Health Benefits of the Intertwine

The health benefits of the Intertwine can be classified according to the following opportunities it provides: Physical Activity, Access to Nature, Social/Community Building, and Environmental Benefit (See Fig 1). Each of these opportunities present multiple avenues for improving the short- and long-term health status of Portland area residents. It should be noted that the health benefits of these opportunities can be described as benefitting both the individual and community level of health.

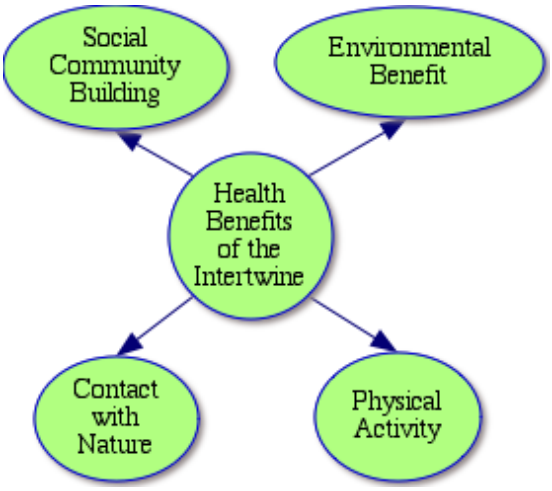


Figure 1

Physical Activity:

The Intertwine provides Metro region residents with a variety of opportunities to be physically active, through recreational sports, hiking, and active transportation. Physical activity is a primary method of health promotion and a recognized instrument for decreasing chronic disease. Among the health conditions that are benefitted by regular moderate physical activity are cardiovascular disease, high blood pressure, diabetes, osteoporosis and some types of cancer. These chronic diseases are the most common and costly conditions affecting our healthcare system. Physical activity also benefits the functioning of the immune system, resulting in less susceptibility to, and faster recovery from, infectious disease. In addition, physical activity has a positive impact on mental health. It improves psychological well-being, elevates mood, and improves psychological resilience. Physical activity is beneficial for preventing and treating psychological disorders such as depression and anxiety.

Physical activity is also a valuable approach for decreasing the impact of obesity, an important mediator in the current national epidemic of chronic disease. According to the Office for Oregon Health Policy and Research, half of the residents in the Portland metropolitan area engage in no regular physical activity and a similar number are over-weight or obese. Childhood obesity in particular is the focus of much current media attention.

The promotion of physical activity is currently one of the top areas of interest for reducing obesity by the US Centers for Disease Control and Prevention (CDC) and the Oregon Public Health Division. The creation of physical infrastructure that facilitates easy access to opportunities to be physical active is currently one of top priorities of many public health organizations. Proximity and accessibility to parks and trails are two of the largest determinants

of use, and have a direct impact on physical activity. One study has found that every park within ½ mile (1 km) of the primary living residence increases a person's likelihood of meeting minimum physical activity guidelines by 17% (Kaczynski, 2009). Similar studies have demonstrated the importance of proximity to bike trails on physical activity (Troped et al., 2001; Pierce et al., 2006). Other infrastructure attributes that influence physical activity include cleanliness, naturalness, aesthetics, safety, and appropriateness (Gobster & Westphal, 2004).

Currently, sparse data exists to calculate how much physical activity the Intertwine facilitates. A regional trail count conducted by Metro in September 2008 & 2009 provide an estimate of trail usage rates, but these point-locations are unable to provide information about trail length or duration (i.e. were people riding 1 mile, 10 miles, 100 miles?) It is possible to approximate the average distance travelled per rider and calculate health-related data, such as caloric expenditure, obesity reduction, and prevention of chronic disease due to physical activity. In addition, a rough economic cost-benefit analysis of the regional trail system could be conducted similar to that done by Wang et al (2005).

With regard to parks and natural areas, current data from Metro and the Coalition for A Livable Future's Regional Equity Atlas provide information on number of parks, park size, and population proximity to park space. Currently, no data exists regarding park/natural area usage rates or activities conducted in such spaces. Without knowing how often people are using these spaces, or the activities they participate in when using these spaces, it is difficult to develop an accurate method for calculating physical activity benefits. Other data sources (i.e. Kaczynski, above) could be used to generate a rough estimate of benefit, though this would be based on sample data that may not be generalizable to other conditions.

Contact with Nature:

A substantial amount of research demonstrates that contact with the natural world has a direct impact on human health in a way that is independent of physical activity. Reviews of this information have been conducted in Britain and Australia by Bird (2007) and Maller et al. (2006), respectively. These health benefits occur as a result of an inherent "biophilic" or nature-loving process that is an instinctive component of human physiology. We react to beautiful environments and natural scenes in conscious and unconscious ways because of acquired evolutionary adaptations to the world around us.

One manifestation of these adaptations to the natural environment is the ability of natural scenery to reduce "allostatic load", the negative repercussions of accumulated stress. Stress is a psychological and physiological process that has deleterious effects on physical health when sustained over extended periods of time. Allostatic load is a contributing factor to many chronic diseases, including obesity, cardiovascular disease and diabetes. Direct experiences of nature have been shown to decrease levels of stress, as well as the physiological indicators of health and disease that measure allostatic load. Large scale epidemiological data supports the theory that the presence of nature reduces stress, decreases allostatic load, and helps to prevent chronic disease (van den Berg et al, 2010).

The presence of nature also reduces the mental and emotional manifestations of stress, and is known to improve a person's perceived quality of life. Feelings of tension, anger, and irritability are decreased in areas of natural scenery. Feelings of joy, happiness, and emotional well-being are increased in these places, and can result in higher reported quality of life for people that live in these areas. The mental health conditions of depression and anxiety are also influenced by a person's experienced level of stress, and have been shown to be reduced after exposure to natural environments.

Contact with nature has benefits for mental function as well as mental health. Task concentration and accuracy are increased during and after exposure to natural environments. This mentally "restorative" ability of nature reduces workplace fatigue that leads to accidents, and increases worker productivity. Being in nature benefits children as well, with demonstrated improvements in academic performance, social skill development, and behavioral problem occurrence. Children with frequent contact with nature demonstrate more creative thoughts, greater initiative for achievement, and increased capacity for focused attention. Exposure to the natural environment has even been promoted as a successful strategy for reducing the effects of attention deficit hyperactivity disorder (ADHD).

Natural areas and parks within the urban region provide places where people can go for inspiration, contemplation and reflection. This is often recognized as a contributing factor to maintaining a high quality of life. Even if natural spaces are not immediately accessible, the awareness of their presence is beneficial to many people and contributes to the "existence value" of such places. Similarly, there is a component of contact with nature that manifests as a place-based concept of self-identity. This sense of identity determines the status of positive mental health for individuals in the context of their local environment. It also creates the green, eco-friendly ideology of Portland that has been responsible for creation and maintenance of projects such as the Intertwine. These opportunities are particularly important to maintain as the urban component of the Metro region expands.

Measurement of direct health effects of contact with nature at the current time is difficult. Such analysis typically correlates health data with accessibility to green space, as measured by proximity to the primary living residence. This approach has been used successfully in a number of studies, most notably coming from the Netherlands (Maas et al., 2006). Data on green space proximity in the Portland region is available most notably via Coalition for a Livable Future's Regional Equity Atlas. However, health data, particularly relevant mental health data, is either not available or is collected in a manner that would not be useful to analysis. Any assessment of the health benefits of contact with nature for the Intertwine would need to rely on future data collected specifically for this purpose or other data sources that have yet to be established. Such data would also need to be adjusted for potentially mediating factors (e.g. income level, history of recent trauma, employment status) to be considered useful.

The collection of data for this purpose would most easily be performed through survey questionnaires, either via direct mail or telephone survey, and focus groups. Once collected, this self-reported health data can be correlated with proximity of primary living residence to greenspace to determine relationship. The extent of investigation in this area is dependant on desired breadth and depth, and on available resources for data collection and analysis. A simple approach would be to include one question as a general measure of health. An example of this type of question would be: "In general, would you say that your health is: Excellent, Very good, Good, Fair or Poor." This question is taken from the CDC's 4-item Health-related Quality of Life (HR-QOL) survey. More extensive survey models might include all or components of the SF-8, SF-12 or SF-36 (http://www.sf-36.org/) or the 26-item WHO Quality of Life BREF (http://www.who.int/substance_abuse/research_tools/whoqolbref/en/). Such scales have been used to assess the impacts of green spaces on health (Guite et al, 2006).

A full exploration of the benefits of contact with nature would require large-scale collection of health data, including diagnoses of physical and mental disorders, self-reported physical and mental health status, subjective experience of quality-of-life, stress, self-esteem and self worth, and perceived sense of coherence. Such an effort is most likely beyond the scope of the current project.

Social Community Building

The parks and natural areas of the Intertwine provide the physical space for people to congregate and form communities. These social spaces are an essential component of healthy well-being. They provide people with a sense of personal and community identity in the context of their local environment. Individuals identify with the physical features of their local surroundings (Proshansky et al., 1983), and pleasant aesthetic parks, trails and natural areas give them positive experiences with which they can identify (Horwitz et al, 2001; Burls, 2007). Communities often are strengthened by the physical space of a park and the activities that occur within it (Kuo, 2003). Local parks and trails can also be rallying points that generate civic engagement and community empowerment, which foster a sense of community identity (Kim & Kaplan, 2004; Westphal, 2003). These concepts of social identity directly impact the management of personal stress and the establishment and maintenance of individual mental health (Baum et al, 2009; Folland, 2007). Social and community activities have been found to directly mediate the influence of urban built and natural environments on health status (Sugiyama et al, 2008).

The social benefit of the Intertwine extends beyond a conceptual sense of identity. It has real repercussions for how people interact with each other for material and emotional support. This development of "social capital" is based on systems of trust and reciprocity, and is fostered by the social networks that are established in public spaces (Semenza & March, 2009; Catell et al., 2009; Baum & Palmer, 2002). The ability of public spaces, particularly those that contain pleasant natural aesthetics, to promote social interaction and facilitate the establishment of supportive social ties that contribute to health is well founded in the literature (Maas et al., 2009a; Meier, 2007; Ziersch et al., 2005).

Another community benefit of the Intertwine may be its impact on neighborhood safety and crime. Active park and trail infrastructure results in more people with eyes on the street, and can act as a deterrent to property and violent crime (Maas et al., 2009b; Kuo & Sullivan, 2001). The concern for nocturnal criminal activity to occur in areas that are unobserved is legitimate, and must be considered.

Measurement of the health effects of the social community building aspects of the Intertwine at the current time is difficult. Such measurements typically take three approaches:

1) Direct collection of social/community development through on-site objective (visual observation) and subjective (intercept survey) methods
2) Indirect survey (e.g. direct mail, phone, email) of sense of community (using various metrics) and correlation of responses with proximity of the primary living residence to accessible green space
3) Correlation of neighborhood crime statistics with proximity of the primary living residence to accessible green space.

Currently, only data of this third type (crime/safety) is available or is known. This data is displayed for the city of Portland through the city's CrimeMapper database (http://www.gis.ci.portland.or.us/maps/police/). Data pertaining to social community building through direct and indirect survey methods is not currently available and would need to be collected.

The primary areas of interest include: Social interaction, social support, social capital, sense of community, civic/community participation, neighborhood satisfaction, and neighborhood safety.

Examples of possible instruments for this purpose include the Sense of Community Index v2 (http://www.senseofcommunity.org/files/SOC_II%20product.pdf) and the social capital/neighborhood satisfaction questions developed by Baum et al. (2009) and Ziersch et al. (2005). These instruments are been validated for use in determining health status, through comparison to the physical and mental health scales of the SF-12 (see above).

Environmental Quality

Though an environmental assessment is being conducted separately, it is useful to briefly consider the environmental impacts of the Intertwine on the health of Portland residents in the following areas: Air Quality, Noise reduction, Regional Biodiversity, and Greenhouse Gas/Climate Change

- Air quality

Air quality has a direct impact on human health (Curtis et al., 2006). Concentrations of airborne particulate matter (PM), Ozone (O3), sulfur dioxide (SO2) and Nitrates (NOx) are known determinants of respiratory disease (e.g. allergies, asthma, bronchitis, pneumonia) (Ostro et al, 2009; Parker et al, 2009; Dominici et al, 2006) and cardiovascular disease (e.g. hypertension, heart attack, heart failure, stroke, arrhythmias) (Brook, 2008). Air pollution is also responsible for increased rates of mortality (Wong et al, 2008). Other airborne chemicals (e.g. benzene, formaldehyde) produced by industry and vehicular combustion are known carcinogens that elevate risk for various types of cancer; such risks have been calculated at five points throughout the Portland area (Tam & Neumann, 2004).

Air quality in the Metro region is influenced by the Intertwine in two principle ways: 1) utilization of Active Transportation resulting in reduction of vehicular miles travelled (VMTs), with subsequent decrease in air pollution from vehicular exhaust, and 2) filtration and capture of airborne pollutants by vegetation.

The reduction of VMT has been investigated by Metro (e.g. Metro/J-PAC Regional Transportation Plan), and data is available for this analysis. In addition, the Portland Air Toxics Assessment (www.deq.state.or.us/aq/Factsheets/06-NWR-015**pata**.pdf*)* provides information of Portland air quality at the census block level. Less well studied are the air filtration and pollution capture capacity of the region's tree canopy. It is possible to calculate the positive impact of urban flora on air quality by using methods such as Nowak & Crane's Urban Forest Effects (UFORE) model (2000); this model has been used to estimate that the total tree canopy of Portland reduces the concentration of airborne particulate matter by 1% (Nowak et al, 2006).

Currently there are no standardized methods for determining the direct relationship between air quality and rates of respiratory or cardiovascular disease. However, preliminary studies have been conducted elsewhere to estimate vegetation's impact on air quality and health benefits on city, region, and even national scales (Tiwary et al., 2009; Currie & Bass, 2008; Powe & Willis, 2004).

Other environmental aspects of the Intertwine that impact human health include:

- Improvement of regional water quality
- Noise reduction due to 1) VMT reduction and 2) barrier-buffering effects of trees
- Enhancement of regional biodiversity

- Decrease in greenhouse gas production due to 1) VMT reduction and 2) carbon sequestration capacity of regional vegetation

Summary

There are multiple avenues in which the Intertwine contributes to the health and well-being of Portland area residents. These avenues fit with intuitive observation and are well supported in the research literature. It is possible to use this body of literature to advocate for the Intertwine as a method of regional health promotion.

Currently, there are three levels of investigation that can demonstrate the effectiveness of the Intertwine to contribute to the health of individuals and communities throughout the Metro region: 1) calculated benefits using existing data, 2) Measurable benefits using acquired data, and 3) Theoretical benefits. The first level (Calculated Benefits) utilizes data that is currently available for analysis. Methodologies for conducting analysis may need to be adapted or developed to suit the specific situation. The second level (Measurable Benefits) requires the collection of new data of various types. The third level (Theoretical Benefits) proposes health benefits that have been discussed and/or demonstrated in the research literature, but are either too abstract or too complex to lend themselves to the data collection process at this time. Such benefits are included because they are likely contributors to health, regardless of whether or not they can be represented quantitatively.

1) Calculated benefits using existing data

Physical Activity

- Contribution to regional physical activity level.
- (Speculative) contribution to calorie expenditure, obesity reduction, and prevention of chronic disease. (Trails only)
- Impact of regional physical activity on healthcare costs

Contact with Nature

- None

Social/Community Building

- Correlation of regional crime & safety statistics with proximity to the Intertwine

Environmental Benefit

- Contribution of VMT reduction to decrease in regional respiratory and cardiovascular disease rates
- Contribution of Urban Tree Canopy to air quality through filtration

2) Measurable benefits using acquired data

Physical activity

- Contribution of parks and natural areas to caloric expenditure, obesity reduction and prevention of chronic disease
- Ability to facilitate physical activity (based on proximity, aesthetics, etc…)
- Ability to reduce chronic disease prevalence

Contact with Nature

- Contribution to physical and mental health status
- Ability to contribute to individual quality of life

Social/Community Building
- Contribution to development and maintenance of social capital, social cohesion
- Contribution to community development & Neighborhood involvement
- Ability to promote sense of place/identity for individuals and communities

Environmental benefits
- None

3) Theoretical benefits

Physical Activity
- Contribution to individual BMI and PA level
- Individual healthcare $$ savings

Contact with Nature
- Ability to impact mental health status
- Healthcare $$ savings from psychological/restorative benefits
- Ability to impact worker productivity
- Ability to impact ADHD severity, frequency

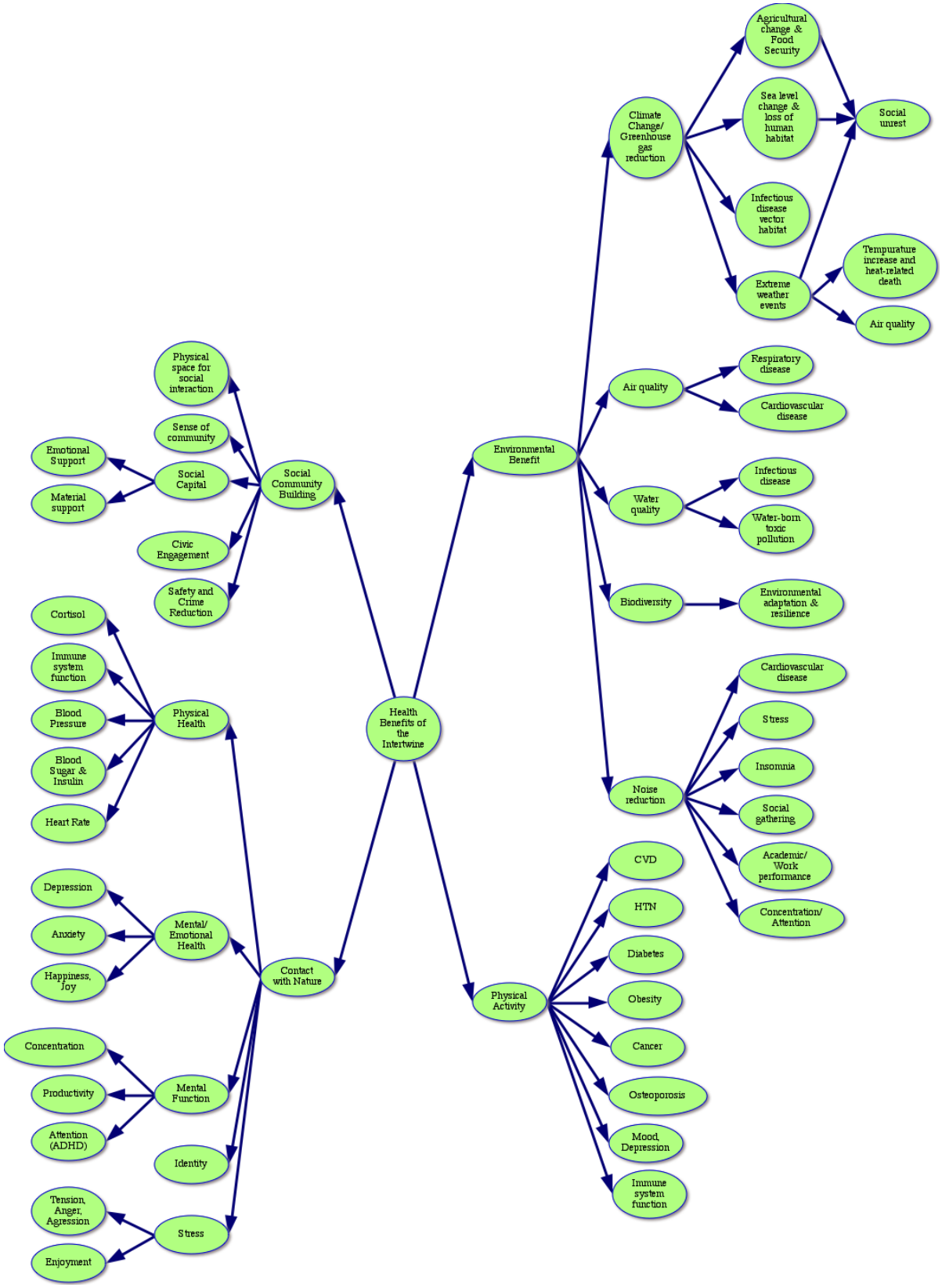
Social/Community Building
- Ability to impact physical and mental health
- Healthcare $$ savings

Environmental Benefits
- Economic Healthcare savings from improved air quality, resulting in respiratory and cardiovascular disease rate reduction
- Ability of Urban Tree Canopy to impact respiratory and cardiovascular disease
- Contribution to reduction of Greenhouse gas & Climate Change, with subsequent impact on health
- Contribution of VMT reduction to decreasing noise pollution, with subsequent reduction in chronic disease rate
- Contribution of Urban Tree Canopy to act as acoustic buffer for noise pollution, with subsequent reduction in chronic disease rate
- Contribution to regional water quality and impact on human health
- Contribution to regional biodiversity and impact on human health

Conclusion:

The Intertwine provides many opportunites for impacting the health of people and communities in the Portland Metro region (See Figure 2). It can be expected that development and promotion of the Intertwine will improve the short- and long-term health status of Portland residents through a variety of these interrelated mechanisms (See Figure 3). A visual inspection of the interrelationships suggests that the ability of the Intertwine to facilitate physical activity (lower

right corner) may provide the greatest opportunity for improving the health of Portland area residents, particularly when conducted in contact with nature (lower left). The social and environmental opportunities that the Intertwine provides can be considered supplemental to improving health.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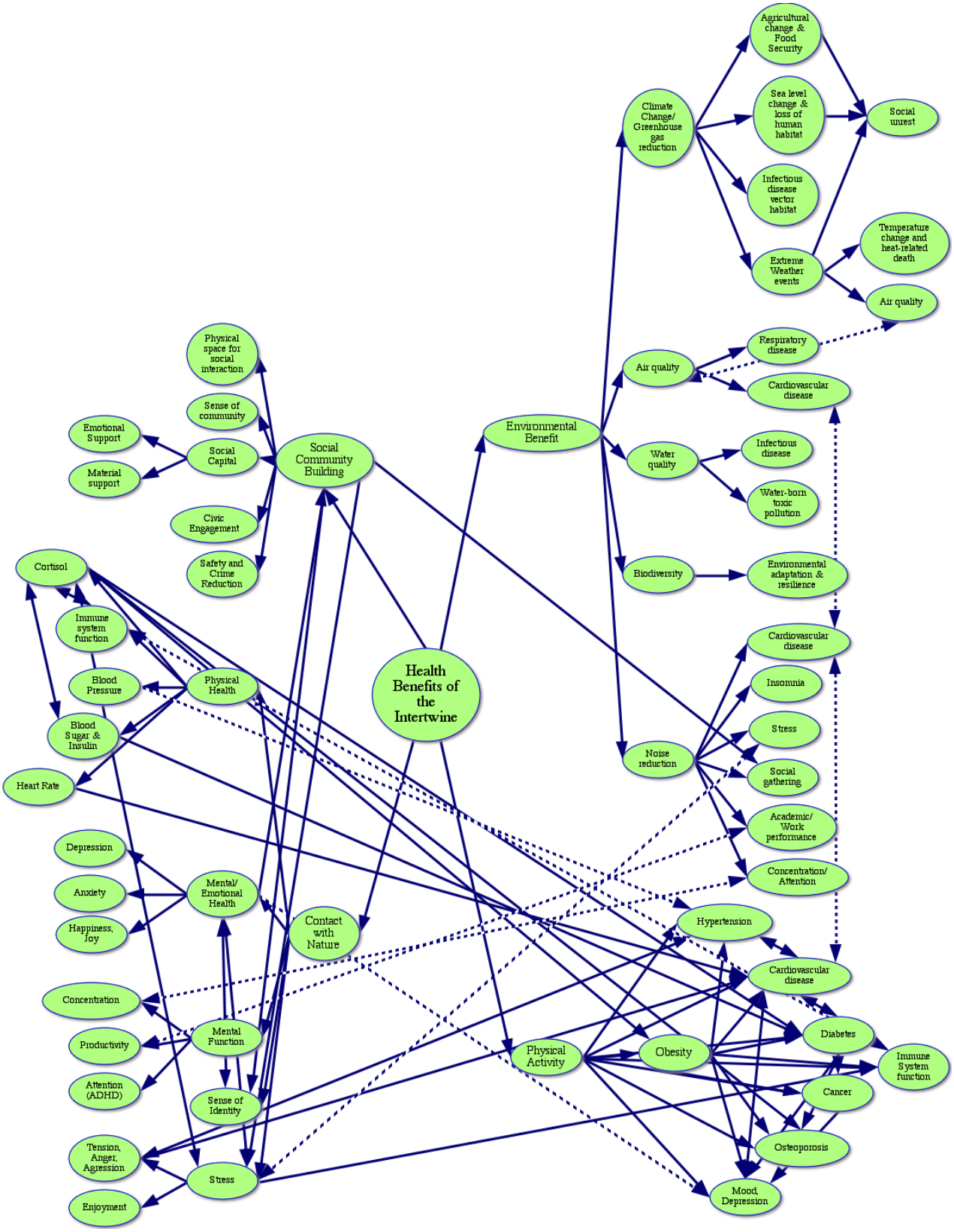
Social Community Building
Physical space for social interaction
Sense of community
Social Capital
Emotional Support
Material support
Civic Engagement
Safety and Crime Reduction
Physical Health
Cortisol
Immune system function
Blood Pressure
Blood Sugar & Insulin
Heart Rate
Contact with Nature
Mental/ Emotional Health
Depression
Anxiety
Happiness, Joy
Mental Function
Concentration
Productivity
Attention (ADHD)
Identity
Stress
Tension, Anger, Agression
Enjoyment
Environmental Benefit
Climate Change/ Greenhouse gas reduction
Agricultural change & Food Security
Sea level change & loss of human habitat
Infectious disease vector habitat
Extreme weather events
Social unrest
Tempurature increase and heat-related death
Air quality
Air quality
Respiratory disease
Cardiovascular disease
Water quality
Infectious disease
Water-born toxic pollution
Biodiversity
Environmental adaptation & resilience
Noise reduction
Cardiovascular disease
Stress
Insomnia
Social gathering
Academic/ Work performance
Concentration/ Attention
Physical Activity
CVD
HTN
Diabetes
Obesity
Cancer
Osteoporosis
Mood, Depression
Immune system function

Figure 2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Air quality
Air quality
Respiratory disease
Cardiovascular disease
Water quality
Infectious disease
Water-born toxic pollution
Biodiversity
Environmental adaptation & resilience
Noise reduction
Cortisol
Immune system function
Blood Pressure
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Happiness, Joy
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Concentration
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Sense of Identity
Tension, Anger, Agression
Enjoyment
Stress
Contact with Nature
Cardiovascular disease
Insomnia
Stress
Social gathering
Academic/ Work performance
Concentration/ Attention
Hypertension
Cardiovascular disease
Diabetes
Immune System function
Cancer
Osteoporosis
Mood, Depression
Physical Activity
Obesity

Figure 3

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