

The Genetic Price of Poverty

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ABSTRACT

In the modern era, achieving social health is increasingly shaped by systemic inequalities. This literature review analyzes the extent to which economic disparities in digital infrastructure and early childhood resources are strongly associated with the epigenetic development of social health. By examining peer-reviewed research through the lenses of the scientific, technological, and economic domains, this paper argues that social health is a resource-dependent outcome shaped at the neural, infrastructural, and institutional levels. The scientific lens shows that early childhood resource deprivation is associated with epigenetic mechanisms, including altered DNA methylation patterns, stress sensitivity, and impaired social development—that can have a prolonged effect on social health. The technological lens shows that social and infrastructural inequalities are linked to amplified disadvantages, mainly a lack of access to the internet, into adulthood, correlating with restricting access to tools that modern social development requires. The economic lens highlights institutional failure, highlighting the long-term costs of inaction, including increases in healthcare spending, reduced productivity, and generational inequality, which significantly exceed the required investment to prevent them. When taken together, the perspectives expose a poverty trap embedded at the epigenetic, infrastructural, and institutional levels. A much-needed intervention requires increased early childhood support, universal digital access, and algorithmic accountability, all of which show that economic disparities in digital infrastructure and early childhood resources are strongly associated with the epigenetic development of social health to a foundational extent that needs to be addressed. Social health in the 21st century is not an individual goal, but an outcome of change.

INTRODUCTION

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According to a landmark advisory by the US surgeon general, an analysis of 128 studies found that high levels of social connection increased the odds of survival by 50% over an average of 7.5 years (Office of the Surgeon General, 2023). The Surgeon General's advisory defines social isolation as the objective lack of social relationships, distinguishing it from loneliness, which is defined as the subjective distress that arises when one's social connections fall short of desired levels. Large scale epidemiological studies commonly quantify both loneliness and social isolation using validated tools such as the UCLA

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Loneliness Scale and the Social Network Index (Berkman & Syme, 1979). Data from across the United States in 2022 show that more than 37% of American adults experience moderate-to-severe loneliness (Zhu et al., 2025), and the KFF/Economist survey found that 22% of adults in the United States report always or often feeling lonely or socially isolated (Kaiser Family Foundation, 2018). The advisory shows the modern "loneliness epidemic" not as a lifestyle failure, but instead as a public health crisis, comparing it to the scale of the tobacco and obesity epidemics. This is reinforced by Holt-Lunstad and colleagues (2015), who analyzed data from over 3.4 million participants and found that social isolation is comparable to smoking 15 cigarettes daily. The urgency has been recognized globally, and the World Health Organization has launched a commission on social connection, declaring loneliness as a systemic threat across countries and income levels (World Health Organization, 2023). Together, these three sources show that social disconnect is not only measurable but a population-level crisis that requires attention. Yet the mechanisms for determining who achieves social health and who doesn't are still being debated. Social health, as defined by sociologist Corey Keyes, is "the appraisal of one's circumstance and functioning in society" (Keyes, 1998, p.122). Researchers measure social health across several dimensions: the quantity and quality of social relationships, sense of belonging, and the degree to which individuals are supported by their communities (Russell, 1996; Killam, 2026). The ability to gain social health is not equal. This paper asks: To what extent do economic disparities in digital infrastructure and early childhood resources determine the epigenetic development of social health? Through a scientific lens, we see how resources shape the brain. The scientific lens shows how economic disparities shape biological development, the technological lens shows how those disparities persist through digital access, and the economic lens examines the costs of both failures. This research argues that social health is a resource-dependent process in which economic disparities are evident at the neural, infrastructural, and institutional levels, and that achieving change requires structural intervention, investment in early childhood resources, expanded digital infrastructure, and increased regulation of social media platforms.

METHODOLOGY

Sources for this literature review were found primarily through Google Scholar, although additional searches were performed on JSTOR. Within google scholar, searches were performed on each subtopic in a sequence: the relationship between social health and epigenetics, the relationship between social health and digital infrastructure, and the economic dimensions of connecting those two concepts. Each of these search terms were applied in both the general and science specific fields in Google Scholar. No fixed publication date was applied, though the very old sources were avoided in favor of more recent research. Each source was evaluated through the CRAAP test (Currency, Relevance, Authority, Accuracy, Purpose) to assess the quality before inclusion. Approximately 30 to 35 sources were reviewed, though a subset was excluded when it became apparent that the direction of the paper would be different from that which was originally considered. The majority of the sources used were peer-reviewed journal articles to ensure the highest quality of evidence, though a few exceptions existed as noted within the limitations section.

THE BIOLOGICAL COST OF EARLY CHILDHOOD RESOURCES

The research question focuses on epigenetic development, and the evidence shows exactly why economic conditions act as biological ones. It is important to distinguish between genetics and epigenetics at the beginning. Genetics refers to the fixed sequence of DNA inherited at conception and does not change based on life experience. Epigenetics, by contrast, refers to modifications, most commonly the addition of methyl groups to cytosine residues in the DNA, commonly known as DNA methylation, and changes in histone acetylation, that alter how genes are expressed without changing the underlying DNA sequence (Virolainen et al., 2023). These epigenetic marks can activate or silence gene expression, and critically, they can be shaped by environmental experiences including early childhood poverty (Parade et al., 2021; Colodro-Conde et al., 2023). Unfavorable experiences such as chronic stress, neglect, and economic struggle in early life have been shown to influence DNA methylation patterns in ways that can continue to affect the subject for decades (Assis et al., 2025; Parade et al., 2021). A study in the *American Journal of Public Health* identified four major mechanisms through which genetic predispositions interact with their social environment: sensitivity to stress, differential susceptibility, goodness of fit, and social enhancement (Reiss et al., 2013). To quickly define these terms, stress sensitivity is the degree to which an individual's biology responds to unfavorable stimuli, differential susceptibility describes how the same genetic background can cause very different outcomes depending on the environment, goodness of fit describes how well a child's biological habits match the demands of their environment, and social enhancement refers to the way positive social environments amplify favorable genetic predispositions (Reiss et al., 2013). These mechanisms show how a child's genetic predisposition can lead to biological differences in a resource-limited environment. A child with a heightened predisposition to stress sensitivity has a much higher likelihood of feeling strong psychological effects during familial conflict, as supported by a peer-reviewed study, while a genetically resilient child may not (Everyday conflict in families, 2022). For example, heightened stress sensitivity in poverty has been associated with altered cortisol (a stress hormone) reactivity and changes in the methylation of the glucocorticoid receptor gene (NR3C1), a well researched epigenetic marker of early disadvantage (Parade et al., 2021). Economic deprivation in this setting may function less as a stressor, but more as a filter correlating with genetic variation in ways that unevenly affect people. This data is quantified by Erola et al. (2022), whose longitudinal study of pairs shows that genetic potential for positive social interaction is more fully realized in stable, wealthy environments. In poorer environments, the body directs resources towards survival and hyper-vigilance, and this shift has measurable epigenetic correlates. Importantly, this does not mean that the genes themselves are different between poor and wealthy children; rather, it is the environmental conditions that determine whether specific genetic predispositions toward social connection are expressed or suppressed. This shift in how the body copes with poverty shows up as real, measurable changes in the DNA. A 2023 longitudinal study found that changes in socioeconomic conditions in childhood predicted differences in DNA methylation patterns at specific CpG sites across the genome (Colodro-Conde et al., 2023). When examining the mechanisms established by Reiss et al., a paradox emerges: a child may carry genetic predispositions that promote social interaction, but without an environment that makes survival seem automatic, the potential will never be realized. Virolainen et al. (2023) identify molecular mechanisms, chronic stress, and pollution as factors that alter epigenetic marks

on the genome, but the complexity of the genome makes it hard to be sure. To be specific, the pollution referenced here refers mostly to air pollution and heavy metal exposure, which are disproportionately concentrated in low-income neighborhoods, creating a greater burden alongside poverty itself (Virolainen et al., 2023). The mechanisms through which these environmental factors alter gene expression include adding methyl groups to DNA (hypermethylation) of promoter regions of the brain, which generally silences gene expression, and loss of methyl groups (hypomethylation) of regulatory regions, which can throw off the body's immune system and stress response. However, it is important to note that epigenetic changes can activate and suppress gene expression at the same time, and the effect depends on which specific genes and regions are affected. Current evidence shows patterns rather than fixed outcomes (Virolainen et al., 2023; Assis et al., 2025). When combined with research by Meloni and Reynolds (2021) showing that experiences alter epigenetic marks on the genome, not the DNA sequence itself, this understanding shows that economic inequality is linked to effects not only at the level of opportunity but also at the level of biological expression at the epigenetic level. The mechanisms established by Reiss and colleagues are not abstract constructs; they appear to be activated or suppressed when connected by the environmental conditions a child is born into. Critically, these epigenetic effects have been shown to continue into adulthood and are not reversed when circumstances improve. A study found that individuals who experienced low socioeconomic status in early life showed accelerated epigenetic aging when compared to individuals from wealthier backgrounds, and that while some reversibility was observed when socioeconomic status improved, the early life environment remained as the strongest predictor of epigenetic outcomes (Dugué et al., 2017). A longitudinal twin study corroborated these findings, showing that childhood social isolation predicts elevated inflammatory biomarkers in adulthood, independent of other risk factors (Lacey et al., 2014). A child in poverty does not face harder circumstances; their epigenome is being read differently, in a way associated with disadvantaged social interactions because of their circumstances. To be precise, this is not a genetic argument. It does not suggest that children in poverty have different DNA, but an epigenetic one. The same genome, expressed in a different environment, is associated with different biological outcomes that correlate with reduced social development. This is what makes the social poverty trap so hard for an individual to escape. The disadvantage is that it settles before the child has a chance to make any personal choice, and it is inscribed in the same biological hardware that would otherwise enable social development to escape it. Evidence that social difficulties associated with poverty continue into adulthood even after circumstances improve is provided by Akgül et al. (2023), whose longitudinal study of low-income children found that early economic difficulty predicted much lower levels of social trust, social support, and wellness even after controlling for current economic conditions. The study suggests that the developmental window of early childhood carries disproportionate weight in determining long-term social health.

DIGITAL INFRASTRUCTURE DISPARITIES: THE DOUBLE-EDGED SWORD

If early childhood resource hardship sets a biological ceiling on social health, then digital infrastructure inequalities may prevent the ceiling from ever being raised. As we become more and more dependent on technology, it has become a prerequisite instead of a convenience for social survival. Tyson et al. (2025)

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found that the COVID-19 pandemic accelerated transformation, providing digital counterparts to emulate the fundamental tools of communication. It is worth acknowledging that the strongest evidence for digital connectivity allowing for strong social health comes from the COVID-19 period, when physical connection was unavailable. Outside of COVID-19, the evidence for technology replacing in person connection is limited and research suggests that virtual contact cannot fully substitute for face to face interaction (Przybylski & Weinstein, 2017). The argument has weaknesses as digital access is a necessary but not sufficient condition for modern social participation, particularly for communities already geographically or economically isolated. For communities already facing high epigenetic costs of resource difficulty, exclusion from digital infrastructure is not only an inconvenience but also isolation as it blocks a significant method of modern social health development. The most significant development with implications of connecting the world is the Low Earth Orbit (LEO) satellite megaconstellations. In a sustainability assessment examining the social implications of the LEO deployment, Osoro et al. (2023) argue that this technological advancement represents a turning point for digital equality, providing connectivity to rural cities that lack the funds to afford infrastructure. It is important to understand that this study predicts future outcomes but doesn't measure results that have already happened longitudinally. Osoro et al. (2023) model what access could look like in the future; they don't prove that connectivity has already led to real social benefits. The importance of their research is in suggesting the importance of establishing infrastructure for equity in digital access as a necessity for social participation. This is not a marginal improvement, but a leading technology that closes the gap between economically disadvantaged communities and the digital resources of modern social life. For communities where broadband is economically inaccessible, LEO access is the only viable solution to social connectivity that survival now requires. Yet access alone is not enough if the platforms new technologies are designed to exploit their users. In a non-peer-reviewed presentation at the Sacred Heart University Academic Festival conference, the shift from genuine connection to validation-seeking behavior on social media has been attributed to companies themselves (Acharki, 2021). Specifically, engagement systems on social media platforms such as Instagram and TikTok optimize for behavioral metrics like keeping users on the platform for longer through reinforcement of likes and follower counts, a design pattern that has been compared to reward schedules in behavioral psychology (Acharki, 2021; Babundo, 2025). Social media appears to have replaced the traditional need to connect with a hunger for validation in the form of likes and followers, creating cycles that seem to promote connection but instead isolate users while operating under the facade of true connection. Babundo (2025), in a non-peer-reviewed capstone project, argues that digital anonymity, along with the validation-seeking mindset, has contributed to measurable increases in teen depression and suicide rates. Alarming, a majority of the damages have fallen on those whose early resource deprivation has already epigenetically reduced their capacity for effective emotional regulation. The algorithm does not create vulnerabilities; instead, it exploits the epigenetic vulnerabilities that already exist as a consequence of economic conditions. Though digital infrastructure has its downsides, it also has the potential to connect people like never before. A peer-reviewed journal states that digital platforms have enabled historically marginalized groups to connect at a scale never before seen (Kim et al., 2018). However, this potential must be weighed carefully. Research suggests that online communities can provide valuable social platforms for marginalized groups, particularly through shared identity and collective organization, but these benefits are more pronounced for adults with developed social

capacities than for children and adolescents whose social brains are still growing (Kim et al., 2018). Newport (2019) and other researchers studying childhood development argue that children, particularly those under 16, may be better served by prioritizing in person social bonds before introducing digital engagement. Connectivity can extend opportunity and community, but cannot undo the epigenetic changes associated with resource deprivation. A child whose stress response system has already been biologically changed to poverty does not immediately benefit from gaining access to digital resources; the child's biological stress responses are already connected with previous environments and their conditions by the time they reach those tools.

ECONOMIC COST OF STRUCTURAL INACTION

The biological and infrastructural failures described above translate into quantifiable costs that tower over the investments to prevent them. Burlina and Rodríguez-Pose (2023) show that geographic and socioeconomic inequality produce gaps in social connections that develop across generations. Costs such as reduced productivity, significant spending in healthcare to combat social health complications, and a lack of support for these marginalized communities contribute to worse social connections, which in turn lead to more spending, creating a cycle. These are the populations identified in the scientific lens that carry the highest epigenetic burden, making the economic costs of inaction a direct cost of the epigenetic costs of inequality. The economic costs of inaction are therefore associated with that biological pattern. Failing to intervene at the epigenetic level in early childhood does not just delay social development, it institutionalizes it across generations furthering the social poverty trap. Mihalopoulos et al. (2025) quantify the growing failure, finding that untreated adolescent mental health conditions, amplified through social media dynamics shown by Babundo (2025), represent an increased need for healthcare, concentrated in the same low-income areas that are least equipped to absorb the costs. The economic lens changes the whole argument; the social poverty trap is not a social issue, but an economic problem with biological consequences. The cost of allowing epigenetic damage to low-income communities, rather than denying them digital infrastructure to support them into adulthood, is a choice, one that is extremely costly in the long term for our government, and with a clear alternative that is significantly cheaper than the failure it would prevent.

LIMITATIONS AND ALTERNATIVE PERSPECTIVES

The arguments presented here face real challenges. The biggest issue is enforcing the idea of biological determinism; framing social health as epigenetically shaped by economic conditions risks communicating that low-income people are permanently damaged, which the evidence does not support. Epigenetic changes are also reversible. The same mechanisms that allow poverty to impact social connection negatively also allow for recovery. Research on epigenetic aging has shown some degree of reversibility when socioeconomic conditions improve, and the brain's capacity to reorganize and adapt (neuroplasticity), means that positive environments and targeted interventions can offset early

disadvantages (Dugué et al., 2017). Many psychologists argue that resilience and grit allow individuals to rise above adverse environments, a view supported by the brain's ability to adapt, or neuroplasticity, and to heal. This is a legitimate perspective, and one that the evidence does not overlook. However, this claim does not contradict the thesis; it actually confirms the problem. A low-resource income individual who achieves high social health does so by using significantly more biological energy than someone from a wealthy environment. Resilience acts as a tax that low-income individuals must pay to reach the same playing field as those from wealthy environments. Though this framing is not present in any single study, an interpretive lens applied to the cited findings makes this a reasonable interpretation. The counterargument, therefore, strengthens the claim instead of undermining it. A methodological limitation is acknowledged in one of the sources. Limitations such as those acknowledged by Virolainen et al. (2023) directly address the nondefinitive conclusions resulting from current levels of epigenetic technology, meaning that epigenetic arguments made are directionally supported but not yet fully provable. It is also important to acknowledge a key limitation: Because causing epigenetic changes in humans for experimental purposes would be extremely unethical and is not permitted, all human evidence is correlational rather than actually proven. Studies can detect differences in epigenetic markers such as DNA methylation or histone modification patterns between individuals from different socioeconomic backgrounds, and can correlate these differences with social health outcomes, but cannot 100% prove causation in the way that animal studies can. This means the epigenetic arguments in this paper are supported by a substantial body of evidence, but have a permanent limitation of observational human research (Virolainen et al., 2023; Parade et al., 2021). Additionally, the publications by Acharki (2021) and Babundo (2025) are not peer-reviewed, which slightly reduces their credibility. They have been used to show general patterns that many established studies have provided, not as standalone evidence. It is also important to note that the three lens structure this paper is written in is purely organizational and does not reflect how these lenses interact in the real world. Epigenetics, infrastructure, and economics overlap and reinforce each other far more than the headers suggest. The economic costs described here are not independent from the biological and infrastructural mechanisms already discussed. The same epigenetic burden shaping social development also pushes the healthcare and productivity costs explained below. Underlying the three main lenses is a broader question this paper can only begin to answer: how does the disadvantage become physically carried in the body over time? Epigenetics shows only a part of the answer, but not the whole picture.

CONCLUSION

The evidence suggests that economic disparities determine social health to a foundational extent through mechanisms reinforced by scientific, technological, and economic perspectives. The scientific lens, grounded in research conducted by Reiss et al. (2013), Erola et al. (2022), Virolainen et al. (2023), and Meloni and Reynolds (2021), shows that early childhood resource hardship is associated with epigenetic changes—particularly in DNA methylation patterns—that alter the expression of genes governing stress reactivity and social engagement, embedding an economic disadvantage in biology before anyone can make any choice about it. The technological lens, led by Osoro et al.'s (2023) analysis of LEO satellite

infrastructure and Tyson et al.'s (2025) documentation of society's need for digital access, shows that these infrastructure inequalities extend this disadvantage to adulthood, withholding access to the tools modern social health requires behind economic barriers that the most affected people are not able to pass through. The economic lens, through Burlina and Rodríguez-Pose (2023) and Mihalopoulos et al. (2025), reframes the argument as an institutional failure, highlighting that the cost of inaction far exceeds the required investment to prevent it. The Social Poverty Trap is uniquely resistant to a single-pronged intervention because it is deeply embedded at the epigenetic, infrastructural, and institutional levels, with each layer reinforcing the others. Fixing just one aspect won't work, similar to providing digital infrastructure after resource deprivation has already shaped one's epigenetic potential for social engagement. Effective solutions must be systemic and simultaneous: early childhood economic support to prevent adverse epigenetic changes at its source; universal digital infrastructure, accelerated by the LEO megaconstellations; and algorithmic accountability for social media companies that remove predatory design features that exploit vulnerabilities created by economic inequalities. The implications of this conclusion are significant. If epigenetic changes linked to early childhood resource hardship have a prolonged effect on social health, then each year of delayed assistance incurs an extreme biological cost across lifetimes and generations. Early childhood economic support is not just a charitable cause, but the most cost-effective point of entry to break the cycle before a majority of the damage is done. Universal digital access is no longer a luxury; it is the necessary scaffolding for the epigenetic disadvantage of permanent social isolation. And forcing social media companies to have some integrity is not a regulatory preference, but a necessary change for the population whose epigenetic vulnerabilities are being exploited. To what extent do economic disparities in digital infrastructure and early childhood resources determine the epigenetic development of social health? To the extent that they determine it before birth, compound it through childhood, extend it through adolescence on social media, and institutionalize it through inaction. Social health in the 21st century is not about who you know. It is whether the economic conditions of your birth allowed your biology to develop into someone capable of knowing others at all. This is not a personal failure. It is a policy one.

REFERENCES

- Acharki, M. (2021, May 5). Self-validation through social media [Paper presentation]. DigitalCommons@SHU. <https://digitalcommons.sacredheart.edu/acadfest/2021/all/37/>
- Akgül, H., et al. (2023). Loneliness, social support, social trust, and subjective wellness in low-income children: A longitudinal approach. *Children*, 10(9), 1433. <https://doi.org/10.3390/children10091433>
- Assis, S. G., et al. (2025). Epigenetics, resilience, protective factors and factors promoting positive outcomes: A scoping review. *International Journal of Developmental Neuroscience*. <https://doi.org/10.1002/jdn.70042>
- Babundo, D. A. (2025). Social media's influence on depression and suicidal behaviors in adolescents (Capstone project). UC eScholarship. <https://escholarship.org/uc/item/0gw3k53p>

- Berkman, L. F., & Syme, S. L. (1979). Social networks, host resistance, and mortality. *American Journal of Epidemiology*, 109(2), 186–204. <https://doi.org/10.1093/oxfordjournals.aje.a112674>
- Burlina, C., & Rodríguez-Pose, A. (2023). Alone and lonely: The economic cost of solitude for regions in Europe. *Environment and Planning A*, 55(8), 2067–2087. <https://doi.org/10.1177/0308518X231169286>
- Colodro-Conde, L., et al. (2023). Socioeconomic changes predict genome-wide DNA methylation in childhood. PMC. <https://pmc.ncbi.nlm.nih.gov/articles/PMC10365844/>
- Dugué, P. A., et al. (2017). Social adversity and epigenetic aging: A multi-cohort study. *Scientific Reports*, 7, 8285. <https://doi.org/10.1038/s41598-017-16391-5>
- Erola, J., Lehti, H., Baier, T., & Karhula, A. (2022). Socioeconomic background and gene–environment interplay in social stratification. *European Sociological Review*, 38(1), 1–17. <https://doi.org/10.1093/esr/jcab026>
- Everyday conflict in families at risk for violence exposure. (2022). <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9908649/> [PMID: 37792968]
- Holt-Lunstad, J., et al. (2015). Loneliness and social isolation as risk factors for mortality. *Perspectives on Psychological Science*, 10(2), 227–237. <https://doi.org/10.1177/1745691614568352>
- Kaiser Family Foundation. (2018). KFF/Economist survey: One in five Americans report loneliness or social isolation. <https://www.kff.org/mental-health/survey-one-in-five-americans-report-loneliness-social-isolation/>
- Keyes, C. L. M. (1998). Social well-being. *Social Psychology Quarterly*, 61(2), 121–140. <https://doi.org/10.2307/2787065>
- Killam, K. (2026). What is social health? *Psychology Today*. <https://www.psychologytoday.com/us/blog/social-health/202302/what-is-social-health>
- Kim, D., et al. (2018). Race, gender, and the technological turn. *Frontiers: A Journal of Women Studies*, 39(1), 149–177. <https://doi.org/10.5250/fronjwomestud.39.1.0149>
- Lacey, R. E., Kumari, M., & Bartley, M. (2014). Social isolation in childhood and adult inflammation. *Psychoneuroendocrinology*, 50, 85–94. <https://doi.org/10.1016/j.psyneuen.2014.08.007>
- Meloni, M., & Reynolds, J. (2021). Thinking embodiment with genetics. *Synthese*, 198(11), 10685–10708. <https://doi.org/10.1007/s11229-020-02793-y>
- Mihalopoulos, C., et al. (2025). Economic costs of loneliness and social isolation. *PharmacoEconomics*. <https://doi.org/10.1007/s40273-025-01516-w>
- Newport, C. (2019). Digital minimalism: Choosing a focused life in a noisy world. Portfolio/Penguin. <https://calnewport.com/digital-minimalism-for-parents/>
- Office of the Surgeon General. (2023). Our epidemic of loneliness and isolation. <https://www.hhs.gov/sites/default/files/surgeon-general-social-connection-advisory.pdf>
- Osoro, O. B., et al. (2023). Sustainability assessment of LEO satellite broadband megaconstellations. *arXiv*. <https://doi.org/10.48550/arXiv.2309.02338>
- Parade, S. H., et al. (2021). A systematic review of childhood maltreatment and DNA methylation. *Translational Psychiatry*, 11, 134. <https://doi.org/10.1038/s41398-021-01207-y>

- Przybylski, A. K., & Weinstein, N. (2017). A large-scale test of the Goldilocks hypothesis. *Psychological Science*, 28(2), 204–215. <https://doi.org/10.1177/0956797616678438>
- Reiss, D., Leve, L. D., & Neiderhiser, J. M. (2013). How genes and the social environment moderate each other. *AJPH*, 103(S1), S111–S121. <https://doi.org/10.2105/AJPH.2013.301408>
- Russell, D. W. (1996). UCLA Loneliness Scale (Version 3): Reliability, validity, and factor structure. *Journal of Personality Assessment*, 66(1), 20–40. https://doi.org/10.1207/s15327752jpa6601_2
- Tyson, A., et al. (2025, February 12). How COVID-19 impacted Americans' relationship with technology. Pew Research Center. <https://www.pewresearch.org/politics/2025/02/12/how-covid-19-impacted-americans-relationship-with-technology/>
- Virolainen, S. J., et al. (2023). Gene-environment interactions and their impact on human health. *Genes and Immunity*, 24(1), 1–11. <https://doi.org/10.1038/s41435-022-00192-6>
- World Health Organization. (2023). WHO commission on social connection. <https://www.who.int/groups/commission-on-social-connection>
- Zhu, X., et al. (2025). Prevalence of loneliness states among the U.S. adult population: Findings from the 2022 HINTS-6. <https://www.sciencedirect.com/science/article/abs/pii/S074937972500426X>