

Invited Commentary: Evolution of Social Networks, Health, and the Role of Epidemiology

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Almost 40 years ago, Berkman and Syme demonstrated that social networks were related to the risk of early mortality (*Am J Epidemiol.* 1979;109(2):186–204). Their study was highly innovative because they directly measured and quantified social networks in a large prospective population-based survey with mortality follow-up. The results of the study showed robust network gradients, whereby those with fewer networks and weaker social ties had significantly higher mortality rates. The important influence of social networks that Berkman and Syme noted many years ago is likely to heighten in the future, as demographic characteristics shift and individuals become more inclined to socialize through online platforms instead of real-world interactions. Berkman and Syme's research in 1979 continues to play a key role in shaping recent efforts to uncover the influence of social networks on health. Looking back on their findings may help epidemiologists better understand the importance of both online and offline networks for population health today.

health; social isolation; social media; social networks

In 1979, Berkman and Syme stated that “[i]ndividuals undergoing rapid social and cultural changes...as well as those living in situations characterized by social disorganization..., and poverty... appear to be at increased risk of acquiring many diseases” (1, p. 186). The extent to which this statement rings true today cannot be overstated. The US population is undergoing rapid changes in the social, technological, political, and economic landscapes that fundamentally alter the social networks and interactions that form the bedrock of societies and ultimately impact health. Some of the barriers to maintaining networks today include increases in aging populations, growing economic inequalities, and a large rise in the numbers of refugees and displaced populations around the world. In their landmark paper “Social Networks, Host Resistance, and Mortality: A Nine-Year Follow-Up Study of Alameda County Residents” (1), Berkman and Syme explored and rigorously tested the theory that diminishing social networks among adults altered their mortality risk from 1965 to 1974.

Berkman and Syme's study was highly innovative in that it was the first in which social contacts in a large population-based health survey were directly measured and enumerated (1). Data

originated from individuals 30–69 years of age who participated in the Human Population Laboratory Sample emanating from the California State Department of Health. The study population was a stratified systematic sample of Alameda County residents that comprised more than 4,000 men and women. Berkman and Syme measured and categorized a range of social ties in an ego-centric network to test whether different types of social networks measures, including marriage, contacts with close friends and relatives, church membership, and informal and formal group affiliations, affected mortality (1). They developed a social network index to measure a construct referred to as “social isolation” that took into account both the number of social ties and the relative importance of these ties by weighting certain contacts. For example, intimate contacts were given greater weight in the index than were church affiliations or memberships in group activities. After collecting social network information at baseline, individuals were followed for 9 years, and information from the state death registry was used to confirm age at and cause of death. The data were presented as mortality rates adjusted for age, socioeconomic status (income and educational level), and “health practice” (e.g., smoking, alcohol intake, preventive health care).

The results of the study by Berkman and Syme showed robust network gradients, whereby those with fewer network connections and weaker social ties had significantly higher mortality rates across age and sex categories (1). There were also some differences by sex. For example, unmarried men had a higher mortality rate than did unmarried women. In contrast, having fewer friends and relatives that one sees regularly was associated with higher mortality rates among women than among men. In addition, the authors observed a dose-response relationship between “social isolation” and mortality that became more pronounced as individuals aged (see Figure 1 from Berkman and Syme (1)). Moreover, the risks associated with greater overall social isolation were larger than those of any single network measure, including marital status or contacts with friends or relatives. Berkman and Syme then identified potential confounding variables and tested whether these factors accounted for the observed associations. The association between social networks and mortality persisted in these sensitivity tests. On the basis of these findings, Berkman and Syme called for future studies in which the physiological pathways that might increase susceptibility to disease and the development of more sophisticated network measures for analysis were explored (1).

Since the work by Berkman and Syme was published in 1979, results from numerous studies and randomized interventions targeting social networks have supported the importance of networks for health and well-being (2, 3). Investigators have demonstrated that humans have a negative physiological response to social isolation that results from persistent overreaction of the stress response system, which may alter hormonal, immunological, and even epigenetic pathways that may ultimately influence health outcomes (4–8). Results from some randomized intervention studies have supported the notion that enhancing social networks and interactions can be beneficial to human health, especially in older-aged populations (9, 10). Together, this body of research has uncovered some of the potential physiological mechanisms that Berkman and Syme had suspected altered host susceptibility in their early work on this topic.

Berkman and Syme’s early call for a better conceptualization of networks continues to be very pertinent today. The recognition that networks matter for health and the composition of one’s social network is important continues to be explored in research addressing social isolation, social exclusion, and segregation (11–17). Moreover, the work by Berkman and Syme has not only influenced the inclination for epidemiologists to collect information on social networks and related phenomena but also likely contributed to highlighting the importance of these measures for causal inference. Indeed, networks and interactions have been found to be key factors in influencing causal inference in the form of “interference” or “dependent happenings” (18, 19).

In addition to conceptual and methodological advances related to networks, the availability of mobile technologies and the Internet have resulted in profound changes in social networks. There are now several global social networking platforms, such as Facebook (Menlo Park, California), Instagram (Menlo Park, California), and Twitter (San Francisco, California). Facebook is by far the most popular networking technology, hosting 1.86 billion users (20). The advent and

widespread use of the Internet, smartphones, and social network online services have fundamentally changed the way that we interact with each other. With the availability of online network data coupled with novel smartphone applications that can track individuals and their contacts in space and time, we can now more accurately measure both online and person-to-person interactions, as well as the changing dynamics of these interactions on a daily basis (21–23). These advances have led and will continue to lead to the development of new tools for network analysis, such as the creation of computer algorithms to process data from large networks online and in the real world (24–26).

It remains unclear whether the network concerns that Berkman and Syme uncovered many years ago will continue to influence disease risk in the same manner today. To catch up with innovation, epidemiology in the 21st century should quickly develop new frameworks and methods for studying the network mortality trends that Berkman and Syme observed in 1979. This should be a public health imperative, given the new, consuming, and almost inseparable ways in which we interact through technology, along with the associated sedentary and isolating behaviors that these innovations promulgate (27). Although results from some studies support a positive impact (28, 29) or no effect (30, 31) of social network site use on mental health and well-being, others have described some concerning negative impacts (32–34). The most recent and perhaps most rigorous test of the influence of Facebook network interactions on health is from a recent paper by Shakya and Christakis (34). Using longitudinal data accessed from thousands of Facebook users, as well as surveys of their social networks, Shakya and Christakis showed that an increased quantity of Facebook use was associated with worse self-rated health, worse mental health, and greater body mass index (34). They also showed that although real world face-to-face interactions were protective for overall health, the negative associations between Facebook use and health were comparable in magnitude to the positive impacts of real-world interactions (34). In addition, having a greater number of Facebook friends over time was not significantly protective for any of the health outcomes examined. Although the associations of real-world networks with health and well-being were quite similar to the protective findings for mortality that were reported by Berkman and Syme almost 40 years ago and the physiological pathways by which real-world social isolation may impact health have since been explored, the specific mechanisms by which Facebook social networking might harm or improve health has not been thoroughly examined. Shakya and Christakis argued that viewing profiles that put forth a blemish-free picture of one’s daily life may influence mental health by leading to negative self-comparisons among Facebook users, which has some support from earlier research (35–37). In addition, they suggested that sedentary behaviors associated with online network engagement may influence health and well-being (34). Technologies such as smart phones have been associated with a decline in both quantity and quality of person-to-person interactions (38, 39), thereby lessening the protective effects associated with strongly connected networks of intimate contacts. One might argue that Berkman and Syme’s call for understanding the physiological pathways

linking networks and health might similarly apply to Facebook users through stress-mediated biological pathways, but this idea has yet to be tested. One issue that researchers will need to contend with when working with social media is the fact that social networking sites tend to provide data on only select segments of society, limiting representativeness.

Overall, the important influence of networks that Berkman and Syme noted many years ago may magnify in the future as more populations gain access to and as a whole become more inclined to socialize through internet platforms, forging face-to-face interactions. Although the internet has been an incredibly beneficial source of information and connection in the 21st century, the potential downsides for real-world social interaction need to be studied more carefully. Additionally, as Berkman and Syme urged many years ago, research should continue on the mechanistic pathways by which networks, now in a virtual realm, influence health. This issue is especially pressing as technology continues to become a cornerstone of modern life.

Berkman and Syme's research continues to be a profound example of the importance of social networks as a determinant of health. Epidemiologists would do well to look back on the context of their findings to better understand the crucial next steps that will need to be taken when examining the impact of both our online and offline social networks on population health in today's technology-driven society.

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