Original Research

Associations amongst poverty, loneliness, and a defensive symptom cluster characterised by pain, fatigue, and low mood

Arran J. Davis [a,b,*] , Emma Cohen [a,b], Daniel Nettle [c,d]

[a] Centre for the Study of Social Cohesion, School of Anthropology and Museum Ethnography, University of Oxford, 51/53 Banbury Road, Oxford, OX2 6PE, United Kingdom
[b] Wadham College, University of Oxford, Parks Road, Oxford, OX1 3PN, United Kingdom
[c] Institut Jean Nicod, Département d'études cognitives, École normale supérieure-PSL, EHESS, CNRS, Paris, France
[d] Department of Social Work, Education and Community Wellbeing, Northumbria University, 15 Coach Lane, Newcastle upon Tyne, NE7 7TR, United Kingdom

ABSTRACT

Objective: Perceived social isolation is associated with increased pain, fatigue, and depression. Other research has shown that pain and depression are more common in individuals experiencing low socio-economic status, and that social relationships are especially important for buffering the negative health effects of low socio-economic status.
Study design: Cross-sectional.
Methods: We used a 20-country, cross-sectional sample of 24,504 respondents to the European Social Survey 7. Multilevel linear regression was used to test for the effects of loneliness, income decile, and their interaction on a symptom cluster variable that was the average of respondent z-scores on self-reported pain, fatigue, and low mood. We hypothesised that loneliness and low income would be interactively associated with higher symptom cluster scores.
Results: Those from lower income deciles were much more likely to feel lonely (48.7 % in the lowest income decile; 15.2 % in the highest income decile), despite no differences in reported time spent socialising. Multilevel linear regression indicated statistically significant associations consistent with our hypotheses: (1) lonely individuals score 0.447 SD higher on the symptom cluster, (2) for every increase in income decile, symptom cluster scores decrease by 0.022 SD, and (3) a loneliness by income interaction on the symptom cluster ($b = -0.018$), with the association between loneliness and the symptom cluster being strongest amongst those in lower income deciles.
Conclusions: Both loneliness and low income were associated with higher scores on the symptom cluster, and social relationships were especially strong buffers of the symptom cluster for individuals experiencing poverty. Results inform understandings of social and economic gradients in health.

1. Introduction

Humans evolved in highly socially interdependent groups in which resources needed for development, maintenance, and survival were accessed through social relationships.[1] As a result, social cues strongly influence the allostatic systems that respond to threat and govern resource consumption, conservation, and expenditure.[2,3] This has important consequences for mental and physical health, with social exclusion, isolation, and low status having consistent and profound effects on morbidity, mortality, and wellbeing via a range of psychophysiological mechanisms.[4,5]

Generally, research has shown that social adversity, such as psychosocial stress, social isolation, and social exclusion, leads individuals to employ psychophysiological strategies that defend against physical threats and encourage energy conservation.[6,7] One such strategy may be a co-occurring, mutually reinforcing symptom cluster, characterised by pain, fatigue, and low mood (henceforth, symptom cluster), and underpinned by increased inflammatory activity.[8–11] Pain and fatigue function to protect the body from injury and overexertion,[12,13] while low mood and depressive symptoms may function, in part, to promote

energy conservation via decreasing physical activity levels.[14,15] This symptom cluster may become more prevalent in response to social adversity; throughout much of human evolution, these social circumstances would have been associated with higher risks of physical injury and resource scarcity,[1,3,6] and a need to (re-) establish supportive social relationships.[16] Research in clinical and geriatric populations has shown that social disconnect and loneliness are associated with both increased proinflammatory activity and the symptom cluster.[17,18] Other research has shown that components of this symptom cluster vary according to socio-economic variables: higher levels of reported pain are associated with financial insecurity and low socio-economic status,[19–21] and there is evidence that negative financial shocks cause depressive symptoms.[22]

A range of findings suggest important interactions between income and social connections on health outcomes. For example, social connection and support (strong negative correlates of loneliness) have been shown to buffer the negative effects of poverty on physical and mental health.[22–25] Social connections may thus constitute what are known in the resilience literature as 'protection factors'; variables that have stronger effects on an outcome (here, the symptom cluster) when risk (here, financial strain) is highest.[26] This literature suggests that associations between loneliness and the symptom cluster will be strongest in low-income groups; in other words, the buffering effects of social connection will be strongest for people living in poverty.

Yet, poverty can strain individuals' social support networks,[27,28] and recent work has linked low socio-economic status with greater feelings of loneliness.[29] Crucially, feelings of loneliness are thought to result from discrepancies between what individuals desire from their social relationships (e.g., support, belonging) and what their social environments offer or are perceived to offer,[30,31] and loneliness is typically only weakly related to social network size and social interaction frequency.[32] Socio-economic adversity may thus impact feelings of loneliness through its effects on how individuals receive and perceive social support, rather than through how many social relationships people have or how often they socialise. In sum, while social relationships may be particularly strong buffers of the symptom cluster for people experiencing poverty, these people may be the most likely to suffer from loneliness.

Here, we use data from the European Social Survey 7 (ESS 7) to investigate cross-sectional associations between perceived social isolation (loneliness), socio-economic status (within-country income decile), and the symptom cluster.[33] The ESS 7 allows for the first investigation into the association between loneliness and the symptom cluster using a multinational, general population sample, and for the first analysis of whether associations between loneliness and the symptom cluster vary by income level. We hypothesised significant associations of loneliness and income with the symptom cluster (symptom cluster scores will be higher in those who are lonely and for those with low incomes), and an interaction between loneliness and income on the symptom cluster (the association of loneliness with the symptom cluster will be strongest in lower income deciles). As exploratory analyses, we also investigated associations between income, loneliness, and reported frequency of social interaction.

2. Methods

All variables were taken from responses to the ESS 7, which employed strict random probability sampling of aged 15 and over residents of 21 European countries in 2014 and 2015; full data for our proposed analyses were available from 24,504 individuals across 20 countries. Variable selection, creation, and analyses were pre-registered on AsPredicted (fhttps://aspredicted.org/xngf-tx7h.pdf). Code and data used in analyses, as well as the Supplementary Information (SI) file, can be found on our Open Science Framework (OSF) project website (https://osf.io/yau3p/).

2.1. Predictor and outcome variables

The income decile variable was created using individuals' within-country income decile. A binary loneliness variable was established using responses to the question "How often in the past week did you feel lonely?", answered using a 4-point response scale ("None or almost none of the time", "Some of the time", "Most of the time", "All or almost all of the time"). Individuals were categorised as lonely if they answered with "Some of the time" or more frequently; 26.3 % of respondents were classified as lonely using this cut-off, consistent with previous research.[29,34]

The ESS 7 had four outcome variables of interest for this study: a variable indicating the total types of pain individuals reported having experienced in the past 12 months (possible range of 0–3), a variable indicating how often individuals "felt everything they did as effort" in the past week (4-point response scale), a variable indicating how often individuals "felt like they could not get going" in the past week (4-point response scale), and a variable indicating how often individuals "felt depressed" in the past week (4-point response scale).

We examined the covariation between these four individual outcome variables to test whether they formed a single symptom cluster. As stated in our pre-registration, clustering was determined using a Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy (variables needed to have a KMO measure of at least 0.6 to be included in the symptom cluster) and through testing for significant positive correlations between the variables in the symptom cluster (all included variables needed to have significant positive correlations). All four outcome variables met the criteria for being included in the symptom cluster; analyses revealed acceptable measures of sampling adequacy for all four outcome variables (KMO = 0.69; all individual values $\geq$ 0.66) as well as significant positive correlations between the four outcome variables (see Fig. S1). We thus created a single-outcome symptom cluster variable that was the average of respondent z-scores for these four outcome variables.

Frequency of social interaction was determined via individuals' response to the question "How often do you meet socially with friends, relatives or colleagues?", answered using a 7-point response scale ranging from "Never" to "Every day".

Please see SI 1 for full variable descriptions.

2.2. Analyses

All statistical analyses were performed in R version 4.2.0. We used the *lme4* package to run two multilevel linear regression models.[35] We used one model to test for the main effects of loneliness (binary) and income decile (mean centred on 0), and one model to test for the interaction effect of loneliness and income decile on the symptom cluster.

The models included as covariates respondent age (continuous: mean centred on 0), gender (binary: female or male), job type (binary: manual or not), total number of listed health problems (continuous: mean centred on 0), number of people living regularly in household (continuous: mean centred on 0), marital status (binary: married or in a civil union, or not), and education level (continuous: mean centred on 0). Please see SI 1 for full variable descriptions. We selected these covariates as they represented potential confounding variables in our analyses (based on their theoretical and empirical relationships to loneliness, income, and the symptom cluster); previous studies on associations amongst social, economic, and health variables have included similar covariates or adjustments in their analyses.[8,18,19,22,36]

The models had a level-two random effect of socio-economic region, creating random intercepts for each region (models with random slopes did not converge). Socio-economic regions were derived from the *nomenclature d'unités territoriales statistiques* (NUTS) 1 geographic regions of Europe (analyses included 80 NUTS 1 regions).

We also ran specification curve analyses (SCAs) using the *specr*

package.[37] These SCAs allowed us to check the results of our multilevel models across all possible theory-driven analytical specifications that could have justifiably been made during variable creation and analyses (e.g., how we created the symptom cluster, how we classified loneliness, and the level-two random effect type used).[38] There were 39,936 possible analytical decisions included in the SCAs (see SI 2 for a full description of the methods used in the SCA).

3. Results

The prevalence of loneliness decreased with each increase in income decile ($b = -3.503$, $SE = 0.367$, $t = -9.55$, $p < .001$; see Table S1): 48.7 % of respondents with incomes in the lowest decile were classified as lonely, whereas only 15.2 % of respondents in the highest income decile were classified as lonely (see Fig. 1a and Table S2 for summary statistics by income decile). Despite significantly higher levels of loneliness in lower income deciles, there was no evidence for an association of income decile with lonely respondents' reported frequency of meeting socially with others ($b = -0.009$, $SE = 0.007$, $t = -1.24$, $p = .214$; see Fig. 1b and Table S3).

Regarding our main models, there was a significant symptom-increasing main effect of loneliness, $b = 0.447$, $SE = 0.009$, $t = 48.07$, $p < .001$, and a significant symptom-decreasing main effect of income decile, $b = -0.022$, $SE = 0.002$, $t = -12.70$, $p < .001$, on the symptom cluster. There was also a significant interaction between loneliness and income decile on the symptom cluster, $b = -0.018$, $SE = 0.003$, $t = -5.54$, $p < .001$ (see Fig. 2). See Table 1 for full model results and SI 3 for model assumption checks.

As shown in Fig. 2, the strength of the association between loneliness and the symptom cluster decreases as income decile increases. Lonely individuals in the lowest income decile have symptom cluster scores 0.621 *SD* higher than non-lonely individuals in this income decile. Lonely individuals in the highest income decile have symptom cluster scores that are only 0.396 *SD* higher than their non-lonely counterparts. This pattern is especially pronounced in individuals with high symptom cluster scores (*z*-score $\geq$1; 8.6 % of individuals included in analyses);

29.8 % of lonely individuals from the lowest income decile had high symptom cluster scores, compared to just 2.3 % of non-lonely individuals in the highest income decile (see Table S2 for summary statistics of symptom cluster scores by loneliness and income decile).

3.1. Specification curve analyses

Results of the SCAs, presented in SI 2, suggest that the associations of loneliness, income decile, and their interaction with the symptom cluster were statistically significant across all reasonable analytical decisions. Observed associations were strongest when symptom cluster scores were calculated *without* the pain variable, suggesting that the observed associations were driven by the other variables in the symptom cluster. Observed associations were also stronger when a more stringent cutoff for loneliness was used.

Using the symptom cluster without the pain questions and increasing the cutoff from feeling lonely at least "some of the time" in the last week (26.3 % of the sample) to at least "most of the time" in the last week (5.8 % of the sample) led the beta-coefficient estimate for loneliness to increase from 0.447 (reported above) to 0.945, an increase of 0.498 *SD* in symptom cluster scores (see Fig. S2). Using the symptom cluster created without the pain variable also led the beta-coefficient estimate for income to increase in magnitude from -0.022 (reported above) to -0.027 (see SI Fig. S3). Finally, using the symptom cluster without the pain variable and the more stringent loneliness cutoff increased the estimated beta-coefficient for the loneliness by income interaction on the symptom cluster from -0.018 (reported above) to -0.029 (see SI Fig. S4).

4. Discussion

Our results offer preliminary evidence for significant relationships between poverty and loneliness, and for their combined association with a cluster of symptoms – pain, fatigue, and low mood – that may represent a defensive psychophysiological strategy in response to social adversity.

Loneliness is significantly more prevalent in lower income deciles, despite no evidence for differences across income deciles in reported
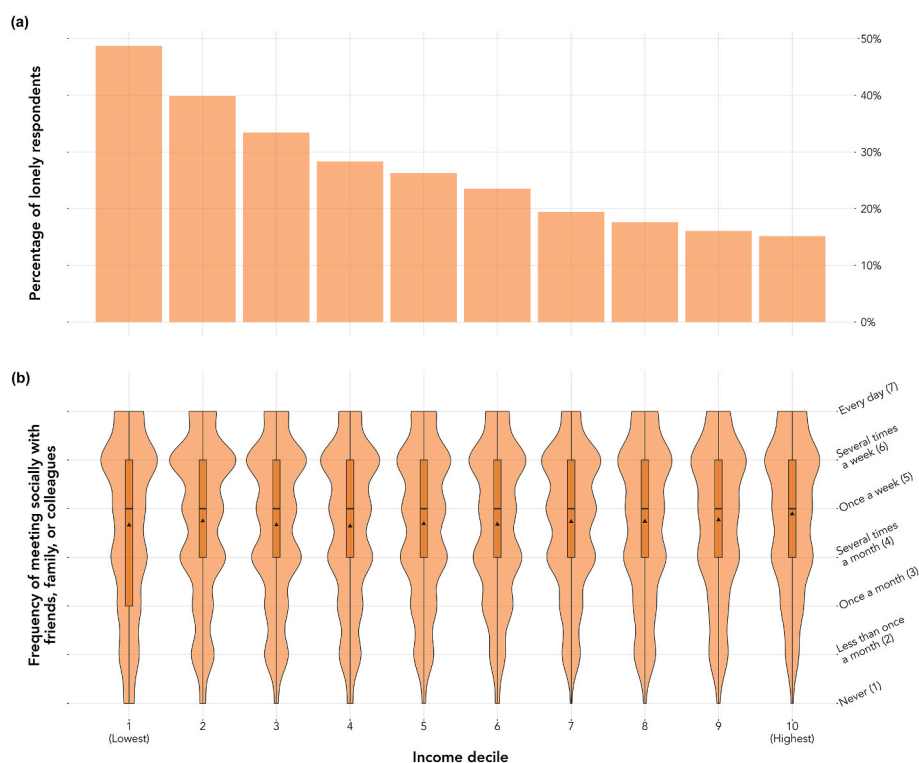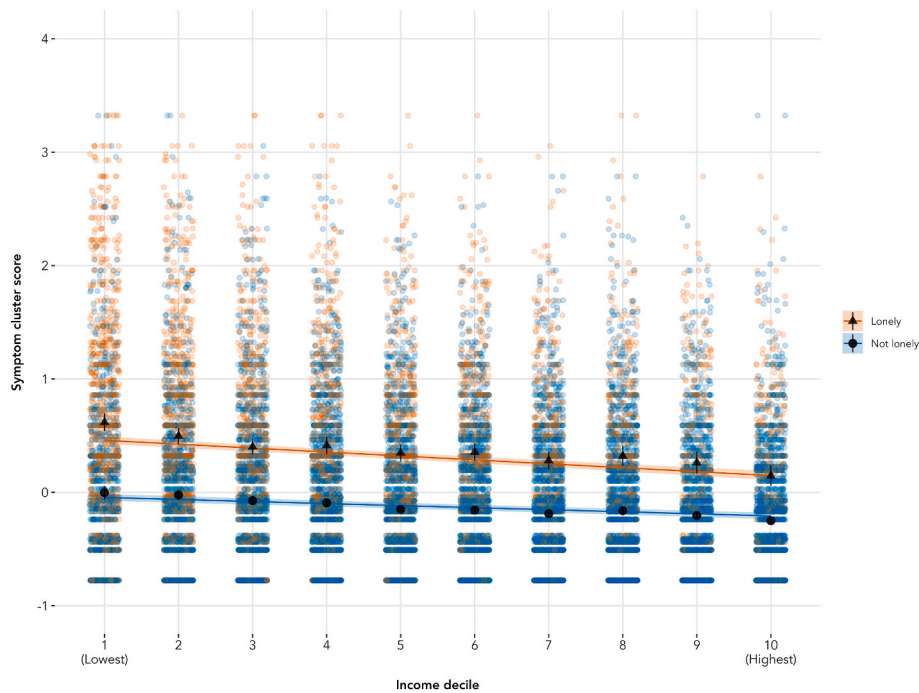

Fig. 1. (a) Percentage of lonely respondents by income decile. (b) Reported frequency of meeting socially with friends, family, or colleagues by income decile.

Fig. 2. Scatter plot of symptom cluster scores by loneliness response and income decile; error bars for each loneliness status by income decile mean represent 99 % confidence intervals; error for regression lines represent 95 % confidence intervals.

Table 1
Multilevel regression models on symptom cluster.

Variable	b	SE	95 % CI	t (df)	p
Intercept	−0.109	0.013	[−0.135, −0.083]	−8.19 (186.8)	<0.001
Loneliness (lonely)	0.447	0.009	[0.429, 0.466]	48.07 (24,490)	<0.001
Income decile	−0.022	0.002	[−0.025, −0.018]	−12.70 (24,180)	<0.001
Age	0.001	<0.001	[<0.001, 0.001]	2.56 (24,470)	0.010
Sex (female)	−0.109	0.008	[−0.124, −0.094]	−13.91 (24,470)	<0.001
Job type (manual)	0.121	0.008	[0.104, 0.137]	14.54 (24,480)	<0.001
Total health problems	0.160	0.004	[0.153, 0.168]	44.24 (24,480)	<0.001
People living in household	0.023	0.004	[0.015, 0.030]	6.14 (24,340)	<0.001
Marital status (not)[a]	−0.009	0.009	[−0.027, 0.009]	−0.94 (24,480)	0.345
Education level	−0.021	0.002	[−0.026, −0.017]	−9.00 (24,480)	<0.001
Loneliness × income decile[b]	−0.018	0.003	[−0.024, −0.011]	−5.54 (24,460)	<0.001

Random part	Variance			SD	
Intercept	0.007[b]			0.085[b]	
$R^2_m = 0.222^b$, $R^2_c = 0.237^b$					

[a]Marital status shows the estimated effect of not being married or in a civil union, as compared to being married or in a civil union.

[b]Estimates derived from the multilevel regression model that included the loneliness by income decile interaction; all other estimates derived from multilevel regression model without the interaction.

frequencies of socialising. This suggests that perceptions of loneliness are influenced by factors beyond frequency of socialising. Our findings are consistent with theoretical work on the causes and experiences of loneliness, which suggests that loneliness arises from discrepancies between individuals' social needs and their perceptions of what their social worlds actually provide.[30,31] From this perspective, the observed association between loneliness and low income is also consistent with previous work showing lower levels of perceived social capital in socio-economically deprived areas, despite findings of more frequent socialising.[39] Taken together, this research suggests that poverty and low socio-economic status impact how individuals experience social connection and support.[23,27,28,40] Our findings are the first to show associations between loneliness and income in a multinational, general population sample. Given its strong connections to health, more quantitative research is needed on the social and economic factors driving

perceptions of loneliness.

We also show that feeling lonely and being part of a lower income decile were associated with higher symptom cluster scores, and that the association between loneliness and the symptom cluster was strongest in the lowest income deciles. In using the ESS 7's general population, multinational sample, we replicate previous associations of loneliness with the symptom cluster in clinical and geriatric populations.[8,18] We also show, for the first time, a socio-economic gradient in symptom cluster prevalence, which is in line with previous findings of similar socio-economic patterns for pain and depression.[21,22]

Our analyses revealed that the gap in symptom cluster scores between lonely and non-lonely individuals narrowed as income rose. Or, in other words, the association of loneliness with the symptom cluster was most pronounced in individuals in lower income deciles. The difference in symptom cluster scores between lonely and non-lonely individuals

was 0.621 *SD* in the lowest income decile, compared to just 0.396 *SD* in the highest income decile. The importance of considering both social connection and income when examining symptom cluster intensity is highlighted by the fact that 29.8 % of lonely individuals from the lowest income decile had symptom cluster scores at least 1 *SD* above the mean, compared to just 2.3 % of non-lonely individuals from the highest income decile.

These findings are in line with a broader literature identifying supportive social relationships as buffers to the adverse effects of poverty. Research has shown that perceptions of social support and connectedness can help to reduce inflammation and the mental health problems associated with poverty.[23,24] Strong and weak social connections not only provide individuals with instrumental help (e.g., short-term loans or rides to work),[28,40] but also with the emotional and informational support needed to buffer perceptions of threat,[41] and to enhance perceptions of control, trust, and reciprocity.[42,43] Applying this research to our findings, we suggest that, as material resources decrease, the importance of social resources increase, with individuals who are both in poverty *and* lonely displaying the highest symptom cluster scores in response to the relative threat and resource scarcity indicated by their social ecologies.[3,6,44]

A primary limitation of this study is that the symptom cluster was not derived from a pre-validated instrument. Instead, it was created using the measures available in the ESS 7. The questions on pain were particularly inadequate, asking about the presence of pain in specific areas of the body at any time in the past year. As such, they were too blunt to capture meaningful variation in daily life (potentially explaining the findings from the SCAs showing that all observed associations were stronger when the symptom cluster did not include the pain variable). Finally, our measure of low mood mentioned feeling "depressed", but it is not a clinically validated measure of depression.

Future research could also better assess socio-economic effects on the symptom cluster through using more frequent (e.g., ecological momentary assessment) and ecologically informed measures of social connection and support, and by working with participants to create a pre-validated instrument to measure the symptom cluster. This work should also consider variables such as race and job type, as they are likely to affect individuals' lived social experiences, and are known to impact a range of outcomes related to the symptom cluster, including inflammatory activity, feelings of pain, and low mood.[20,45,46]

Research could also expand measures of social connection to reflect the human capacity to find safety, support, and belonging not just via close relationships but also via connections to the larger social groups they belong to.[3] Previous research has shown that feeling bonded to multiple, extended groups (e.g., friends, country, and government) is associated with fewer depressive symptoms and better well-being.[47] It may be that when social and material support are lacking in multiple aspects of an individual's social ecology (e.g., from close others *and* civic institutions), they are especially likely to respond with a defensive psychophysiological strategy marked by pain sensitivity, fatigue, and low mood.

In conclusion, this study offers preliminary evidence for associations between social connection, socio-economic status, and a symptom cluster characterised by increased pain perception, feelings of fatigue, and low mood. We view the symptom cluster as an evolved response to the physical threat and resource scarcity associated with social disconnect and exclusion in ancestral environments.[6,44] As such, pain, fatigue, and low mood likely represent symptoms of a broader psychophysiological strategy that functions to protect the body from harm and conserve its resources in the face of social adversity.[3,7,48–50] The symptom cluster may thus co-occur with other socially-influenced outcomes that, when chronic, are known to negatively impact long-term health, such as increased inflammation and reduced physical activity levels.[18,51] These findings should generate new lines of research into the interrelated socio-economic, psychological, and physiological processes underpinning the symptom cluster, and their role in explaining well-known links between sociality and health, while also supporting policy development in these priority areas.[4,5]

Appendix A. Supplementary data

Supplementary information for this article can be found online at https://doi.org/10.1016/j.puhe.2025.02.037.

References

1. Tomasello M, Melis AP, Tennie C, Wyman E, Herrmann E. Two key steps in the evolution of human cooperation: the interdependence hypothesis. *Curr Anthropol.* 2012;53:673–692. https://doi.org/10.1086/668207.
2. Beckes L, Coan JA. Social baseline theory: the role of social proximity in emotion and economy of action. *Soc. Pers. Psychol. Compass.* 2011;5:976–988. https://doi.org/10.1111/j.1751-9004.2011.00400.x.
3. Slavich GM. Social safety theory: a biologically based evolutionary perspective on life stress, health, and behavior. *Annu Rev Clin Psychol.* 2020;16:265–295. https://doi.org/10.1146/annurev-clinpsy-032816-045159.
4. Snyder-Mackler N, Burger JR, Gaydosh L, et al. Social determinants of health and survival in humans and other animals. *Science.* 2020;368:eaax9553. https://doi.org/10.1126/science.aax9553.
5. Holt-Lunstad J, Uchino B. Social support and health. In: Glanz K, Rimer BK, Viswanath K, eds. *Health Behavior and Health Education: Theory, Research, and Practice.* John Wiley & Sons; 2015: 183–204.
6. Cohen E. Are placebo effects special? In: Hurst P, Beedie C, eds. *Placebo Effects in Sport and Exercise.* New York, USA: Routledge; 2023:45–56.
7. Slavich GM, Roos LG, Mengelkoch S, et al. Social Safety Theory: conceptual foundation, underlying mechanisms, and future directions. *Health Psychol Rev.* 2023; 17:5–59. https://doi.org/10.1080/17437199.2023.2171900.
8. Jaremka LM, Andridge RR, Fagundes CP, et al. Pain, depression, and fatigue: loneliness as a longitudinal risk factor. *Health Psychol.* 2014;33:948. https://psycnet.apa.org/doi/10.1037/a0034012.
9. Jaremka LM, Fagundes CP, Peng J, et al. Loneliness promotes inflammation during acute stress. *Psychol Sci.* 2013;24:1089–1097. https://doi.org/10.1177/0956797612464059.
10. Cacioppo JT, Hawkley LC, Thisted RA. Perceived social isolation makes me sad: 5-year cross-lagged analyses of loneliness and depressive symptomatology in the Chicago Health, Aging, and Social Relations Study. *Psychol Aging.* 2010;25:453. https://doi.org/10.1037/a0017216.
11. Slavich GM, Irwin MR. From stress to inflammation and major depressive disorder: a social signal transduction theory of depression. *Psychol Bull.* 2014;140:774–815. https://doi.org/10.1037/a0035302.
12. Noakes TD. Fatigue is a brain-derived emotion that regulates the exercise behavior to ensure the protection of whole body homeostasis. *Front Physiol.* 2012;3:1–13. https://doi.org/10.3389/fphys.2012.00082.
13. Wiech K, Tracey I. Pain, decisions, and actions: a motivational perspective. *Front Neurosci.* 2013;7. https://doi.org/10.3389/fnins.2013.00046.
14. Stieglitz J, Trumble BC, Thompson ME, Blackwell AD, Kaplan H, Gurven M. Depression as sickness behavior? A test of the host defense hypothesis in a high pathogen population. *Brain Behav Immun.* 2015;49:130–139. https://doi.org/10.1016/j.bbi.2015.05.008.

15. Roshanaei-Moghaddam B, Katon WJ, Russo J. The longitudinal effects of depression on physical activity. *Gen Hosp Psychiatry*. 2009;31:306–315. https://doi.org/10.1016/j.genhosppsych.2009.04.002.

16. Cacioppo JT, Cacioppo S, Boomsma DI. Evolutionary mechanisms for loneliness. *Cognit Emot*. 2014;28:3–21. https://doi.org/10.1080/02699931.2013.837379.

17. Jaremka LM, Sunami N, Nadzan MA. Eating moderates the link between body mass index and perceived social connection. *Appetite*. 2017;112:124–132. https://doi.org/10.1016/j.appet.2017.01.016.

18. Hughes S, Jaremka LM, Alfano CM, et al. Social support predicts inflammation, pain, and depressive symptoms: longitudinal relationships among breast cancer survivors. *Psychoneuroendocrinology*. 2014;42:38–44. https://doi.org/10.1016/j.psyneuen.2013.12.016.

19. Chou EY, Parmar BL, Galinsky AD. Economic insecurity increases physical pain. *Psychol Sci*. 2016;27:443–454. https://doi.org/10.1177/0956797615625640.

20. Case A, Deaton A. *Deaths of Despair and the Future of Capitalism*. New Jersey, USA: Princeton University Press; 2020.

21. Todd A, McNamara CL, Balaj M, et al. The European epidemic: pain prevalence and socioeconomic inequalities in pain across 19 European countries. *Eur J Pain*. 2019; 23:1425–1436. https://doi.org/10.1002/ejp.1409.

22. Nettle D, Chevallier C, de Courson B, Johnson EA, Johnson MT, Pickett KE. Short-term changes in financial situation have immediate mental health consequences: implications for social policy. *Soc Pol Adm*; 2024:1–16. https://doi.org/10.1111/spol.13065.

23. Richards L. For whom money matters less: social connectedness as a resilience resource in the UK. *Soc Indic Res*. 2016;125:509–535. https://doi.org/10.1007/s11205-014-0858-5.

24. Moskowitz D, Vittinghoff E, Schmidt L. Reconsidering the effects of poverty and social support on health: a 5-year longitudinal test of the stress-buffering hypothesis. *J Urban Health*. 2013;90:175–184. https://doi.org/10.1007/s11524-012-9757-8.

25. Carroll JE, Gruenewald TL, Taylor SE, Janicki-Deverts D, Matthews KA, Seeman TE. Childhood Abuse, Parental Warmth, and Adult Multisystem Biological Risk in the Coronary Artery Risk Development in Young Adults Study. *Proc Natl Acad Sci*. 2013; 110:17149–17153. https://doi.org/10.1073/pnas.1315458110.

26. Masten Wright MO W. Resilience over the lifespan: Developmental perspectives on resistance, recovery, and transformation. In: Reich JW, Zautra AJ, Hall JS, eds. *Handbook of adult resilience*. New York, USA: The Guilford Press; 2010:213–237.

27. Desmond M. Disposable ties and the urban poor. *Am J Sociol*. 2012;117:1295–1335. https://doi.org/10.1086/663574.

28. Lubbers MJ, García HV, Castaño PE, Molina JL, Casellas A, Rebollo JG. Relationships stretched thin: social support mobilization in poverty. *Ann Am Acad Polit Soc Sci*. 2020;689:65–88. https://doi.org/10.1177/0002716220911913.

29. Berlingieri F., Colagrossi M., Mauri C. Loneliness and Social Connectedness: Insights from a New EU-wide Survey. European Commission. 2023:JRC133351. https://publications.jrc.ec.europa.eu/repository/handle/JRC133351.

30. Hawkley LC, Capitanio JP. Perceived social isolation, evolutionary fitness and health outcomes: a lifespan approach. *Phil Trans R Soc B*. 2015;370:20140114. https://doi.org/10.1098/rstb.2014.0114.

31. Cacioppo JT, Hawkley LC, Crawford LE, et al. Loneliness and health: potential mechanisms. *Psychosom Med*. 2002;64:407–417. https://doi.org/10.1097/00006842-200205000-00005.

32. Hawkley LC, Burleson MH, Berntson GG, Cacioppo JT. Loneliness in everyday life: cardiovascular activity, psychosocial context, and health behaviors. *J Pers Soc Psychol*. 2003;85:105–120. https://doi.org/10.1037/0022-3514.85.1.105.

33. European Social Survey European Research Infrastructure (ESS ERIC). ESS7 - integrated file, edition 2.3 [Data set]. Sikt - Norwegian Agency for Shared Services in Education and Research. https://doi.org/10.21338/ess7e02_3.

34. Macdonald SJ, Nixon J, Deacon L. Loneliness in the city': examining socio-economics, loneliness and poor health in the North East of England. *Public Health*. 2018;165:88–94. https://doi.org/10.1016/j.puhe.2018.09.003.

35. Bates D., Maechler M., Bolker B., Walker S. lme4: linear mixed-effects models using Eigen and S4. R package. 2014 https://cran.r-project.org/package=lme4.

36. Bimpong K, Thomson K, Mcnamara CL, et al. The Gender Pain Gap: gender inequalities in pain across 19 European countries. *Scand J Publ Health*. 2022;50: 287–294. https://doi.org/10.1177/1403494820987466.

37. Masur P.K., Scharkow M. Specr: Conducting and Visualizing Specification Curve Analyses. R package.2020. https://cran.r-project.org/package=specr.

38. Simonsohn U, Simmons JP, Nelson LD. Specification curve analysis. *Nat Hum Behav*. 2020;4:1208–1214. https://doi.org/10.1038/s41562-020-0912-z.

39. Nettle D. *Tyneside Neighbourhoods: Deprivation, Social Life and Social Behaviour in One British City*. Cambridge, UK: Open Book Publishers; 2015.

40. Wellman B, Wortley S. Different strokes from different folks: community ties and social support. *Am J Sociol*. 1990;96:558–588. https://doi.org/10.1086/229572.

41. Thoits PA. Mechanisms linking social ties and support to physical and mental health. *J Health Soc Behav*. 2011;52:145–161. https://doi.org/10.1177/0022146510395592.

42. Ross CE, Mirowsky J. The sense of personal control: social structural causes and emotional consequences. In: Aneshensel CS, Phelan JC, Bierman A, eds. *Handbook of the Sociology of Mental Health*. Dordrecht, Netherlands: Springer; 2013:379–402. https://doi.org/10.1007/978-94-007-4276-5_19.

43. Stolle D, Rochon TR. Are all associations alike? Member diversity, associational type, and the creation of social capital. *Am Behav Sci*. 1998;42:47–65. https://doi.org/10.1177/0002764298042001005.

44. Davis AJ, Hettinga F, Beedie C. You don't need to administer a placebo to elicit a placebo effect: social factors trigger neurobiological pathways to enhance sports performance. *Eur J Sport Sci*; 2020:302–312. https://doi.org/10.1080/17461391.2019.1635212.

45. Shavers VL, Bakos A, Sheppard VB. Race, ethnicity, and pain among the US adult population. *J Health Care Poor Underserved*. 2010;21:177–220. https://doi.org/10.1353/hpu.0.0255.

46. Geronimus AT. *Weathering: The Extraordinary Stress of Ordinary Life in an Unjust Society*. London, UK: Hachette; 2023.

47. Tunçgenç B, van Mulukom V, Newson M. Social bonds are related to health behaviors and positive well-being globally. *Sci Adv*. 2023;9:eadd3715. https://doi.org/10.1126/sciadv.add3715.

48. Stijovic A, Forbes PA, Tomova L, et al. Homeostatic regulation of energetic arousal during acute social isolation: evidence from the lab and the field. *Psychol Sci*. 2023; 34:537–551. https://doi.org/10.1177/09567976231156413.

49. Eisenberger NI, Master SL, Inagaki TK, et al. Attachment figures activate a safety signal-related neural region and reduce pain experience. *Proc Natl Acad Sci U S A*. 2011;108:11721–11726. https://doi.org/10.1073/pnas.1108239108.

50. Davis AJ, Crittenden B, Cohen E. Effects of social support on performance outputs and perceived difficulty during physical exercise. *Physiol Behav*. 2021;239:113490. https://doi.org/10.1016/j.physbeh.2021.113490.

51. Hawkley LC, Thisted RA, Cacioppo JT. Loneliness predicts reduced physical activity: cross-sectional & longitudinal analyses. *Health Psychol*. 2009;28:354–363. https://doi.org/10.1037/a0014400.