

Utilizing the “One Health” Model to Study Human Aging in Urban Environments

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Abstract

The “One Health” concept has resulted in a rich research literature that integrates human and animal systems, with a focus on zoonotic diseases; however, this narrow focus is at the expense of one of the leading causes of global human mortality: non-infectious, chronic diseases. Here, we provide a viewpoint that applying the integrated One Health framework to public health issues such as the impact of stressful urban environments on the process of human aging has the potential to elucidate potential causal mechanisms that have previously gone unnoticed. Given the success of the One Health paradigm in studying human health in rural areas, we posit that this model would be a useful tool for studying human, animal, and environmental interactions in urban settings.

Keywords

aging, chronic diseases, health equity, global public health, One Health, urban, environmental stressors, models

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Introduction

“One Health” has been extensively utilized by public health and other researchers trying to untangle complex human health problems (Dantas-Torres et al., 2012; Richard et al., 2021; Robinson et al., 2016). The One Health concept is a transdisciplinary approach to investigating the interdependence between humans, animals, and plant species in socioecological systems (Zinsstag et al., 2011). Because of the focus on human and animal interactions, the One Health conceptual framework has increased collaborative work between human health researchers and veterinary medicine, often focusing on zoonotic diseases (Dantas-Torres et al., 2012; Green, 2012) and rural health (Purohit et al., 2017). Despite such current applications of One Health research, Destoumieux-Garzón et al. (2018) suggest that this concept has even more potential to help understand physiological stresses on populations due to environmental changes, including non-infectious chronic diseases, in urban environments. Moreover, calls to more thoroughly integrate the One-Health model with the social sciences have been largely ignored (Hinchliffe, 2015; Wolf, 2015). Others have called for a truly integrative model of One Health that includes a focus on the social, behavioral, and personal components that impact human health (Davis & Sharp, 2020; Destoumieux-Garzón et al., 2018; Rock et al., 2009). We also support this movement and suggest extending the One Health model

to diverse contexts where human health and aging processes are adversely affected by myriad environmental factors.

Integrated theoretical models, such as the socioecological model, can allow researchers to understand the multiple factors that influence human health (Lejano, 2011). Developed by Bronfenbrenner (1992), the socioecological model posits that human development is influenced by the environment, with the most direct relationships having the most significant effect on development. This framework has been effectively applied to human health because it accounts for environmental and social influences often lacking in other models (Kilanowski, 2017), in line with the World Health Organization (WHO, 2015) definition of health as “. . . a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity.” However, the One Health model extends and enhances this approach by emphasizing human health as *part of an integrated system* rather than the outcome of a broader system. In particular, the One Health concept

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provides a different perspective for understanding the reciprocal relationships between humans, animals, and environmental factors, as these relationships are presented in an “interwoven” fashion rather than simply in bidirectional alignment. The socioecological model is largely anthropogenic whereas the One Health Model stresses a “whole-systems” approach, of which humans are a part. This holistic view can help reframe research questions in new ways, for example, when used as a lens to explore the ways in which human aging can be affected by urban environments. Here we explore this concept in an Alaskan context, where access to healthy natural ecosystems is an important part of aging for Indigenous peoples and other Alaskans who feel connected to the land. Although we have provided examples specific to our work in Alaska, we believe that the One Health model could be successfully used in all urban settings.

In this paper, we briefly review the theoretical underpinnings of the One Health model, the socioecological processes of human aging, and the study of urban environments. Our goal is to illustrate how the One Health concept can be helpful for expanding researchers’ perspectives on public health issues by utilizing the example of the complexities of human aging in urban environments. We feel that the One Health model is underutilized and can be expanded to help researchers, clinicians, and public health professionals to better understand the complexities of older adults in diverse environments.

The One Health Model

The “One Medicine” concept, created in 2004, advocates for a combination of human medicine and veterinary medicine to address zoonoses (Zinsstag et al., 2015). The theoretical innovation was the inclusion of wild fauna and ecosystem health (Lebov et al., 2017). Since then, the One Health model has expanded to consider how human health is affected by an “interdependent continuum” between humans, animals, and ecosystems. For example, this model has been effectively used to study complex relationships such as the long-term effects of toxins in the environment and their direct and indirect effects on human health through a longitudinal process of ecological and biological study (Purohit et al., 2017).

According to the Centers for Disease Control (CDC), the One Health model is an approach using multiple scientific disciplines to study the interconnectedness of humans, animals, and the environment and how these interactions affect human health. The framework necessitates these interdisciplinary collaborations because of the multidimensional nature of human well-being (Lebov et al., 2017). The One Health model was endorsed as a vital initiative by the Arctic Council in light of the unprecedented threat that climate change poses to the region’s ecosystem and the health of its peoples (Hueffer

et al., 2019). We suggest that interweaving the One Health model with measurable social and mental health outcomes will expand our understanding of how environmental change affects the whole person and can lead to more effective public health solutions. In the Alaskan context, one example of these types of outcomes is the psychological effects that result from changes in available food resources affected by climate change.

The Aging Process

A variety of conceptual models have been created to define the aging process. Rowe and Kahn’s gerontological model describes three main criteria that must co-occur for healthy aging: (1) the low probability of disease and disease-related disability, (2) maintenance of high cognitive and physical functioning, and (3) a continued engagement in life (Rowe & Kahn, 1997, 1987, 1998). This model is not without criticisms (Pruchno, 2015; Rowe & Kahn, 2015); in fact, researchers have suggested that this model is missing essential components, such as spirituality (Crowther et al., 2002). Others have criticized its rather static nature and failure to consider the developmental process throughout the individual’s lifespan, and the lack of added nonclinical dimensions in its definition (Stowe & Cooney, 2014). Moreover, Lewis (2010) censured the model for its lack of inclusiveness as it may exclude Indigenous and non-white models of aging.

Baltes and Baltes (1990) proposed another model of healthy aging called Selection, Optimization, and Compensation (SOC). SOC posits that older adults who negotiate their physical and cognitive declines by emphasizing their strengths are most successful. Here, the definition of “success” centers on doing one’s best in light of personal circumstances while pursuing a particular goal or set of goals. Likewise, successful aging has also been theorized within the preventive and corrective proactivity (PCP) model (Kahana & Kahana, 1996). According to the PCP framework, older adults are likely to experience normative stressors associated with the aging process, including illness, social loss, and person-environment incongruence. However, they are also able to experience successful aging to the extent that they can call upon internal and external coping resources, such as hopefulness (internal), available social supports (external), and engage in corrective and adaptive behaviors (e.g., planning for the future, environmental modifications).

Additionally, emotional well-being plays a critical role in the aging process and is influenced by a number of factors, the most important of which are social relationships (Charles & Carstensen, 2010). Emotional well-being is one’s experience of positive and negative emotions. Older adults often report higher levels of some aspects of emotional well-being when compared with their younger counterparts (Carstensen et al., 2011;

Shallcross et al., 2013; Stone et al., 2010). Resilience is yet another factor that has been identified as contributing to health and well-being in older adults. Resilience has been defined as one's capacity for maintaining and restoring physical and psychological health when confronted with stressor, both daily and major (Bonanno, 2004).

The WHO (2015) defines healthy aging as "the process of developing and maintaining the functional ability that enables wellbeing in older age". This definition, coupled with the WHO (2015) definition of health (above), provides a workable framework for developing inclusive models of healthy aging. However, the components that comprise most current models of aging do not comprehensively encompass the many personal and environmental factors that are a part of a comprehensive cross-cultural theory of healthy aging.

The Urban Environment and Healthy Aging

Life in urban areas can present significant stressors to aging adults that are not experienced in the same way by rural residents (Schell, 1997; Willie et al., 2016). For example, in a study of urban women over age 40, participants more frequently report barriers to physical activity such as high neighborhood crime and pollution, lack of time, and less social support than their rural counterparts (Wilcox et al., 2000). Exposure to urban air pollution presents another barrier to outdoor enjoyment and negatively impacts overall well-being of urban-dwellers (Gallo et al., 2011; Schell & Denham, 2003). Such environmental pollutants increase the oxidative stressors experienced by urban residents, which have been linked to an increased risk of cognitive impairments among older adults living in cities (Sánchez-Rodríguez et al., 2006).

Additionally, adults may experience a variety of neighborhood-level psychological stressors in urban environments. For example, residents in Baltimore cited neighborhood violence and racial inequities as a barrier to healthy aging (Chard et al., 2016). Brenner et al. (2013) found that neighborhood stressors, such as socioeconomic disadvantage, can result in greater levels of psychological stress and steeper increases in stress over time for people living in low-income neighborhoods compared to wealthier neighborhoods. They found that residents of such stressful communities were more likely to utilize negative intra-individual coping strategies, such as substance abuse, unless they had adequate social supports. Ageism compounds the stressful effects of environments where prejudice, discrimination, and health disparities already exist (Wallace, 2021).

Social supports are often lacking in urban environments, where rates of self-reported loneliness are higher and residents report fewer social relationships compared to their rural counterparts (Henning-Smith et al., 2019). Although older adults may have more access to

social services such as food distribution programs or low-cost physical activity facilities, urban residents in some studies have been found to be more disconnected from their peers and family than closer-knit rural seniors (Holmes et al., 2008; Holtfreter et al., 2017). In Toronto, older adults living alone in urban locations are at risk of exclusion from civic life and social isolation (Nguyen et al., 2013). Research in Japan has also concluded that urban seniors are significantly more likely to experience social isolation and related depression than rural elders, especially urban women (Tanaka & Johnson, 2010). However, other studies suggest that urban residents are more socially integrated and experience better overall health than rural elders (Havens et al., 2004; Vogelsang, 2016).

Research also indicates that the urban dietary environment can be very different than in rural areas. Accessible, low-cost, unhealthy fast food options can effect dietary intake of seniors in urban settings. Older women state that fast food restaurants are often within walking range, making them difficult to avoid (Jilcott et al., 2009). Indeed, urban dwellers consume more refined grains (rather than whole grains) and sugar-sweetened beverages than rural residents (Miller et al., 2012; Schoenberg et al., 2013). However, urban residents can have some advantages over rural residents in terms of access to food resources. The same studies cited above that found urban residents consumed more refined grains and sugary drinks also found that these city dwellers consumed more healthful foods like fruits, vegetables, and meat, resulting in lower BMIs than rural residents (Miller et al., 2012; Schoenberg et al., 2013). A large European study found that resources that are more accessible in urban environments, such as access to grocery stores, a car, and a primary physician, strongly correlated with a more varied and healthful diet for seniors (Dean et al., 2009).

Spending time out in natural environments has been shown to improve physical (Brown et al., 2016; de Vries et al., 2003; Korpela & Ylen, 2007; Pretty, 2004), mental (Pretty, 2004), and cognitive well-being (Bratman et al., 2015; Kaplan & Talbot, 1983) as well as provide stress relief (McFarland et al., 2010) and a feeling of restoration (Kaplan, 1995). Researchers have studied the benefits of spending time in nature extensively, and the evidence overwhelmingly touts the positive effects of the natural environment (Kaplan & Talbot, 1983; Ulrich et al., 1991). Older adults benefit from spending time in nature and even the opportunity to view nature pictures can have positive physical and mental health benefits (Gamble et al., 2014; Pretty, 2004). Moreover, the availability of greenspace throughout the life course can result in long-term benefits such a slowing of age-related cognitive decline (Cherrie, 2018). Wilson (1984) posited that humans are innately drawn to nature; coining this phenomenon "Biophilia." This biological predisposition to associate with nature includes humans seeking interaction with the natural environment as well as other living creatures. Architects and city planners

have often utilized these positive influences when designing green spaces in the city to relieve city-dwellers of undue stress (Ulrich, 1993). The importance of urban greenspace, such as parks, nature areas, trees, and flowers, cannot be overstated. However, it may be the case that urban dwellers have fewer opportunities to spend quality time immersed in nature compared to people living closer to wild spaces. In an Alaskan context, the relationship between Indigenous elders and the land is an important one; however, this critical component of well-being is often overlooked when evaluating the health of urban seniors. Because of the complex interactions between humans and their urban environments, One Health may be well suited to help investigate the pathways to healthy aging in this context.

Using One Health to Understand Urban Aging: Evidence From Alaska

We argue that the One Health concept can help us understand the opportunities and stressors that the urban environment may place on human aging and extends the socio-ecological model by emphasizing a deep connection between human health, the ecosystem, and animals with which we live. Our work on aging in Alaska's two largest cities (Anchorage and Fairbanks) has shown that a variety of interactions between humans, animals, and the urban environment can play a substantial role in the health of older adults.

It is critical to consider the importance of the connection that older adults have with both the natural environment and other living creatures, including emotional and spiritual connections. The relationships between humans and animals can provide an essential bond that improves well-being in a multitude of ways. Social interactions between humans and non-human animals can provide valuable emotional support in times of stress. Detailed investigations of human-animal psychological relationships are a relatively new area of study, but evidence supports a critical need to advance this research (Amiot & Bastian, 2015). In studies concerning pet ownership, researchers have demonstrated that pets in the home increase elders' well-being and physical health, as well as health behaviors. Pet ownership is associated with fewer health problems, fewer prescription medications, lower stress, and improved pain relief (Heuberger, 2017; Ogechi et al., 2016). Moreover, pet ownership is related to improved quality of life through increased stimulation of oxytocin, an increased sense of purpose in life, and decreased loneliness (Wells, 2019). The findings concerning loneliness, in particular, are corroborated by Stanley et al. (2014) who found that older adults owning pets were 36% less likely to report loneliness than their non-pet owning counterparts. Having a pet has also been noted to increase and improve social interactions in neighborhoods and enhance the sense of community cohesion (Bulsara et al., 2007). Despite these many positive benefits, the causal relationship between pet

ownership and health is quite complicated, and further research is needed to elucidate these mechanisms. The emotional support provided by non-human animals is an area of human health that could be explored more fully through the lens of the One Health model.

The interaction between older adults and animals as emotional support is especially important in urban areas, where social isolation and loneliness may be markedly greater than among rural seniors, as mentioned above. In Fairbanks, interviews with 32 older adults revealed that many viewed their pet as a companion and a driving purpose in their lives (Peterson et al., in prep). Pet ownership was endorsed as a factor defining healthy aging among these participants. Likewise in Anchorage, five focus groups with 53 older adults indicated that relationships with animals become increasingly important for companionship as people get older (Howell et al., 2020). Participants in two of these focus groups agreed that the unconditional love of an animal, especially a small dog, is an important component of healthy aging and maintaining positive mental health. Dogs, rather than cats, also had the added benefit of ensuring urban Alaskan seniors get some physical activity, by requiring regular short walks outdoors every day (Peterson et al., in prep).

Our work in Anchorage has also revealed that access to wild animals through hunting, fishing, and trapping (a practice known as subsistence use) for customary and traditional uses such as food and bartering is important for seniors, even in urban places (Howell, 2020). Although subsistence activities were most significant among Alaska Native seniors, non-Indigenous Alaskans reported the importance of local flora and fauna in their diet as well. For example, among a sample of 82 older adults who completed food frequency questionnaires and semi-structured interviews in Anchorage (Howell, 2017), 88% of respondents reported consuming local fauna such as salmon ($N=74$), halibut ($N=72$), berries ($N=62$), moose ($N=35$), dried fish ($N=34$), and caribou ($N=31$). These findings are interesting considering only 15% of the sample reported being of Alaska Native ethnicity, demonstrating the importance of local animals on the dietary patterns of ethnically-diverse urban residents of Anchorage including Asian, White, and African American seniors. Despite this high use of local wild foods, several older adults reported with sadness and remorse that as they got older they were less able to engage in the subsistence practices to acquire these items themselves, as local fishing, hunting, and gathering practices can be labor-intensive (Howell & Bardach, 2018). Urban older adults were sometimes able to barter for desired local wild foods from others, usually friends and family members living in other regions of Alaska. However, our findings also suggest that the oldest seniors in Anchorage may have the fewest social networks on which they can rely for food provisioning or other supports (Howell et al., 2019).

Our work in Fairbanks and Anchorage also suggests that the effects of climate change are being felt by older adults living in urban Alaska. Older adults are more sensitive to changes in their environment and can suffer greater negative effects than younger people (Haq et al., 2008; Rowles & Bernard, 2013). In Anchorage, seniors often report that warmer temperatures are a problem in summer, where many homes do not have air conditioning. Low-income older adults are especially vulnerable to climate changes because they are more likely to lack resources to adapt to their environment, for example, by encumbering the increased expense of air conditioning or by purchasing an indoor air purifier to avoid smoke from wildfires (Gamble & Balbus 2016; Tillett, 2013). In Alaska, increasing frequency of freeze/thaw cycles that turn winter precipitation into ice make traveling outdoors a difficult proposition (Howell, 2017). Indeed, research shows that unintentional falls are the leading cause of fatal and nonfatal injuries among older Alaskans (Alaska Department of Health and Social Services, 2013), which often contribute to hospitalization and early mortality (Talbot et al., 2005). Similarly, exposure to wildfire smoke can cause a number of cardiorespiratory health outcomes (Hahn et al., 2021) and older adults with pre-existing conditions and weakened immune systems are often disproportionately affected (Delfino et al., 2009; Nunes et al., 2013, Simoni et al., 2015). The frequency of large wildfire seasons (>1 million acres burned) has increased in Alaska over the past several decades (Markon et al., 2018), and the number of smoky days in Alaska's largest cities has also increased (Thomas & Walsh, 2019), presenting a substantial negative environmental exposure for older urban Alaskans.

Despite these difficulties, seniors across the Circumpolar North, including in urban locations, report strong connections to the land (Howell & Peterson, 2020; Lewis, 2013; Peterson et al., 2020). Likewise, participants in both Fairbanks and Anchorage tend to report a desire to age-in-place and maintain access to nature. For those less mobile seniors who believe they can no longer perform the outdoor activities they used to, elders express regret for the medical conditions that have placed these restrictions on pursuing such hobbies and interests (Howell & Bardach, 2018).

These examples demonstrate that psychological links to companion animals, access to wildlife, changing climate and weather, and connection to nature are important components of what it means to be a "healthy older adult" in urban Alaska. The One Health framework richly enhanced our processes for developing our research questions, listening to participants, and analyzing our data. Researchers could more clearly identify these connections between people and their broader ecosystem through the holistic lens of One Health. We argue that using a One Health framework to explore the diverse set of factors that affect human health can lead to greater insights into healthy aging and chronic disease prevention in urban environments.

Conclusion

The One Health model has been successfully used for the past decade to increase collaborative research efforts between human and veterinary health specialists and to expand research on the interactions between humans and their (largely rural) environments. However, we suggest that One Health has been limited in its utility, so far, by its intense focus on zoonotic and other infectious diseases. Other researchers have suggested, and we agree, that One Health could also be useful for understanding the role human-animal-environment interactions may have on non-infectious, chronic conditions, which remain the leading cause of mortality in the world, especially among older adults. There are many opportunities to expand One Health research in urban environments, where our preliminary work shows that the psychosocial and other health benefits from connections to animals and the environment are greatly reduced when compared to those experienced by rural Elders. Although our experience in utilizing this model to study city dwelling older adults is largely limited to Alaska, we believe that the use of this model can be expanded to many other locations and settings. Urban environments provide fertile ground for researchers seeking to expand the scholarship of the human-animal-environment interactions embedded in the One Health model to include chronic disease prevention.

Therefore, we argue that the complexities and persistent gaps in our knowledge about the processes of human aging, as well as myriad other chronic health issues, can be elucidated by the One Health concept. Here we provided examples of urban Alaska as an ideal location to move beyond the socioecological framework of public health and utilize a One Health model to frame the opportunities and barriers to healthy aging (Hueffer et al., 2019). As part of the Circumpolar North, urban Alaska is characterized by a population of seniors attempting to age healthfully in an extreme environment on the front lines of climate change while maintaining reliance on local fauna and meaningful relationships to the land (Howell & Peterson, 2020). As we embark on this effort to further integrate the One Health model into our own studies on successful aging in the urban Circumpolar North, we encourage other researchers to also consider the benefits of this model on the investigation of non-infectious, chronic diseases experienced by older adults in urban environments.

Authors' Note

Brittney M. Howell is now newly affiliated to Division of Population Health Sciences.

Micah B. Hahn is now newly affiliated to Institute for Circumpolar Health Studies.

Author Contribution

All authors contributed substantially to this manuscript.

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