



What are the keys to a longer, happier life? Answers from five decades of health psychology research

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ABSTRACT

Rationale: It has long been known that factors of the mind and of interpersonal relationships influence health, but it is only in the last 50 years that an independent scientific field of **health psychology** appeared, dedicated to understanding psychological and behavioral processes in health, illness, and healthcare.

Objective and method: This article (a) reviews important research that answers the question of how human beings can have longer, happier lives; and (b) highlights trends in health psychology featuring articles in *Social Science & Medicine* as well as other related literature.

Results: Since the 1970s, health psychology has embraced a biopsychosocial model such that biological factors interact and are affected by psychological and social elements. This model has illuminated all subjects of health, ranging from interventions to lower stress and/or to improve people's ability to cope with stressors, to mental and physical health. Importantly, a health psychology perspective is behavioral: The majority of chronic diseases of today can be avoided or reduced through healthy lifestyles (e.g., sufficient exercise, proper diet, sufficient sleep). Thus, behavior change is the key target to help reduce the immense public health burden of chronic lifestyle illnesses. Health psychology also focuses on how social patterns influence health behavior and outcomes, in the form of patient-provider interactions or as social forces in communities where people live, work, and play. Health psychology is congenial to other health sciences, especially when allied with ecological perspectives that incorporate factors upstream from individual behavior, such as networks linked to individuals (e.g., peer groups, communities). Over its history, health psychology research has been responsive to societal and medical needs and has routinely focused on understanding health disparities.

Conclusion: By relying on a strong interdisciplinary approach, research in health psychology provides a remarkably comprehensive perspective on how people can live healthier lives.

1. Introduction

What are the keys to a healthy, happy, productive life? Along with other scientific fields, this question has been richly addressed by **health psychology**, which is concerned with psychological and behavioral processes in health, illness, and healthcare. Health psychology emerged in recent decades as an important contributor to a broader effort aimed to ameliorate the most pressing health-related issues in the world today: health, medical care, stress and coping, and how best to prevent, treat, and/or manage chronic disease. Health psychology offers a diverse, interdisciplinary perspective featuring a biopsychosocial model that takes into account psychological, physiological, and environmental influences on health. Health psychology also brings other key factors to bear on health, including culture, socioeconomic factors, stigma, patient-provider interactions, among others. Health psychology is

concerned both with morbidity and mortality.

Our main goal in this article is to review health psychology's prominent findings and theoretical perspectives, while giving some sense of the field's history. Of course, it is impossible to do this subject justice in a single article; moreover, it is important to honor all of the history of health psychology as well as influences from related fields, even while we highlight scholarship published in *Social Science & Medicine*. Many of the trends we observe in health psychology are in fact part of trends in science and health; at key junctures, we elucidate intersections of this field with other disciplines. It is also important to acknowledge that whereas the field of health psychology addresses global health, this review focuses mainly on issues related to Western society and its health. In Section 2, we describe the dominant theoretical perspective in health psychology, the *biopsychosocial model*, which reveals the often dynamic interrelationships between biological, psychological, and

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social factors. This model emerged from research on health psychology's most central subject matter, stress. This section highlights the central role that habitual behavior plays in setting the stage for chronic illnesses such as hypertension and coronary heart disease. In Section 3, we consider how social interactions and networks (e.g., patient-provider interactions; community stress) affect health and review interventions to lower stress, to improve people's ability to cope with stressors, and to address other health issues. In Section 4, we offer reflections on trends in health psychology, and Section 5 sums up the field's answers to the question of how best to maximize lives lived.

2. The necessity of an integrative conceptualization of health

2.1. From communicable to non-communicable diseases and the centrality of health behaviors

Medical science has witnessed many revolutions in its history, and these continue to unfold at a quickening pace. As medical science improved, so did public health: Until this era, human lives might in fact be well typified as nasty, brutish, and short, to paraphrase the 17th century political philosopher, Thomas Hobbes. Between 1800 and 2000, lifespans doubled from an average of about 35 years to 70; developed countries led the trend in expanding lifespan, but in recent decades, lagging nations have been closing the gap. Medical science developed steadily better maternal care—saving the lives not only of more women giving birth but also the lives of their newborn infants. Until at least the first half of the 20th century, viral influenza strains regularly killed millions of people in brief epidemics—medical science developed antibiotics and vaccines that transformed fatal or debilitating diseases into nuisance conditions that can be stopped before they threaten life or, at best, prevent them altogether. It is important to recognize that it was not just improvements in medical care that drove progress but also improved nutrition, shelter, transportation, and perhaps most of all, improved public sanitation services. Even as medical solutions and technological advances improved public health, they also created unanticipated problems. In developed countries, the decreasing incidence of acute infections appears to be contributing to the increase in autoimmune and allergic diseases, according to the *hygiene hypothesis* (Okada et al., 2010). Moreover, assistive technology has also led to a sedentary lifestyle coupled with the easy availability of fast (and processed) food that has created a rise in avoidable chronic diseases. While there are still over 800 million people in the world suffering from chronic hunger, worldwide obesity rates have more than doubled since 1980, and youth obesity rates have tripled in the past 30 years (Chan, 2016; Ogden et al., 2015). America is in the midst of a healthcare crisis; approximately 84 million U.S. adults have prediabetes, and more than one-third of American adults have obesity, contributing to some of the leading causes of preventable death (Ogden et al., 2015).

The financial burden of chronic lifestyle illness is rising, placing a large toll on the healthcare system that may not be sustainable. In 2014, 16 million people died prematurely—before the age of 70—due to chronic disease, according to the World Health Organization (WHO, 2015). Chronic disease conditions are *noncommunicable diseases* as they are not passed from person to person, and include four main types: 1) cardiovascular diseases (e.g., heart attacks and stroke); 2) cancers; 3) chronic respiratory diseases (e.g., chronic obstructive pulmonary disease, asthma); and 4) diabetes. In 2015, the WHO stated that “Premature noncommunicable disease deaths can be significantly reduced through government policies reducing tobacco use, harmful use of alcohol, unhealthy diets, and physical inactivity, and delivering universal health care.” Notably, the success of this perspective hinges on individuals adopting and maintaining healthy lifestyles and receiving network support such as care from providers who understand and address the causes of these conditions. Accordingly, policy officials increasingly view **behavior change** on the population level as a key target to help reduce the immense burden of chronic disease.

2.2. A biopsychosocial approach emerges

For the past two centuries, the biomedical model dominated medical science and practice, defining *health* as freedom from disease, pain, and defects; thus, the normal human condition is “healthy.” Yet, health is a continuum, and the absence of disease does not necessarily mean one is in a state of good health. Modern medical systems are expected to excel at treating diseases of biological etiology, but in the past, the biomedical model was built on a narrow, reductionist strategy that focused on biological aspects of disease and illness. Is illness always caused by biological factors? Will targeting detrimental biological factors guarantee a return to health? Health psychologists increasingly have argued that these are false assumptions, and stress is known to interact with and exasperate diseases of biological etiology (e.g., Wade and Halligan, 2004). Although the biomedical model certainly drove and still drives many innovations in medicine and medical care (e.g., including increasing understanding of the biological mechanisms of mental disorders), a biomedical perspective alone does not guarantee a positive outcome, nor does it explain a number of phenomena such as placebo effects and health disparities; psychological and social elements must also be included, as well as community-level and environmental factors.

Health care professionals bear witness to the importance of other factors besides disease in the etiology of illness, and health psychology has provided updated models to take these factors into account. In the 1970s, the field of health psychology more formally emerged, allied with *behavioral medicine*, which posited that positive behavior change creates better health (Schwartz and Weiss, 1978). Physician George L. Engel (1977) was one of the first to propose and label a broad *biopsychosocial model* that emphasized the importance of an ecological relationship between an individual and his/her environment and how an individual perceives his/her environment. Health psychologists quickly embraced and promoted this perspective, and today, biopsychosocial models are nearly universally embraced—at least in theory, if not in practice (Adler, 2009; Ogden, 1995). Moreover, as Section 3.2 expands, a biopsychosocial perspective is congenial not only to health psychology but also to other disciplines. It provides a foundation for “lifestyle medicine”, which is an emerging effort to broaden the scope of mainstream medicine to include the use of evidence-based lifestyle therapeutic approaches, such as a predominantly whole food, plant-based diet, exercise, sleep, stress management, alcohol moderation and tobacco cessation, and other non-drug modalities, to prevent, treat, and, potentially even reverse lifestyle-related, chronic diseases (Antonovsky, 1993; Egger et al., 2009). Similarly, education programs for medical professionals are incorporating lifestyle medicine into their curriculum to help healthcare providers better assist patients in developing self-care strategies to improve one's own health (Vinje et al., 2017; Egger et al., 2009). In short, a more holistic view of health is necessary.

2.3. Mechanisms underlying stress and chronic disease

Stress is a central concept in health psychology because it impacts nearly any bodily system, either directly or indirectly. Traditionally, health psychologists measured stress based on self-reports of daily stressors, stressful life events, adverse childhood experiences (ACEs) such as emotional, physical, and sexual abuse, or food insecurity. More recently, biological measures of chronic stress have become commonplace with cortisol as a predominant biomarker. Studies linking stressful life conditions to later morbidity and mortality show that stress can have direct and measureable effects on the body through *allostatic load*, which is overall stress-induced physiological wear-and-tear. Studies often divide common measurements of allostatic load into categories representing the underlying physiological systems, such as (a) neuroendocrine system, (b) immune and inflammatory system, (c) metabolic system, (d) cardiovascular and respiratory systems, and (e)

Biological Pathways of Stress: Common Biomarkers for Allostatic Load

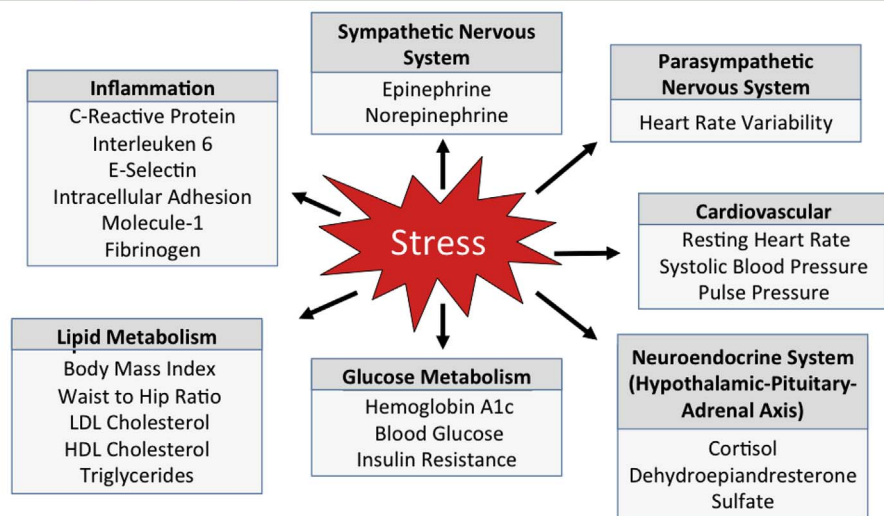


Fig. 1. Stress can have a negative long-term impact on health through multiple physiological pathways and biological systems (Schwartz, 2017). Biological measures appear below each system; researchers commonly combine measurements such as these to quantify overall allostatic load.

nervous system (Solís et al., 2016). New biomarkers are emerging at a rapid pace to measure the impact of stress upon each of these biological pathways. A recent study used 23 different biomarkers to quantify allostatic load (see Fig. 1; Schwartz, 2017); multivariate approaches that employ a broad range of biomarkers are preferred due to the high complexity of the underlying biological systems, whereas studies that focus on only one or two biomarkers may yield inconsistent findings (Morrisette-Thomas et al., 2014).

In more detail, Fig. 2 illustrates pathways through which chronic stress can contribute to chronic disease, including physiological responses that interact with changes in mood, behavior, and environment, and may also be influenced by genetics and epigenetic modifications. Stress results from a combination of both objective stressors (e.g., trauma, discrimination, poverty) and subjective interpretation of perceived ability to handle and recover from the stressor. Both external factors (e.g., social support) and internal factors (e.g., genetics, sense of purpose) influence a person's ability to cope with stress (Folkman and

Lazarus, 1988; Mariotti, 2015). Repeated activation and prolonged stress can cause imbalance of the neuroendocrine, immune and autonomic nervous systems, impair other components of the body's physiological systems at multiple levels, as well as alter behavior, mood, emotions and cognitive abilities. Pathways are complex, bidirectional, and can be self-reinforcing. Studies have shown that social and environmental stressors such as low parental education, maternal distress, and child abuse lead to increased cardiovascular disease-related risks in children, which may be due in part to desensitization of the children's neuroendocrine-immune response (Riis et al., 2016). Among other results, Schwartz (2017) found that allostatic load was higher in people who perceived more inequality, emphasizing the importance of the perception in determining how stimuli convey their effects. Similarly, social adversity (e.g., poverty, unemployment, low education, and lack of social support) increases the risk of chronic disease through changes in immune cell distribution, contributing to the dualistic response of immune function in the face of chronic stress (i.e., reduced immune

Complex Bidirectional Pathways Connecting Stress and Disease: Points of Intervention

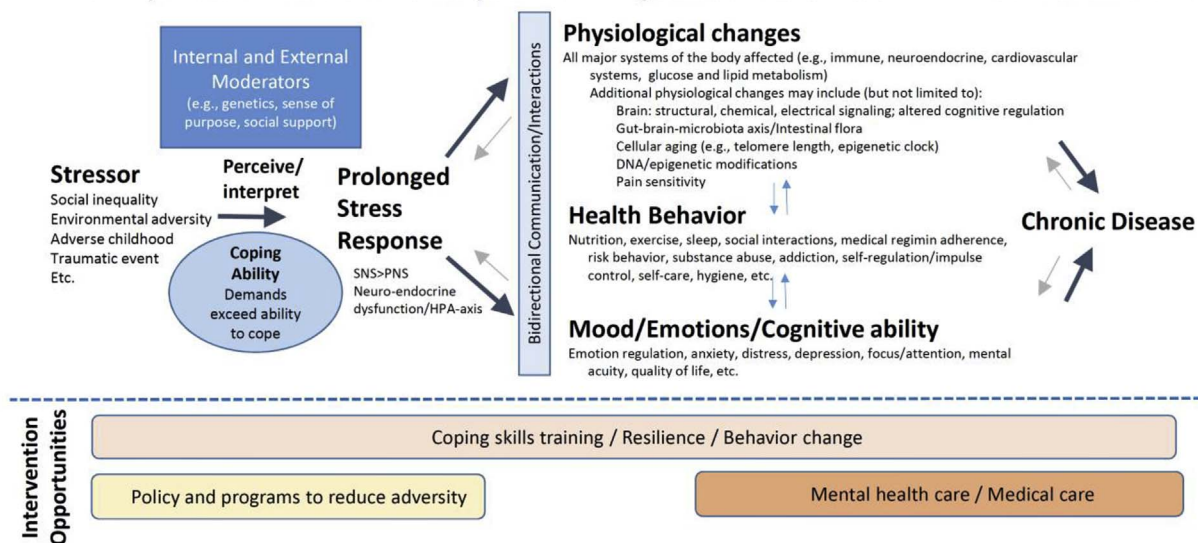


Fig. 2. Pathways and points of intervention between stress and chronic disease. The relationship between stress and chronic disease is highly complex, bidirectional, and often self-reinforcing (blue and light gray arrows). Intervention opportunities to reduce the negative health burden of stress along the pathway appear below the dashed line. See Fig. 1 for additional physiological changes. PNS = parasympathetic nervous system; SNS = sympathetic nervous system. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

function and increased chronic inflammation) (Acabchuk et al., 2017; Simons et al., 2017). Disparities in education offer a further example of a stress-related impact, with inflammation accounting for the largest portion of the link between low education and increased risk of mortality (Todd et al., 2016). Thus, inflammation is emerging as an important biological pathway underlying health disparities.

Much research has shown that stress leaves a biological mark, getting “under the skin” through various pathways to contribute to long-term health or disease (Acabchuk et al., 2017; Das, 2016). Given that stress has such powerful effects, it is crucial not only to understand what causes stress but also to identify plausible opportunities of intervention (Fig. 2). Programs that enhance coping skills, especially those that build resilience, can offer a protective buffer against the negative health burden of stress. *Resilience* is defined as the ability to thrive and survive despite exposure to difficulties (e.g., trauma, adversity). Factors that improve resilience include positive appraisal coping, effective cognitive and emotion regulation, self-efficacy, strong social support and family bonds (e.g., Bonanno, 2004; Li et al., 2017). A large part of current research focuses on investigating mechanisms of action, or “active ingredients” of interventions aimed to improve self-regulation and build resilience to stress in order to maximize outcomes when such interventions are translated into community-based programs. The points of intervention opportunities Fig. 2 visualizes emphasize the broad reach of behavior change and resilience building strategies to reduce the burden of stressors and thereby improve mental and physical health.

3. Social interactions, networks, and interventions

3.1. Social networks for—or against—health

Section 2 documented the powerful role that stressors play in health and listed some social pressures that are connected to stress (e.g., trauma, stigma). In fact, stresses humans face often result from other people: family obligations, relationships, work stress, financial issues, legal problems, and even minor disruptions like traffic or waiting in line. Furthermore, struggling to maintain healthy behavior (trying a new diet, too much or too little exercise, quitting smoking) can also be a major source of stress. Regardless of whether stresses are caused by other people or not (e.g., food insecurity, lack of electricity, extreme weather), social support is a key element of the solution; allied networks can be a force for health.

3.1.1. Networks can be positive or negative for health

There are two sides to social networks, negative and positive. On the negative side, it is no surprise that other people cause stress, ranging from the death of a close friend or family member to the stress caused by a demanding boss, abusive spouse, or sick child. The influence of the social environment is especially critical during development: Youth from a family environment marked by socioeconomic disadvantage, a lack of support and structure, hostility, and conflict (and other ACEs) are at higher risk for developing poor mental and physical health outcomes such as depression, substance use, cardiovascular disease, hypertension, and obesity (Repetti et al., 2002). Parental smoking is one of the best predictors for smoking in their children (Palmer, 1970). More family illnesses occur when a parent is deeply depressed (Lewis et al., 1989). Stressed or burnt-out teachers also stress their pupils (Oberle and Schonert-Reichl, 2016). Of course, having a particular disease or illness potentially links into negative social pressures, as has been amply demonstrated in the stigma associated with HIV/AIDS (e.g., Parker and Aggleton, 2003), mental illness (Livingston and Boyd, 2010), and addiction (McGinty et al., 2015). The same is true for people with stigmatized identities in terms of gender (Hankivsky, 2012), sexual orientation (Hatzenbuehler et al., 2014), or race (Reid et al., 2014). Workplace inequality creates stress-related illness (e.g., de Jonge et al., 2000; Marmot et al., 1991; Schnorpfeil et al., 2003; Siegrist et al.,

2004). People commonly fret economic debts or time commitments to others. Such robust effects offer stark testimony to the stress that negative social networks often create. It may even often be, as the French existential philosopher Jean-Paul Sartre put it, that “hell is other people.”

On the positive side, other people are essential to human development itself and good social relationships help individuals thrive (Folkman, 1997). Of course, secure child development is associated with longer, happier, more productive lives (Berkman et al., 2000). But the health benefits of strong relationships are not limited to development; they are essential throughout the lifespan. Marriage is consistently linked to health (Lewis et al., 2006); Umberson (1992) found that married men engage in healthier behavior because their spouses monitor and attempt to control their health behavior. Marital satisfaction was found to be a better buffer of day-to-day fluctuations in perceived health and happiness in older adults compared to time spent with others, emphasizing the importance of strong relationship bonds in maintaining happiness in the lives of older adults (Waldinger and Schulz, 2010). Quality of close relationships appears crucial; for example, in a Harvard study, relationship satisfaction at age 50 predicted health at age 80 better than any biomarker (Waldinger and Schulz, 2016); as Mineo (2017) aptly summarized, “Good genes are nice, but joy is better.” People with larger social networks suffer fewer colds despite direct exposure to a rhinovirus (Cohen et al., 1997). Positive networks can promote having a greater sense of purpose, which is a critical determinant of longevity (Boyle et al., 2010). People who volunteer for community causes improve their mental health (Borgonovi, 2008). Social support, whether in the form of friends or family, was found to assist minority women in initiating an exercise regimen (Eyler et al., 1999). Open communication between father and child positively affects the family's psychosocial functioning (Christensen, 2004). People with larger social networks suffer fewer colds despite direct exposure to a rhinovirus (Cohen et al., 1997). Social networks also have a role in illness recovery: Breast cancer patients who felt satisfied with the level of support they received from family members were significantly less anxious and depressed (Neuling and Winefield, 1988). Many people with serious disabilities nonetheless report having a high quality of life, in part due to good relationships (Albrecht and Devlieger, 1999). Some people and communities are more resilient than others due to the positive social interactions at critical junctures (Bonanno, 2004; Berkman and Syme, 1979). In summary, positive social networks improve productivity, healthy behavior, immune function, disease recovery, purpose, resilience and overall quality of life. Clearly, social networks, at their best, improve physical health and are probably the biggest contributor to positive mental health.

3.1.2. Interventions to improve behavior are positive networks in action

Interventions to improve health behavior by altering appraisal strategies are common targets for intervention. Stressful life events may be inevitable, but how one perceives and interprets these events can greatly influence the magnitude of harm imparted upon one's health (Hagger et al., 2017; Leventhal et al., 1998). Cognitive distortions, such as rumination, magnification and catastrophizing can cause additional stress beyond the initial stressor, contributing to prolonged, chronic stress (Zola, 1973), which can contribute to chronic disease (Fig. 2). Thus, coping interventions (e.g., cognitive behavioral therapy, mindfulness-based interventions, goal setting, etc.) emphasize strategies such as emotion regulation, impulse control, and cognitive restructuring to improve mental health and health behavior (e.g., Barker, 2014; Ferguson et al., 2015; Folkman and Lazarus, 1988; Giles-Corti and Donovan, 2002; Loucks et al., 2015). New research is beginning to determine the components of behavior change interventions in order to identify critical regulatory mechanisms that underlie improved coping skills for stress reduction. For example, a recent dismantling trial identified acceptance as a critical component of mindfulness training, where acceptance is an attitude of receptivity and equanimity toward

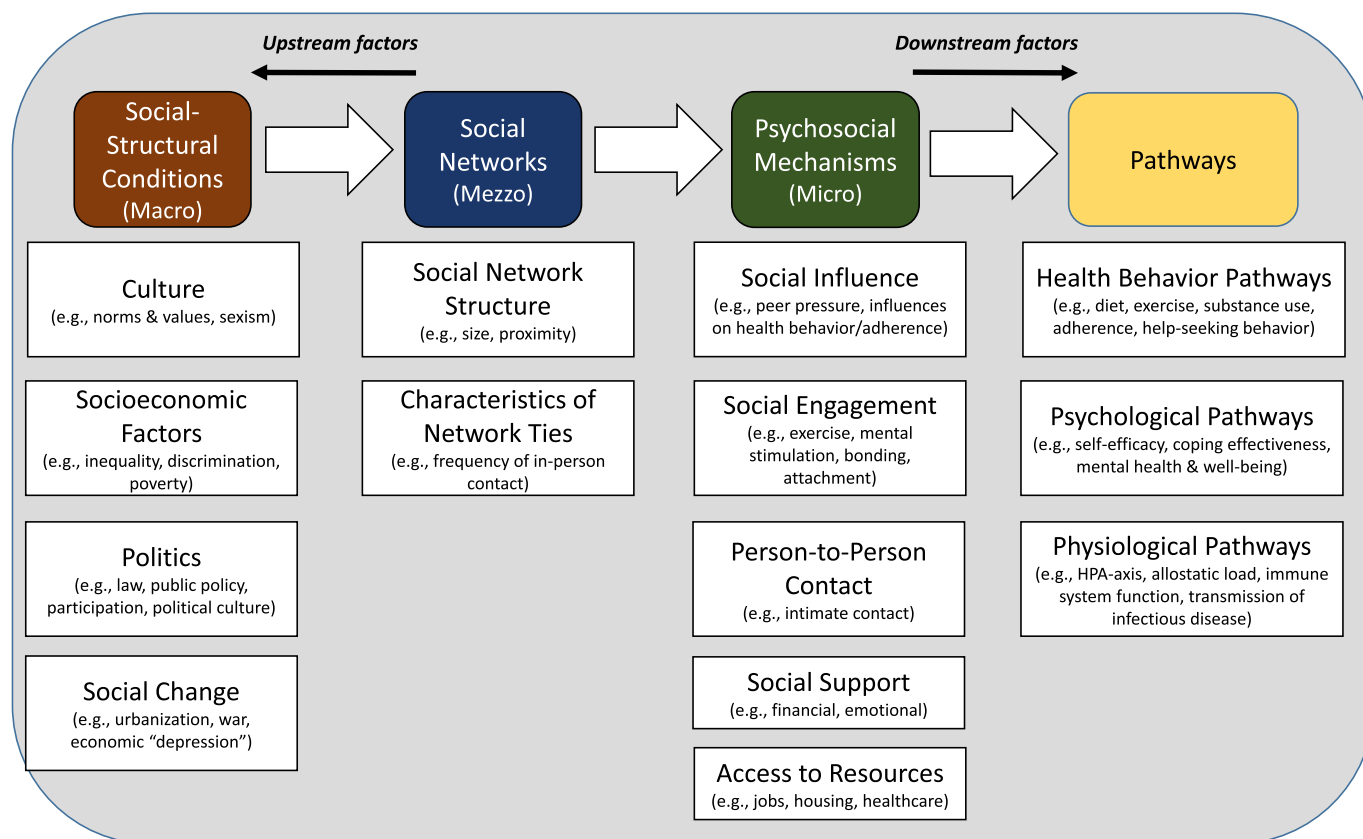


Fig. 3. A conceptual model of how social networks impact health (excerpted from Berkman et al., 2000).

all momentary experiences that allows even stressful stimuli to pass without reactivity (Lindsay et al., 2018).

Most health psychology interventions try to improve self-regulation of emotions, cognitions, and behaviors (e.g., Barker, 2014; Felton et al., 1984; Folkman and Lazarus, 1988). In so doing, interventionists network with target individuals to promote health in person, or more recently, through technology and social media (Head et al., 2013; Johnson et al., 2010). This strategy attempts to educate, provide needed skills, or to enhance motivation to act in a healthy fashion. Behavior change theories provide frameworks for evaluating interventions and identifying target mechanisms that produce desired outcomes (e.g., Fisher and Fisher, 1992; Gardner et al., 2010). A taxonomy of 93 behavior change techniques provides researchers with a reliable and valid method for identifying the key "active ingredients" of a behavior change intervention (e.g., prompts/cues, social support, and feedback) (Michie et al., 2013). Such behavior change techniques as goal setting and self-monitoring appear particularly useful in promoting the development of healthy behaviors, while factors related to internal motivation and autonomy appear more critical for maintaining those efforts (Kwasnicka et al., 2016; Samdal et al., 2017). Nonetheless, health behavior change and maintenance do not happen in a vacuum; social networks are critical. Interventions that accommodate social contagion will spread behavior change more effectively (Aral and Nicolaides, 2017). Loneliness and high conflict relationships undermine health, and strong positive close relationships offer protective factors to both the mind and body. Close relationships help keep us happy and healthy, but they are not a quick fix: relationships take time and effort to establish and maintain. Although much research has highlighted the importance of close personal relationships to improve physical and mental health, the challenge remains to translate such knowledge into interventions to improve social relationships (Dunkel Schetter, 2017).

3.1.3. Patient-provider interactions as social networks

Medical and other health providers must interact with patients for routine care and in the case of illness and other maladies. Since the 1970s, medical practice has moved toward a patient-centered approach such that patients are no longer passive recipients of health instructions but in fact "have expectations of the doctor, evaluate the doctor's actions, and are able to make their own treatment decisions" (Stimson, 1974, p. 97; see also Mead and Bower, 2000). Indeed, part of the placebo response to medical treatments may stem from the patient's beliefs and expectations about the provider (Bishop et al., 2012; Noble et al., 2001). Interestingly, Hall and Dornan's (1988) meta-analysis on patient satisfaction surveys found that patients considered the overall quality, humaneness, and competence of the provider to be of higher importance than actual health outcomes. How and when doctors choose to impart critical medical information can influence a patient's ability to comprehend and recall such information (e.g., providing instructions while under the duress of impending test results may not be ideal; Portnoy, 2010). Effective communication strategies may be even more important when the patients are members of vulnerable populations (e.g., low SES patients, children). In their systematic review, Kodjebacheva et al. (2016) found that medical communications with children improved when providers undertook role-playing and seminars, when parents read booklets or attended discussions, and when children watched videos showing how to communicate with physicians. Together, these studies illustrate just some of the reasons why patient-provider interactions are an important component of the healthcare network.

Another issue related to patient-provider interactions is the need to adhere to medical regimens that the provider prescribes, because adherence is a primary determinant of treatment success. The WHO found that only 50% of patients who suffer from chronic diseases adhere to treatment recommendations (Sabate, 2003). Consequences of poor adherence include both health and economic implications; thus, the issue

is logically a way to improve public health.

4.2. Societal and technological trends

Culture and social networks shape habits and behavior in almost an unconscious level, having a strong impact on how we cope with stress and handle anxiety (e.g., Zola, 1973). Fewer people are involved in organized religion, which traditionally helped facilitate a sense of community and connection with a meaningful set of values. A contemporary rise in spirituality may be an attempt to fill this void, as people seek to find meaning in their lives (e.g., WHOQoL SRPB Group, 2006). Importantly, educational systems are working to bring healthy meals and mind-body programs into the classroom to improve student attention and behavior; corporations are investing in lifestyle programs for employees to increase productivity and reduce healthcare costs; law enforcement personnel are receiving training to reduce implicit bias and discrimination to improve relationships between police officers and community members. These are just a few examples of changes in culture and social networks that may affect health at a broader level.

Technology continues to change society rapidly, altering many facets of daily life and as an extension, people's health. With these changes come both new opportunities and new problems, and new problems require novel solutions. Health-related benefits of an ever-more-wired era include online support groups, easily accessible apps to help people deal with problems like addiction, and an array of fitness trackers, app monitors, and feedback tools that empower people to take control over their own personal health. Technology is also transforming the doctor-patient relationship in positive ways, through improved communication, increased monitoring capabilities, and more personalized care. Of course there are also many concerns associated with the rise in use of technology, such as reduced face-to-face interactions with physicians due to the push towards telemedicine, which could potentially impair quality of interaction and subsequent compliance. Examples of other concerns include increased screen time in youth contributing to childhood obesity, diminished social skills, depression, or issues with attention and impulse control in a society surrounded by instant gratification (e.g., Exelmans and Van den Bulck, 2016; Head et al., 2013; Liu et al., 2015). It is not yet known whether social media addiction (e.g., obsessive monitoring of 'likes' on Instagram) will translate into increased health issues and risk behaviors, but research does suggest that repetitive stimulation of dopaminergic reward systems can prime addiction pathways, especially during development (Kim et al., 2017). Recent studies investigate new internet-related issues that arise such as the prevalence of biased online reviews of medical treatment outcomes (de Barra, 2017), which can lead to consumers/patients basing treatment decisions on *evidence-based hearsay* rather than principles of evidence-based medicine (Ioannidis, 2017).

4.3. Research trends and scientific advancements

Similar to trends found in related fields, health psychology increasingly investigates causal pathways. While earlier work focused on identifying and exploring *what* mental, behavioral, environmental and cultural factors influence health and illness, as we documented in section 2.3, more recent investigations work to identify *how* these factors influence health. Exemplifying this trend in depression, early studies focused on identifying groups vulnerable to depression, and investigated ethnic differences in care seeking behavior (Sussman et al., 1987). More recent studies address *how* environmental factors contribute to depression. For example, studies ask: Does neighborhood crime influence depressive symptoms via epigenetic alterations (Lei et al., 2015)? And, what is the directional link between inflammation and depression (Das, 2016)? These studies illustrate a larger biodemographic trend that relies on interdisciplinary strategies, often combining "big data" (e.g., spatially linking large public datasets) with advanced biomarker technology to address challenging health-related

issues. Spatiotemporal approaches are increasing in health psychology scholarships, both in terms of meta-analyses and in terms of original studies (Johnson et al., 2017; Marrouch and Johnson, in press) and represent a bridge between fields such as health psychology and social epidemiology (Kawachi and Subramanian, 2017).

As collaborations across fields seek to provide novel insight into complex health issues that are often beyond any single scientist's area of expertise, it becomes essential to proceed with care; social scientists must appreciate the rigor required and honor the limitations of biological measurements, and basic scientists must appreciate the challenges involved in working with uncontrolled samples outside of the laboratory setting (Johnson and Michie, 2015; Kaufman et al., 2014). Choosing appropriate study designs is critical, especially when using biomarkers such as cortisol or alpha-amylase that have naturally occurring diurnal variations (Skoluda et al., 2017). As we noted, new biomarkers for stress and inflammation are emerging and more commonly used, especially as less invasive methods of collection become available. Rather than having to obtain blood or urine samples, several markers can now be analyzed via saliva, and hair samples may even be used to examine temporal change in chronic stress gauged through cortisol levels (Pacella et al., 2017).

In the future, emerging scientific advances including those derived from animal studies will likely spur the field of health psychology to address novel questions related to health, stress, and disease. As an illustration, animal studies on the microbiota-gut-brain axis have shown that stress changes the internal environment of the intestinal tract to make it less habitable for the 'good' bacteria, increasing levels of the 'bad' bacteria. Changes in the microbiome can affect signaling in the brain, alter mood regulation, increase pain sensitivity and may even be related to increased risk of disease (e.g., vascular issues that can lead to stroke or cognitive decline) (Tang et al., 2017). Scientific advances in understanding the influence of gut microbiota on emotion, cognition and behavior may propel social scientists to ask new questions about the associations between nutrition and stress, mental health and disease. This interdisciplinary research is essential to tackling maternal depression and developmental consequences of child malnutrition worldwide, among other public health problems.

Advances in neuroscience demonstrate that while environmental stressors can create lasting impairments in behavior and brain functioning through neuroplasticity, these effects can also be reversible through reduced stress and persistent re-patterning (Liston et al., 2009). Such findings lend important implications for stress reduction strategies, resilience training and learned coping skills to mitigate the sequelae of chronic stress (e.g., improve cognitive function and behavior). New forms of cognitive behavioral therapy based on mindfulness, compassion, gratitude, and acceptance (Kahl et al., 2012; Otto et al., 2016) are examples of mind-body interventions geared towards empowering individuals to take greater control over their own thoughts, emotions, behaviors and habits. Fortunately, neuroplasticity exists even late in life (Ellwardt et al., 2015; Boyke et al., 2008), potentiating positive health behavior change and maintenance. As a final illustration of health psychology research providing insights into how to live a long, happy life, rejecting negative stereotypes about aging is associated with more successful aging (Levy et al., 2014).

5. Conclusion: the secret to successful living

To reduce the immense public health burden of chronic disease, health behavior change is necessary at the population level. Positive social networks along with efforts to improve self-regulation are critical to establishing and maintaining healthy attitudes and behavior. Public policy to address income inequality will help alleviate health disparities, but similar to the underlying biological mechanisms of stress, issues surrounding inequality are highly complex and often bidirectional. A wide opportunity for intervention lies in improving coping strategies and stress reactions, such as resilience training to reduce

additional suffering that often goes beyond the initial stressor.

Although not commonly stated as such, the lessons of health psychology research offer an answer to the secret to successful living: Maintain a sense of purpose, positive social relationships and healthy habits, including a nutritious diet, sufficient exercise and sleep; moderation and optimism are best. Not only does health psychology offer a recipe for successful living, but successful aging, as well. The caveat is that many factors can interfere with these lessons, and unless social networks are supportive, health will be compromised. Although many factors may remain out of an individual's control (Figs. 2 and 3), behavior change strategies can empower individuals and populations to improve health, longevity and quality of life. In the end, the ultimate lesson of health psychology is that good health hinges on taking a comprehensive approach that optimizes biological, psychological, social, and environmental (natural and built) forces. Future research that uses increasingly rigorous and interdisciplinary perspectives will elaborate the mechanisms involved and ensure that, in years to come, health psychology will continue to play an essential role in understanding the keys to a long, happy, productive life.

Author notes

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Appendix. Supplementary data

Supplementary data related to this article can be found at <http://dx.doi.org/10.1016/j.socscimed.2017.11.001>.

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