

Green and Blue Wellness: A Model for Improving Physical and Mental Health

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ABSTRACT

Exposure to green spaces (e.g. public parks, gardens) and blue spaces (e.g. rivers, lakes) is associated with improved physical and mental health. Pathways to explain this association include reduced air pollution, increased physical activity, enhanced relaxation and more social connections. Chronic, non-communicable disease (NCDs) is caused by poor health behaviors, such as lack of physical activity, poor stress coping and poor nutrition. Improved health through lifestyle changes such as increased physical activity, improved diet, and coping effectively with stress are a global priority in preventing NCD's. It appears that prescriptions to spend increased time in green and blue spaces should be incorporated into existing programs designed to improve health behaviors. It does not appear that a comprehensive model that incorporates green and blue spaces, physical health, relaxation, nutrition and social connections has been developed. This paper fills that gap with a Green and Blue Wellness™ program designed for implementation in health care settings or as a consumer project consistent with principles of patient health self-management.

INTRODUCTION

Non-communicable diseases (NCDs) are the leading cause of death worldwide, with 63% of deaths in 2008 due to NCD's, primarily cardiovascular diseases, diabetes, cancers and chronic respiratory disease ^[1]. Multimorbidity, the co-occurrence of two or more chronic conditions, is present in two thirds of the elderly and is responsible for 66% of total health care costs in high-income countries due to high utilization of medical services and About 80% of yearly deaths from NCD's occur in low- and middle-income countries This is not just a problem for the elderly, as 67% of healthcare costs are for treatment of NCDs for working adults less than 65 years old ^[2-5]. About 30% of all comorbidities are comprised of medical and behavioral conditions associated with high functional impairment and disability ^[6]. Behavioral conditions such as psychiatric, neurological and substance use disorders comprise 13% of the global burden of disease ^[7]. The global cost of behavioral disorders was estimated at US\$ 2.5 trillion in 2010, with projected increase to US\$ 6 trillion in 2030 ^[8]. In summary, the rise in NCDs and multimorbidity is a global epidemic leading to increases in morbidity, mortality and costs ^[9].

Research shows that behavioral or lifestyle risk factors are a root cause of NCD's ^[9]. Five behavioral risk factors are responsible for most deaths and premature mortality in the U.S.; tobacco use, poor diet, physical inactivity, alcohol abuse and drug abuse ^[10]. Poor nutrition (e.g. high saturated and trans-fatty intake, low vegetable and fruit intake) and lack of physical activity and excessive sedentary behavior are key factors in the development of NCD's and mortality and are a global priority for improvement ^[1]. An exemplar behavioral intervention for NCDs is the Diabetes Prevention Program (DPP), a structured lifestyle intervention program focused on weight loss through improved nutrition, increased physical activity, motivational enhancement and stress reduction (Diabetes Prevention Program Research Group, 1999). The key finding of the DPP was that behavioral interventions that led to weight loss reduced three-year incidence of diabetes by 58% ^[14]. A 10 year follow-up study showed that diabetes incidence was reduced by 34% and concluded that the DPP lifestyle intervention benefits can persist for at least 10 years (Diabetes Prevention Program Research Group, 2009). The Center for Disease Control and Prevention (CDC) recently established the National DPP ^[15]. The use of behavioral interventions to prevent and improve the management of NCD's is a global health priority ^[1,9].

Emerging research has demonstrated a significant association between green space in urban areas and physical and mental health ^[16]. The beneficial effects of urban green spaces include improved mental health, reduced cardiovascular morbidity and

mortality, obesity and risk of type 2 diabetes [16]. Green space includes both naturally occurring areas of greenery, such as public parks and gardens and blue space, representing water sources such as lakes, rivers and beaches [16]. Underlying causal mechanisms to account for the health benefits of green spaces have been proposed as pathways linking green space to improved health, including decreased air pollution, air temperature and noise, increased physical activity, stress reduction and social cohesion or support [16]. Green spaces have been associated with physical health and wellness, including self-perceived health, perceived physical and mental health, well-being cardiovascular disease and reduced obesity [17-23]. Green spaces are associated with improved mental health, stress reduction and cognitive function [24]. Individuals living closer to green space have reduced stress and improved well-being compared to those with poorer access to green space [20]. Green spaces are also associated with improved: general mental health, perceived mental health, stress, depression and anxiety, and mental health and vitality [20,25-27]. Higher levels of green space were associated with reduced depression, anxiety and stress and mental well-being was associated with blue space [26,28]. Greater use of green and blue spaces was associated with improved behavioral development and reduced ADHD in children [29].

It is hypothesized that contact with green space can improve relaxation and can be restorative to health and two main theories have been proposed to explain this association [30]. The psychophysiological stress reduction model proposes that contact with green space can have a positive effect by producing a state of relaxation. Exposure to green spaces are hypothesized to trigger a parasympathetic response resulting in improved relaxation and well-being [30]. The attention restoration model posits that attention focused on stimuli in green spaces helps to improve performance on demanding cognitive tasks [31]. Research shows that exposure to green space demonstrate restorative physiological responses, such as lowered blood pressure and heart rate and evidence of psychoneuroendocrine responses such as lowered concentrations of cortisol, greater parasympathetic nerve activity and lower sympathetic nerve activity [32-35]. Exposure to green space reduces stress in individuals living in deprived urban areas based on diurnal cortisol pattern as a biomarker for chronic stress [36,37]. Green space exposure was also associated with reduced stress using hair cortisol as a stress biomarker [38,39]. Cortisol markers of stress have also demonstrated reduced stress associated with time spent in gardening activities [27].

Nature relatedness, defined as level of connectedness with nature, plays a role in engagement with nature and related benefits [40]. Nature relatedness is associated with time spent in gardens and psychological well-being [41-43]. Found that nature-relatedness was associated with frequency of visits to green spaces, and that it was the strongest predictor of visit frequency to green spaces out of several in the study. Research had demonstrated that access to outdoor green spaces for older adults in residential care facilities had a positive effect on perceived health: a sense of being away, frequent visitation, and better health [44]. A growing body of research demonstrates that gardening is associated with improved health, including increased fitness, reduced pain, improved coping with chronic illness, and reduced stress and depression [45,46]. A study by Castro et al. demonstrated that community gardening combined with nutrition education resulted in improved their body mass index (BMI) at the end of a 7 week long program for obese and overweight children.

Green spaces are associated with increased physical activity [47,48]. Physical activity is the fourth leading risk factor for mortality and increasing physical activity is a major public health priority [49,50]. Physical activity improves cardiovascular health, mental health, and general well-being to prevent obesity and chronic disease [51]. A systematic review found that green space is associated with reduced obesity [23]. Increased physical activity in green spaces, referred to as green exercise, may be more beneficial than other types of exercise [52]. Social support and relationships are protective risk factors for wellness, while social isolation is a predictor of morbidity and mortality [53,54]. Exposure to green space may also associate with enhanced social interactions [1,55]. Distinguish between the terms social capital, reflecting social resources available to an individual and social cohesion, referring to shared norms, values, feelings of acceptance and positive social relationships [56]. A significant association was found between quantity and quality of streetscape greenery and social cohesion [17]. Found that perceived neighborhood green space was associated with social coherence and local social interaction. Other research found that a lack of green space was associated with perceived loneliness and lack of social support [57-59]. In summary, exposure to green and blue spaces is associated with improved physical and mental health, increased physical activity and reduced stress and increased social contacts. The predominant approach to the study of green and blue space has been cross-sectional and the primary approach to increasing exposure to green space has been through public health projects, such as increasing public park space in urban areas [16,56]. However, the strength of the research on green and blue spaces and health point to the need to add prescribed exposure to green and blue spaces as a lifestyle behavior change component of health care delivery. Taken together, these findings support adding exposure to green and blue spaces as a behavioral intervention to improve physical and mental health in the population to prevent and improve the management of NCDs.

GREEN AND BLUE PATHWAYS TO WELLNESS

Identified 21 plausible pathways between green space and wellness organized into five domains: 1) time spent in or around green space, 2) the environmental conditions that lead to health benefits, such as decreased air pollution, beneficial chemicals and biological agents in green spaces (e.g. phytoncides, negative air ions), and sights and sounds of nature, 3) physiological states (e.g. relaxation, immune function, attention), 4) behavioral factors and conditions (e.g. physical activity, obesity, sleep, social connectedness), and, 5) health outcomes (e.g. anxiety, depression, diabetes, cardiovascular disease) [60]. Proposed that, based on his review of the literature, a likely central pathway for the benefits of green space on wellness is enhanced immune system

functioning. Noted that improved immune function was known to account for 18 out of 20 pathways between green space and health [60].

Conducted a review of existing reviews on the relationship between nature and health and identified four major pathways through which contact with green space can influence health and wellness: 1) air quality, 2) physical activity, 3) social contacts, and, 4) stress (reduced exposure to stress, improved coping, restoration) [56]. Identified methodological challenges in research on green spaces and wellness [56]. Exposure to green space is difficult to measure and varied significantly in the research, generally falling into one of three categories: 1) exposure defined by how much nature space (e.g. public park) there the study participant area of residence, 2) survey questions about distance, frequency, and desirability of green spaces, and, 3) objective measures via GPS (Global Positioning Systems) technology. There is inconsistency in how variables such as time, duration in green space, and quality are measured [56]. In addition, it is difficult to evaluate generalizability from studies of the individual or lab-based studies to population-based studies in the natural environment.

Noted that most of the green space research is based on cross-sectional design that is vulnerable to confounding and reverse causality [56]. Lastly, they note that the effect size for studies showing a positive effect of green space on health are small, but also note that even a small beneficial impact can be significant when applied to large number of people in a population health research [61]. Identified priorities for further research, beginning with increased population-based experimental research that utilizes comparable measures of green space, exposure and health outcomes. Next, continued research to identify which of the many pathways identified between green space and wellness most contribute to the positive impact on health is needed. Lastly, the authors acknowledge the competing funding priorities in health care research and recommend evaluating the impact of green space on wellness from an economic perspective. For example, a cost-effectiveness analysis could include the cost of adding exposure to green space against the cost-savings associated with health benefits achieved [56].

SUMMARY AND SYNTHESIS OF RESEARCH

It was observed that research has grown significantly, with a search for “green space and health” yielding 2 hits for 1990-1999, 34 for 2000-2009 and 45 from 2010 to June 2013 [62]. Identified 16 review articles from 2005 to 2015. The consensus from these reviews is that exposure to green space is associated with improved physical and mental health outcomes [16]. There is also consensus that specific pathways are associated with exposure to green space and improved health, including improved air quality, increased physical activity, improved social connectedness and reduced levels of stress [16,56]. There is no consensus on which pathways contribute the greatest to the observed impact of green space on health, although makes the case for improved immune function as a central pathway [60].

The methodological barriers to interpreting the results of research on green space and health are substantial. The reliance on cross-sectional research, lack of consistency in how green space exposure is measured and in the outcome measures used to evaluate exposure leave the interpretations open to confounding and reverse causality also note that there is a disconnect between individual patient level studies and population-based research, the former often reported in psychological journals, the latter in environmental or urban-design journals [56].

It is notable that in addition to the benefits of green space on health identified in this research, many of the explanatory pathways such as physical activity, relaxation, social connectedness and gardening are already independent areas of research showing a positive impact on health contributing to prevention and improved disease management [63]. Taken together, this body of research demonstrates that green and blue spaces are associated with improved health and should be considered as a component of existing approaches to the prevention and improved management of NCD's.

To date there has not been a systematic effort to incorporate these green and blue space pathways into a formal set of recommendations, interventions, and patient health self-management activities. The purpose of this paper is to present a systematic model that incorporates green and blue space, physical activity, stress management/relaxation and social connectedness into a Green and Blue Wellness™ Program that will serve as a guide to health care providers in developing wellness interventions and programs as well as a resource for individual consumers interested in learning these approaches on their own to promote health self-management. This program will incorporate nutrition under the umbrella of green and blue health, based on USDA dietary guideline recommendations to increase intake of water, vegetables and fruits, nuts and seeds while decreasing intake of processed foods, sugars and red meat. In addition, the program will incorporate health technologies that have proven successful in patient condition self-management to improve health behaviors, such as mobile phone apps for health (mHealth) and wearables/sensors to record and monitor physiological activity [64].

GREEN AND BLUE WELLNESS™ PROGRAM

To date the growing body of research on green and blue spaces has not been translated into a comprehensive and practical program of recommended behavioral health interventions designed to improve physical and mental health. The Green and Blue Wellness™ (GBW) program is a comprehensive approach to improving health behavior based on a multidimensional application of green and blue spaces to health behavior. The green and blue space health component of the program incorporates existing

recommendations for increased time spent in green and blue spaces, ranging from outdoor settings (parks, beaches) to community gardens and reflecting pools, to indoor gardens and water stimuli (home fountains or aquariums). Physical activity and relaxation in green settings are integrated into the green and blue spaces to support stress reduction. Green exercise includes walking, bicycling, gardening, dancing, martial arts, yoga and related physical activities conducted in green spaces. Blue exercise includes swimming, wading, pool exercises, skiing, and ice skating. Green and blue exercise can be combined as in a hike or bike ride along a river path, or a walk on the beach followed by a swim (Table 1).

Table 1. Green and Blue Wellness™ activities.

Activity	Green Wellness		Blue Wellness	
	Individual	Community	Individual	Community
Green Space	Plant(s) Garden Digital media Visualization/imagery	Community Garden Clinic garden Public park or garden	Aquarium Fountain Digital media Visualization/Imagery	Public pool Lake River
Physical Activity	Walk Run Bike Hike Gardening Yoga, Tai Chi, etc.	All individual activities in group, class, or clinic Dancing	Bath or shower Swim Wade Boat, kayak, etc. Snow skiing Ice skating All individual activities in group, class or clinic outing	
Nutrition (USDA Dietary Guidelines)	Increase: Vegetables, especially dark-green, red and orange; Whole fruits; Beans and peas; Fat-free/low-fat dairy; Proteins (lean meats, poultry, eggs) Decrease: Saturated trans fats; Sugar; Sodium	Cooking classes; Clinic program; Online group	Increase: Water; Tea; Seafood Decrease: Drinks with sugar and artificial sweeteners (soda, energy drinks)	Cooking classes; Clinic program; Online group
Mind and Body	Mindfulness stress reduction; Meditation, yoga, tai chi, etc.; Relaxation, guided imagery and visualization; Green digital media (audio, photo, video, virtual reality)	Group class; Community group; Clinic program	Mindfulness stress reduction; Meditation, yoga, tai chi, etc.; Relaxation, guided imagery and visualization; Blue digital media (audio, photo, video, virtual reality)	Cooking classes; Clinic program; Online group
Social Support	Phone, internet calls; Home visits; Online support group; Virtual reality group	Community group; Clinic group; Park group	Phone, internet calls; Home visits; Online support group; Virtual reality group	Group class; Community group; Clinic program

The GBW program also includes recommendations for nutrition and diet. Green nutrition is focused on increased intake of vegetables, fruits, nuts, and decreased intake of processed foods. Blue nutrition is focused on increased intake of water, fruit and vegetable based drinks and reduction in sugar and artificial sweetener based drinks. Blue nutrition also includes increased intake of fish and reduced red meat. While improved nutrition is typically not directly associated with research on green spaces, it is the focus of research and a benefit of therapeutic gardening and community gardening [65]. In addition, it seems likely that it will be beneficial for individuals to conceptualize and internalize a comprehensive approach to green and blue health that includes nutrition as well as exposure to green and blue space, exercise, relaxation and social support. The objective of this program is for individuals to develop a set of values that drive health behavior change and maintenance of these changes to promote health. GBW combines elements of evidence-based approaches to health improvement such as the Diabetes Prevention Program that includes nutrition, physical activity, motivation and stress management with green space activities such as time spent in parks, gardening and other exposures to green space.

The GBW also incorporates *in vivo* and imaginal exposure to green spaces, such as listening to audio recordings of water (e.g. ocean waves, babbling brook), digital photo or video images of green space and imagery or visualization approaches that incorporate nature. Mental exercises consistent with green and blue wellness include visualization and guided imagery and Mindfulness exercises such as imaging a blue sky and clouds [66,67]. Technology applications include viewing digital photographs or videos of nature, listening to audio files of nature sounds (ocean waves, babbling brook, etc.) and web-based avatars and virtual reality video headsets with nature themes. The GBW program is designed to be delivered to individuals as a specific intervention in health care settings. A GBW program will include a health care provider trained in green and blue health, individual and group education and skills-based groups to promote education and self-management, and a population-health framework with consistent identification, evaluation, treatment and follow-up for at-risk patients. In addition, the GBW program is also available as a self-help approach in which individuals can access GBW resources on education about the benefits of green and blue spaces, recommended activities, and mHealth and wearable technology resources that are associated with improved health behaviors and outcomes [64]. The GBW is useful both as a preventive health model for individuals who are not at risk for cardiovascular, metabolic or other diseases, as well as a disease management program for individuals with one or more chronic conditions that can be improved through improved health behaviors.

GBW interventions are conceptualized on a continuum ranging from the individual to the community. Individual GBW activities include growing plants in the home, maintaining an aquarium in the home, preparing healthy foods in the home and home relaxation. GBW activities at the community level include community gardens, group social activities in local parks, clinic based gardens or reflecting pools. The community-based GBW approaches are especially recommended for individuals in need of the social support benefit. Many health care facilities maintain green and blue spaces in the facility to provide these benefits to patients. It is recommended that clinics incorporate GBW activities into their settings as a formal component of treatment, with the goal of encouraging patients to develop their own activities at home and in the community. **Table 1** provides examples of GBW activities.

EXEMPLAR GREEN AND BLUE WELLNESS™ PROGRAM

A primary care, community health or mental health clinic is an ideal place to launch a Green and Blue Wellness™ program. The population health management approach advocated by can be applied by identifying at-risk populations (e.g., overweight and obese, pre-diabetes and type 2 diabetes, depressed) and assessment of access to, and perceived quality of local green spaces. Populations can be stratified into low-, medium- and high-risk groups based on a combination of medical record data and green space exposure [56]. Identified patients will be contacted and invited to participate in the program, with an emphasis on patient engagement by explaining the concept of green spaces, and benefits of exposure. For example, a high-risk group may include patients with diagnoses of diabetes, depression and low access to green spaces.

The patient assessment will integrate information on chronic medical and behavioral conditions, and health risk factors, ideally via completion of a health risk assessment. Principles of shared decision-making with GBW decision-aids for green spaces, physical activity, nutrition and social support will be used to develop an individually tailored treatment program [68]. The GBW program recommendations will include patient education on how to increase exposure to green spaces, from the individual to the community level. The individual level includes starting/expanding a home garden, increasing time spent in local parks, shifting from unhealthy to healthy foods, and practicing relaxation. *In vivo* individual GBW activities such as listening to digital recordings of nature sounds, viewing digital photos or videos and imaginal exposure through imagery or visualization. At the community level the emphasis is on developing or improving the social relationship network. Family, friends, significant others and co-workers are all potential sources of support that will be identified with the goal of the patient recruiting others to participate in GBW activities, as well as joining existing social or educational groups consistent with GBW, such as exercise, dancing or relaxation courses. Group activities in local green spaces will be encouraged, as will creation of new green spaces such as community gardens.

The clinic will offer GBW intervention resources including a garden area, education and skills-based groups to promote green space exposure in the home and community. The GBW treatment plan will include treat to target goals such as time spent in green spaces, physical activity duration, relaxation practice time, and number of active social supports. GBW activities will be integrated with the medical and behavioral treatment plan. A dedicated GBW clinician will serve as the key point of contact for the program and follow the patient over time consistent with population health management. Patients will be encouraged to develop a GBW self-management approach that will integrate program principles into their daily routine. Patients will also be encouraged to use mobile phone apps consistent with GBW, such as exercise, nutrition, behavioral health (e.g. depression), and relaxation (e.g. mindfulness-based stress reduction). Patients will also be encouraged to use social media apps and internet to continue to develop social supports for GBW activities and to use wearables such as activity trackers to monitor and motivate health behaviors, such as walking, running or biking. Patient outcomes will be measured repeatedly over the course of treatment to evaluate individual patient response to treatment and in aggregate for overall program effectiveness.

RECOMMENDATIONS FOR GREEN AND BLUE WELLNESS™ RESEARCH

A major emphasis of GBW treatment programs is longitudinal research on the effects of increasing green space exposure on health. Baseline assessment of access, quantity and quality of green space will be compared to post-treatment measures to evaluate the impact of exposure to green and blue spaces on patient outcomes. The relative contributions of hypothesized pathways that mediate green and blue health improvements will also be evaluated. Consistent with program costs for delivering the GBW program will be calculated along with cost-savings attributable to reduced utilization of services such as emergency department visits or hospital days to calculate return on investment.

It is recommended that in addition to self-report measures of green space exposure GPS technology based measures are also incorporated into research. The WHO has published a green space indicator and data analysis toolkit [16]. The use of GPS-based measures will add objectivity and precision to measurement of green space exposure. This data can be used at the clinic level for program evaluation purposes and at the municipal level to advocate for the design of urban green spaces.

There are plans for the GBW program to be incorporated into a larger study of the impact of a green growth program in Hebei, China, a multi-stakeholder project including Arizona State University [69]. Current plans include adding GBW as a component of a broader project to apply an innovative green development model in the less developed region of Hebei, China.

SUMMARY

Research clearly demonstrated a positive relationship between exposure to green space and health, including physical and mental health, relaxation, physical activity and to social support [16]. To date there are no known efforts to consolidate this emerging body of research into a comprehensive, evidence-based and feasible set of programmatic recommendations targeted to both health care providers and individuals in the community. This paper extends the focus on traditional green and blue space activity to include nutrition, since poor diet is a leading risk factor for NCDs, and because GBW appears to provide a good heuristic for individuals to conceptualize health behaviors on a continuum from the environment to the home.

The activities in are a first effort to develop activities appropriate for clinic treatment programs and for individuals via education materials and complimented by mobile phone apps and wearables. Both clinic and consumer-based approaches to GBW are based upon principles of patient condition self-management. It is anticipated that GBW activities can be readily incorporated into existing medical and behavioral prevention and disease management programs. The goal is to demonstrate that adding green and blue space targeted activities will contribute significantly to global effort to prevent and better manage NCDs by improved health behaviors.

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