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Review Article

Gardening is beneficial for health: A meta-analysis

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ABSTRACT

There is increasing evidence that gardening provides substantial human health benefits. However, no formal statistical assessment has been conducted to test this assertion. Here, we present the results of a meta-analysis of research examining the effects of gardening, including horticultural therapy, on health. We performed a literature search to collect studies that compared health outcomes in control (before participating in gardening or non-gardeners) and treatment groups (after participating in gardening or gardeners) in January 2016. The mean difference in health outcomes between the two groups was calculated for each study, and then the weighted effect size determined both across all and sets of subgroup studies. Twenty-two case studies (published after 2001) were included in the meta-analysis, which comprised 76 comparisons between control and treatment groups. Most studies came from the United States, followed by Europe, Asia, and the Middle East. Studies reported a wide range of health outcomes, such as reductions in depression, anxiety, and body mass index, as well as increases in life satisfaction, quality of life, and sense of community. Meta-analytic estimates showed a significant positive effect of gardening on the health outcomes both for all and sets of subgroup studies, whilst effect sizes differed among eight subgroups. Although Egger's test indicated the presence of publication bias, significant positive effects of gardening remained after adjusting for this using trim and fill analysis. This study has provided robust evidence for the positive effects of gardening on health. A regular dose of gardening can improve public health.

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1. Introduction

Globally, the prevalence of the so-called "lifestyle diseases," such as heart disease, stroke, depression, diabetes, and obesity is becoming a major public health issue (Caballero, 2007; Janssen et al., 2005; Moussavi et al., 2007). It is, for example, estimated that worldwide, approximately 415 and 350 million people presently suffer from diabetes and depression, respectively, and hence both are costly to national health care budgets (IDF, 2015; WHO, 2016). Unfortunately, this trend is expected to continue for the foreseeable future as a high number and proportion of the world's population will be living in urban areas (Seto et al., 2012). Indeed, urban living is associated with various adverse health consequences, such as high-fat diets, sedentary lifestyles, and increased levels of social and psychological stress and environmental pollutants (Clougherty et al., 2007; Lambert et al., 2015; Peer et al., 2003; Sodjinou et al., 2008). As a consequence, promoting health of urban populations has become one of the most challenging issues of the 21st century (Dye, 2008; Tzoulas et al., 2007).

Nature in cities can play a key role in achieving a healthy society (Groenewegen et al., 2006; Tzoulas et al., 2007). Indeed, there is mounting evidence that direct experience with natural environments offers a wide range of health benefits (Hartig et al., 2014; Keniger et al., 2013; Soga and Gaston, 2016). Louv (2005) argued that a decrease in contact with nature results in a number of health and behavioural problems, especially for children, which in sum can constitute a "nature-deficit disorder." Recent studies suggest that daily contact with nature has a long-lasting and deep impact on health, including on depression and anxiety symptoms (Beyer et al., 2014), birth weight (Dadvand et al., 2012), diabetes, and obesity (Lachowycz and Jones, 2011), circulatory and heart disease (Maas et al., 2009), and longevity (Takano et al., 2002). It is therefore increasingly recognized that a regular contact with nature can promote human health and be used as a form of preventive medicine (Groenewegen et al., 2006).

Gardening is arguably one of the most common ways of interacting with nature and indeed is enjoyed as a popular pastime in many countries. In the UK, there are estimated to be 27 million people, approximately 40% of the total population, who actively participate in gardening (Bisgrove and Hadley, 2002). Likewise, it is estimated that in the US, 117 million people, one in three, participate in gardening (Statista, 2015), and that in Japan, 32 million people, one in four, participate in daily gardening as a hobby (Statistics Bureau, Ministry of Internal Affairs and Communications, 2011). Gardening requires, at most, a relatively small piece of land, and in many parts of the world, such gardens are today common. In the UK, it is estimated that 22.7 million households (87%) have access to a domestic garden, which comprise 432,924 ha of land in total (Davies et al., 2009). Mathieu et al. (2007) also showed that more than a third of the land in the city of Dunedin, New Zealand, was used for domestic gardens. Alongside domestic gardens, allotment and community gardens, pieces of land with plots rented by an individual or group to grow plants for non-commercial use also offer places in which people can participate in gardening. The city of Stockholm, Sweden, for example, contains approximately 10,000 allotment plots, which occupy 210 ha of land and involve 24,000 people (c.f. Barthel et al., 2010). Given the scale of gardening activities, and the apparent feasibility of accommodating them in cities and towns, these have great potential for limiting the ongoing loss of human–nature interaction—the extinction of experience (Soga and Gaston, 2016; Soga et al., 2016).

There is increasing awareness among researchers and health practitioners of the potential health benefits derived from gardening activities (Clatworthy et al., 2013; Genter et al., 2015; Wang and MacMillan, 2013). Indeed, previous studies have shown that gardening increases individual's life satisfaction, vigor, psychological wellbeing, positive affects, sense of community, and cognitive function (Gigliotti and Jarrott, 2005; Gonzalez et al., 2010; van den Berg et al., 2010; Wakefield et al., 2007; Wichrowski et al., 2005; Wood et al., 2016). Reductions in stress, anger, fatigue, and depression and anxiety symptoms have also been documented (Rodiek, 2002; Wichrowski et al., 2005; Wilson and Christensen, 2011; Wood et al., 2016). In consequence, engagement with gardening has increasingly been recognized as not only a cost-effective health intervention (Clatworthy et al., 2013) but also a treatment or occupational therapy for those with psychological health issues, so-called "horticultural therapy" (Gonzalez et al., 2010, 2011a). Despite this, surprisingly, to date no meta-analysis has been conducted to assess the consistency of the positive effects of gardening on health. There have recently been two systematic reviews of studies exploring the association between gardening and health (Genter et al., 2015; Wang and MacMillan, 2013). However, since they presented no quantitative synthesis and only focused on health benefits of allotment gardening (Wang and MacMillan, 2013) and for elderly people (Genter et al., 2015), respectively, more comprehensive and convincing evidence is still wanting. Here, we present a formal meta-analysis of research examining the effects of gardening on health.

2. Materials and methods

2.1. Terminology

As defined by the WHO (1948), health is "a state of complete physical, mental and social wellbeing and not merely the absence of disease or infirmity," we interpret "health" in a broad sense to include physical and psychological wellbeing. Positive effects on health are thus not simply the amelioration of symptoms associated with chronic illness (e.g. depression, anxiety, obesity) but include the presence of positive emotions (e.g. quality of life, life satisfaction, sense of community, happiness) and the absence of negative emotions (e.g. anger, loneliness, confusion), and the state of being able to perform the normal actions of daily life without the hindrance of both physical and psychological dysfunction. Increased physical activity level was also included as a positive health outcome, as it has proven to be a good indicator of risk for obesity-related diseases (Janssen et al., 2005). We use the term "gardening" for "an activity in which people grow, cultivate, and take care of plants (flowers and vegetables) for non-commercial use," which is not simply limited to an activity in domestic gardens but includes that in allotment and community gardens. In this study, horticultural therapy, a practice of engaging patients in gardening activities to improve their physical, psychological, and social health, was also considered as a form of gardening.

2.2. Systematic review and inclusion criteria

We focused on studies that collected data on people's health outcomes in the context of gardening, were published in peer-reviewed scientific journals after 2001, and were written in English. This study followed the PRISMA statement (Moher et al., 2009). We performed the search, assessed eligibility, and extracted data. Literature search was conducted using the PubMed database in January 2016. We used the following terms in the keyword search: *Physical activity* OR *Health* OR *Restoration* OR *Recovery* OR *Therapy* OR *Well-being* OR *Wellbeing* OR *Well being* OR *Psychology* OR *Quality of life* OR *Life satisfaction* OR *Happiness* OR *Anxiety* OR *Depression* OR *Stress* OR *mood* OR *Pain* OR *Obesity* OR *Social* AND *Gardening* OR *Allotment* OR *Allotment gardening* OR *Horticulture* OR *Horticultural therapy* OR *Community Garden*. The PubMed search resulted in 2456 records. We also ran similar queries on Google Scholar in January 2016 to identify studies that had previously been missed. We searched using all possible combinations of the above 19 health terms and 6 gardening terms (114 combinations), and examined the first 50 hits from each (5700 records in total). Studies identified through PubMed and Google Scholar were screened on title, abstract, or both, and 79 full-articles were assessed for eligibility. The eligible articles were obtained from the Internet, via the University of Tokyo electronic library, or by personal contact with the authors. To be included in