandemic than before the pandemic (r=-.20 versus -.09). Having documented a Cohen's q test to confirm the greater effect size of the pandemic/loneliness relationship versus the pre-pandemic/loneliness relationship validates inactivity as a risk factor for loneliness, although the loneliness/inactivity relationship is likely reciprocal or bi-directional [25].

The lower levels of activity may relate to more time on social media and its effects on loneliness. Examples come from a study on adolescents that have revealed a relationship between loneliness, texting and mental health problems. And, another example can be seen in the report from China suggesting that cyber bullying victims were experiencing greater loneliness. Still a third study from Hong Kong (N=2863 children and adolescents) suggested that gaming was related to loneliness. Based on a multinomial logistic regression, feeling lonely was associated with problematic gaming behavior and this association was surprisingly stronger for older female adolescents even though gaming was generally more prevalent in male adolescents. The prevalence of gaming was surprisingly high at 83%, with excessive gaming occurring for 21% of the sample and pathological gaming for 5% of the sample [11].

Given the relationships between sedentary behavior, excessive social media activity, and loneliness, it is perhaps not surprising that sleep disturbances are associated with all of those problems. Although, once again, the directionality of these variables is difficult to determine given that most of the data derive from cross-sectional studies and that those that result from longitudinal studies may simply reflect an arbitrary selection of pre-and post-variables by the researchers. Although loneliness might be expected to

contribute to excessive social media activity and thereby to sleep disturbances, those variables have not been studied in a multivariate data analysis, as for example, a structural equations analysis to determine directionality of effects or their reciprocity. In that respect, mediation analysis of these variables may be more informative [17].

Mediation analyses

Several significant relationships involving loneliness have been revealed by mediation analysis. These have included loneliness as a predictor variable and loneliness as an effect. In the loneliness as predictor variables, hopelessness and worries about COVID have been mediators for anxiety, depression and sleep problems. In one analysis, loneliness predicted hopelessness that in turn predicted depression. In this study from South Africa (N=347 University students) parallel and serial mediation analyses support the hypothesis that loneliness is associated with hopelessness which in turn mediates depression. Interestingly, although loneliness was entered here as the predictor variable with typically a worse mental health problem depression being the outcome, the author referred to loneliness as being the signature mental health consequence of the pandemic [26].

In a second analysis in which loneliness was used as predictor variable, worries about COVID was considered a mediator for the outcome variables anxiety, depression and sleep disturbance. In this study from France, mediation models based on hierarchical linear regression and mediation analysis suggested that loneliness predicted the three mental health problems (anxiety, depression, insomnia) mediated by COVID worries. To further complicate these results, employment moderated the relationship between loneliness and anxiety with employment reducing anxiety. And the loneliness-insomnia relationship was moderated by living alone, a history of medical or psychological problems as well as COVID worries.

In a study in which loneliness was the outcome variable, self- disclosure and its relationship to loneliness was mediated by peer relationships. In this study from China (N=830, M age=14 years), loneliness was considered a subjective variable in contrast to isolation as an objective factor. In a study from the United Arab Emirates (N=170 university students), grit (defined as dedication to long-term goals) was noted to moderate (decrease) the detrimental influence of loneliness on academic stress during the pandemic. In this study 37% of the university students reported receiving support from their parents, 32% from their friends and only 2.5% from the universities [27-29].

Buffers for loneliness

Several buffers for wellness have been identified. These have included peer relationships, parent relationships, emotional support, sharing thoughts, meditation and exercise (Table 4).

TABLE 4

Buffers for loneliness in youth during COVID-19 and first authors

Country	Buffer	First author
China	peer relationships	Chen
China	peer relationships	Han
UK	parent relationships	Cooper
United Arab Emirates	Parent relationships	Mosanya
Greece	sharing thoughts and feelings	Golemis
Germany	physical activity	Lippke

In the study from China, peer relationships were a significant mediator for the relationship between self-disclosure and loneliness. And peer relationships were the primary protective factor for reducing loneliness and anxiety in another sample from China. In a systematic review on 58 studies, lessons on friendship were an effective intervention for reducing loneliness and isolation. Surprisingly, in this review, robotic pets were also effective at reducing loneliness.

Parent relationships were effective buffers of loneliness in at least two studies. In one, the closer the relationship with parents, the less loneliness and depression. In the study from United Arab Emirates, 37% of university students reported support from their parents for reducing loneliness. Given these two major sources of support, it's surprising that social support was only effective at reducing loneliness in male students in the study from the UK. This effect may have been confounded by employment and being-in-school variables that also reduced loneliness, especially in male students [30,31].

Activities that have been noted to reduce loneliness include sharing thoughts, meditating and exercise. In a study from Greece (N=1559 students), sharing thoughts and feelings regarding COVID lead to less loneliness. Meditation has been referred to as a mental health self-care strategy for coping with loneliness during the pandemic. In this review on 58 studies, mindfulness was a significant mitigation of loneliness.

Exercise has been a significant buffer of loneliness in several studies on the COVID-19 lockdown. In one study, correlation analyses suggested that indoor, outdoor, and outdoor exercise with someone else were positively related to scores on the Health Scale and negatively related to scores on the Anxiety, Depression, Fatigue, Sleep Disturbance, and PTSD scales. In addition, indoor exercise and outdoor exercise with someone else were positively correlated with scores on the Connecting and Working Scales. Several other studies have consistently shown that those who exercised during lockdowns were significantly less lonely, probably because they were exercising outside with others or on zoom group exercise sessions.

Other interventions have had small effects including cognitive behavior therapy, and exercise programs called Mood Gym, SPARX, and Think, Feel and Do. The therapies that seemed to be the most effective were face-to-face and those that involved parents. As noted by this research group, "as loneliness involves social comparison, it is possible that the shared experience of social isolation imposed by disease containment measures may mitigate the negative effects with an increase of Internet- mediated relationships".

Methodological limitations of this literature

Several methodological limitations can be noted in this literature. The frequent sampling of university students, although convenient, limits generalizability to younger youth. The university youth may be living alone more frequently thereby confounding isolation with loneliness especially during lockdowns when they may have been more likely to be living alone. Further, the surveys are from different countries at different stages of COVID-19 making comparisons difficult and may explain the absence of meta-analyses. Some are lockdown surveys while others are from non-lockdown periods resulting in significant variability

DISCUSSION

Another problem is the cross-sectional design of the studies that limits inferences about causality or directionality. Longitudinal data are needed to determine direction of effects but have been relatively unavailable because of the unpredictability of the onset of the pandemic or the timing of the lockdowns. In addition, even though the surveys are anonymous, the participants may be giving social desirability or "faking good" responses. The quantitative ratings on the surveys may be less informative than open-ended questions of qualitative interviews.

Although the independent measure/predictor variable has typically been loneliness as measured by the UCLA Loneliness Scale and the dependent measures have been anxiety as measured by the GAD-7 and depression as measured by the PLQ-9 or both being assessed by the Depression, Anxiety and Stress Scale, the selection of independent and dependent measures is arbitrary. It is as likely that anxiety and depression have led to isolation and related loneliness, although isolation has rarely been assessed. These variables may be bi-directional or reciprocal.

These relationships are further complicated by mediating and moderating variables that have been considered in some studies but not in most. And, researchers have also arbitrarily selected mediating and moderating variables so they differ from study to study. The selected mediating and moderating measures appear to reflect authors' interests, as in "pet variables". This has resulted in widely diverse mediating variables The mediation/moderation analyses highlight the complexity of loneliness as both a cause and an effect variable.

The loneliness questions on the surveys are confounded by several other factors including social isolation and other overlapping variables. Potential confounding variables including pre-existing psychopathology, individual differences in personality characteristics, and the lack of exercise, sleep problems, and excessive social media use have rarely been entered into the regression or mediation/moderation analyses. Even sociodemographic variables have been frequently overlooked. And, no data were provided on whether the participants suffered from the virus and/or grief from the loss of someone to the pandemic.

Even when a number of these variables have been included in the data analysis, the amount of variance explained is relatively small, suggesting that other salient variables are not being considered. Further, the variance was often unknown as hierarchical logistic regressions yielding odds ratios were often used as opposed to stepwise regressions that would indicate the relative significance of predictor variables. The number of relevant variables affecting and affected by loneliness may suggest the use of the more complex structural equations models rather than the hierarchical logistic regression and mediation/moderation models that have frequently been used.

CONCLUSION

Very few Intervention studies have appeared in the COVID-19 literature on loneliness. Those studies that document peer and parent relationships as mitigators of loneliness seem obvious, although a significant literature suggested that relationships occurred mostly on social media, especially during lockdowns (98% of folks on Facebook). And, it's not clear that these social media relationships were good substitutes as that literature has also documented touch deprivation as a prevalent lockdown problem (at 68%). Activities such as meditation and exercise that buffered loneliness for youth in this literature are consistent with adult studies on meditation and exercise as mitigators of loneliness. It is not clear how much of the meditation and exercise effects were mediated by engaging in those with other folks on zoom classes or outdoor exercise with others. Despite these methodological limitations, loneliness is a perennial problem, not just a pandemic lockdown problem, highlighting the importance of continuing research not only on potential underlying mechanisms but also on physiological effects and effective interventions for reducing loneliness.

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