

## 绿色等于健康？ 建立高密度健康城市研究的实证基础

# GREEN EQUALS HEALTHY? TOWARDS AN EVIDENCE BASE FOR HIGH DENSITY HEALTHY CITY RESEARCH

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摘要 ABSTRACT: 虽然城市绿化能够有助于身心健康这一观点已在景观和城市规划中得到了广泛认可, 但是其仍缺乏具体的研究成果来支持。本文探讨“绿色植被”和健康之间的关联如何在景观和城市设计的历史进程中得到发展, 并提出以明确实证为支持在城市中创建更多更高品质的绿色植被基础的迫切需要。我们就增加城市绿色植被和改善公共健康之间的诸多假设性的因果关联进行了讨论, 并根据广泛的文献综述, 对那些发现了这二者之间关联方面的近期研究予以了着重阐述。除此之外, 本文还对未来的研究方向提出了建议。

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### 摘要

虽然城市绿化能够有助于身心健康这一观点已在景观和城市规划中得到了广泛认可, 但是其仍缺乏具体的研究成果来支持。本文探讨“绿色植被”和健康之间的关联如何在景观和城市设计的历史进程中得到发展, 并提出以明确实证为支持在城市中创建更多更高品质的绿色植被基础的迫切需要。我们就增加城市绿色植被和改善公共健康之间的诸多假设性的因果关联进行了讨论, 并根据广泛的文献综述, 对那些发现了这二者之间关联方面的近期研究予以了着重阐述。除此之外, 本文还对未来的研究方向提出了建议。

### 关键词

城市绿地; 绿色植被; 公共健康; 步行; 景观; 城市规划

### ABSTRACT

The doctrine that urban greenery is positively associated with physical and mental health is widely acknowledged in landscape and urban planning, but is not underpinned by specific research findings. This paper examines how the association between “greenery” and health has developed through the history of landscape and urban design, and sets out the need for clear evidence based research as the foundation of credible arguments for the provision of more and better quality greenery in the city. We discuss the many hypothetical causal pathways between increased urban greenery and improving public health, and from a broad literature review we highlight recent research studies that have found associations between them. Directions for future research are suggested.

### KEY WORDS

Urban Green Space; Greenery; Public Health;

Walking; Landscape; Urban Planning

## 1 引言

在大多数文化、文学、民俗、宗教历史以及传统中, 绿地都与精神健康和福祉相关。

绿地常常被看作是一个思索物质世界的不同维度的地方, 这里指的是机制层面上的, 而非感官层面上的。在多数宗教典籍中, 天堂被比喻成或直接描绘为一个河流壮美、植物茂盛、绿荫浓浓、果实累累之地, 存在于未受腐蚀的远古岁月, 或正义之士的美好来世之中。例如, 在远古的法老统治时期的埃及, 宗教思想孕育了对花园的景观化, 并规定了宗教场所的植物品类。其中许多植物都具有象征意义。一些树木是神灵的象征, 例如海枣树是太阳神“拉”和生产与收获之神“敏”的象征, 棕榈树是智慧之神“透特”的象征, 桑树是爱情及欢乐之神“哈索尔”的象征, 而怪柳则象征着地狱之神“奥西里斯”<sup>[1]</sup>。在中国古代文化中, 道教的人与自然的相互关系及其潜在的和谐, 在寓意长寿和长生不老的早期皇家园林中得以体现。中医传统则是与之相同的观点, 在对植物和食物的利用方面有所体现。中国士大夫私家园林受到众多园林的影响, 其创造了追求精神和智力的乌托邦, 以及身体安康的场所<sup>[2]</sup>。从更大的尺度上来讲, 诸如长安和北京等皇城遵照风水原则, 认为宇宙和园林的力量可以有助于身心健康、强盛繁荣。北京的颐和园及其他皇家别苑通过整合周边景致, 对愉悦、放松、健康、福祉等功用的精心设计, 也体现出了类似的思想。

绿色植被与身体健康的总体和特定方面之间明确相关的议题是较近期出现的。19世纪公共空间概念的发展以及西方工业化国家对娱乐与社交空间的需求, 都受到了出于公众健康和道德福祉, 以及美学考虑的推动。纽约中央公园即是这些渊源的一个典型代表: 其设计师弗雷德里克·劳·奥姆斯特德和卡尔弗特－沃克斯明确地将公众健康作为公园创建的一大目标<sup>[3]</sup>。奥姆斯特德在美国南北战争结束之际重返景观设计界之前, 曾为美国卫生委员会的领导。而在更早开始工业化进程的英国, 其历史上的皇室和私人绿地都于19世纪和20世纪被转化为了服务于公共卫生的公园<sup>[4]</sup>。

在景观设计学科内, 克莱尔·库珀·马库斯始于20世纪90年代中期的治疗性花园将园艺实践和健康实践(如职业治疗)相结合, 强调人工设计的景观在患者康复和治疗中的重要性<sup>[5][6]</sup>。在马库斯与纳奥米－萨克斯于2014年合著的《治疗景观: 设计治疗性花园和恢复性户外空间的实证途径》<sup>[7]</sup>一书中, 汇集了可供设计人员和政策制定者建立治疗性景观的

## 1 Introduction

In the cultural, literary, folk and religious histories and traditions of most peoples, green spaces are linked to spiritual health and well-being.

Green spaces have often been seen as a place to contemplate the different dimensions of the physical world that point to mechanisms beyond the senses. In most holy books, paradise is described metaphorically or literally as possessing splendid rivers, wonderful vegetation, shade trees and sweet fruits: in the uncorrupted ancient past and as the reward for righteous people in an afterlife. In ancient Pharaonic Egypt, for example, religious ideas inspired the landscaping of gardens and dictated the kinds of plants to be grown in them. Many of the plants had symbolic significance. Trees were sacred to certain deities, for example, the date palm to Re and to Min, the doum-palm to Thoth, the sycamore fig to Hathor and the tamarisk to Osiris<sup>[1]</sup>. In ancient Chinese culture, the Taoist human-nature interrelationship and its potential harmony is expressed in early royal gardens symbolizing long life and the search of an elixir. Chinese medicinal traditions stem from this harmonic view of the world in the use of plants and food. Chinese scholar gardens drew inspiration from extensive landscape references and have been utilized to create defined spaces for the spiritual and intellectual pursuits of a utopia and physical well-being<sup>[2]</sup>. Operating at a larger scale, imperial cities such as Chang’an and Beijing are oriented on principles of Fengshui, the cosmic and landscape forces believed to promote physical and spiritual health as well as prosperity. The Summer Palace in Beijing and other imperial retreats express similar ideas, integrating with surrounding landscape and intentionally designed for pleasure, relaxation, health and wellbeing.

Explicit association of greenery with general and particular aspects of physical health is comparatively more recent. The development of concepts of public space and the need for dedicated places for recreation and social interaction in 19th Century western industrializing nations was driven as much by concerns for public health and moral wellbeing, as by aesthetic concerns. New York’s Central Park offers a dramatic representation of these origins, where designers Frederick Law Olmsted and Calvert Vaux explicitly embraced public health as an argument for the park’s creation<sup>[3]</sup>. Olmsted himself went on to be leader of the U.S. Sanitation Commission before returning to landscape design at the conclusion of the American Civil War. In the English context, where the processes of industrialization had earlier beginnings, historically royal and private green spaces were transformed to public parks in the service of public health throughout the 19th and 20th Centuries<sup>[4]</sup>.

Within the discipline of landscape architecture, Clare Cooper Marcus’ work starting in the mid-1990s on therapeutic gardens linked horticultural practices and health care practices such as occupational therapy, emphasizing the importance of designed landscapes in the recovery and treatment of patients<sup>[5][6]</sup>. In their 2014 book *Therapeutic Landscapes: An Evidence-based Approach to Designing Healing Gardens and Restorative Outdoor Spaces*, Marcus and Sachs<sup>[7]</sup> compile scientific evidence to support designers and policy makers to create therapeutic

科学依据，并呼吁将实证设计纳入景观设计之中。

我们在本文第3和第4章节中，分别通过两个问题来审视健康的绿色植被这一议题：城市绿色植被和健康之间存在怎样的假设因果关系？有哪些证据可以证明绿色植被能够改善健康？然而，我们将从这些调查的方法论的简要阐释开始。

## 2 方法论

专业的景观设计师、城市设计师和规划师往往容易遵循某些定论。正如前文所述，“绿色就意味着健康”这一观点正是一个广为认可的定论。尽管其有科学支持，但其已然成为了公认的定律，而不再需要更详细的科学调查。但是，如果我们想要了解其背后的科学，也许向这一定律发出质疑或为之辩护，又或者想要获知有关健康－绿化效应的更详细的信息，我们又应怎么做呢？

许多目前关于这一课题的研究的薄弱环节在于：1）主观测量；2）在研究设计中过分依赖案例研究；3）调查设计中样本量较小；4）缺乏预期时序数据；5）缺乏个体效应分析；6）测量绿地可达性时通常采用基于欧几里得（直线）距离的非常粗略的度量指标；7）对绿地效应的测量通常仅限于单一的、任意的空间尺度。

我们将在下文中对上述问题进行简要说明，并为绿色基础设施不同的构成、数量和品质所产生的健康效应提出一种更有力的研究设计方法。

### 2.1

无论是健康状况，还是景观干预，它们的测量往往都受到了主观影响。城市居民被询问感觉良好程度或幸福程度，景观依照测量者或调查对象的主观评价而被分级。测量者越专业，调查工具越规范并经过预测试，测量数据和结果就越可靠、越有效。但主观测量带来了大量的“噪音”（不明原因的误差），于是乎总是最好使用客观记录的数据。绿色植被的密度和构成可以通过高精度遥感图来进行测量。健康数据可以通过有根有据的公众健康或流行病学研究进行测量。由医学研究和实践团体以及景观和规划团体认真进行的流行病学研究是至关重要的。从本质上来说，客观地衡量景观品质是有问题的，因为“品质”永远指的是某些特定的价值。

### 2.2

景观/健康研究中的案例研究设计通常出于两个目的：提出假设或驳斥假设。例如，一个拥有众多长寿者的山村，或者一个特别精心设计

landscapes and call for landscape architecture to embrace evidence-based design.

In this paper we take stock of the doctrine of healthy greenery by asking two questions, addressed in sections 3 and 4 respectively: what are the hypothetical causal pathways between urban greenery and health, and what is the evidence that greenery can improve health? We start, however, with a short preamble on the methodology for such investigations.

## 2 Methodology

Professional landscape architects, urban designers and planners tend to work with doctrines. The idea that “green is healthy” is a received doctrine, as we have illustrated above. It has scientific support but it is almost too established a doctrine to require detailed scientific investigation. But if we were to want to understand the science behind it, perhaps to challenge or defend it or to be more specific about health-greening effects, how should we go about it?

The weaknesses of much current research on the subject include: 1) subjective measurements, 2) the over-reliance on case studies as a research design, 3) small sample size in survey designs, 4) lack of prospective time-series data, 5) lack of individual effects analysis, 6) accessibility to green space typically being measured using very crude metrics based on Euclidean (straight-line) distance, and 7) the effects of green space typically being measured only at a single, arbitrary spatial scale.

We address each of these briefly in the following, and point to the way forward for stronger research designs in establishing the health effects of alternative configurations, quantities and quality of green infrastructure.

### 2.1

Both health outcomes and landscape interventions are often measured subjectively. City dwellers are asked how well or how happy they feel and landscape is rated subjectively by surveyors or by survey subjects. The more expert the surveyors and the more standardised and pre-tested the survey instruments are, the more reliable and valid the data and the results. But subjective measurements introduce a great deal of noise (unexplained errors) and it is nearly always better to use objectively recorded data. Density and configuration of greenness can be measured from high-density remote-sensed imagery. Health data can be measured from well-founded public health or epidemiology studies. The latter are vital if the study is to be taken seriously by medical research and practice communities as well as landscape and planning communities. Objectively measuring landscape quality is intrinsically problematic because “quality” is always specific to a particular set of values.

### 2.2

Case study designs in landscape / health research are generally

的景观社区，那里的居民一直认为绿色环境为他们带来了健康和福祉，如果对这些地区进行“深入研究”，则可能会产生有助于建立广义原则（即理论）的观点。这些“深入研究”无法依靠其自己来测试这些原则，然而，由于采用的是案例研究设计，我们不能确定居民健康是由于绿色植被，而不是由于其他影响健康和福祉既定关系的因素。例如，其可能是由于生活在该社区的人口的住房历史，或该山村人口的遗传学因素。

### 2.3

要测试理论，就需要对那些可能影响健康和福祉的变量因素进行控制，通常采取横向，或更优的纵向调查方式。要令人信服地测试景观构成对健康的独立影响，就需要进行控制多个容易令人混淆的其他变量的大规模调查。

### 2.4

然而，即便在大数量研究中，也可能无法得出很多因果关系，只能够得出关联度的强弱。从“树的密度的增加了多少与肥胖几率降低多少显著关联”这样的陈述到“树木密度的增加促进了人们更多地步行，从而降低了肥胖几率”的陈述，所需要的不仅仅是相关性分析。其需要假设因果关系的方向上具有说服力的逻辑推导，并由建议因果关系中的中间阶段的补充性分析来加强。所以我们需要知道，例如，树的密度与肥胖几率之间的负相关性并不是因为“瘦”的人（体重指数较低）迁入树木密度较高的地区。通过控制其他因素，也有助于科学地得出树木密度与步行倾向间存在正相关性。提供因果关系证据的最可行的方法是基于案例研究和横向的相关性研究的纵向研究。这些案例研究显示，因果性假设是可以进行检验的；横向研究证明了相关性；时序分析表明与绿色植被的接触会影响健康。我们需要在实践中运用这一方法，而且该领域中的大部分理论仅仅依赖于基于案例研究的横向相关性研究，因果关系的方向仍缺乏实证，部分方向依靠的是逻辑推导，或者仅仅是主观断言。

### 2.5

许多有关景观和健康的地理学上的研究都是值得批判的，或应该被尽量规避的，这二者都与聚合问题相关。所谓“生态学谬误”（EF）是由于将一组客体的属性归结为每一个个体。所以我们对聚合数据的基础加以概括，将之运用于个体上，无论它们与该组的平均情况的相似度如何。所谓“可塑性面积单元问题”（MAUP）的产生是由于一组统

appropriate for two purposes: generating hypotheses and refuting hypotheses. “Going deep”, for example, in a study of a mountain village where many people live exceptionally long lives, or a notably well-landscaped neighbourhood where residents consistently claim health and wellbeing benefits of their green surroundings, may well yield ideas that help build generalised principles, i. e. theory. “Going deep” cannot be relied upon on its own to test such principles, however, because with a case-study design, we cannot be sure that it is the greenery and not other factors that account for the stated relationship with health and wellbeing. It may, for example, be due to the housing history of the population living in the neighbourhood, or the inherent genetics of the mountain village population.

### 2.3

To test theory, you need research designs that control for other variables that might impact on health and wellbeing, normally by cross-sectional, or better, longitudinal surveys. To convincingly test the independent effects of landscape configuration on health, controlling for multiple other confounding variables, large surveys are needed.

### 2.4

Even with a large-N study, however, it may not be possible to say much about causality; only about strength of association. To move from a statement that “an increase of tree density of X is significantly associated with an reduction of Y in the odds of obesity” to “an increase of tree density lowers the odds of obesity through encouraging more walking” requires more than correlation analysis. It requires convincing logic of the direction of hypothesised causality and it is strengthened by additional analysis of intermediate steps in the suggested causality. So we need to know, for example, that the negative association between tree density and odds of obesity is not due to a systematic tendency for “lean” people (with a low body mass index) to move into areas with high densities of trees. It also helps to establish scientifically that tree density is positively associated with the propensity to walk, controlling for other factors. The most feasible way of providing evidence of causality is longitudinal studies supported by case studies and cross-sectional correlation studies. The case studies suggest causal hypothesis that can be tested; the cross-sectional studies demonstrate the associations; and the time-series analysis demonstrates that health follows exposure to greenery. This is demanding in practice and most theory in this area relies only on cross-sectional associational studies supported by case studies, with the direction of causality left unevidenced, partially evidenced through logic, or merely asserted.

### 2.5

Many geographical studies of landscape and health can be criticised, if not undermined, by two methodological problems, both related to aggregation. The so-called ecological fallacy (EF), arises when attributes of a group of subjects are attributed to each individual. So we make generalisations on the basis of aggregated data, which we apply to

计相关结果始终与用于组织数据的聚集空间单元相关。通过尺度更小或更大的空间框架来集合个体可能会使模型系数发生变化。“会发生何种变化”便成为了我们关注的问题。以上两种方法层面上的问题都可通过模拟个体效应的方法来避免。也就是说，创建一个个体变量的研究数据库，并在可能情况下避免聚合数据。

## 2.6

要对健康和绿色植被之间的关联性进行测量，必须对可达性进行量化。这通常采用欧几里德距离。分析的地理尺度越具体，量化结果就可能越准确。依据网络对可达点进行距离测量会取得更为良好的效果，因为城市沿网络发展。在汽车、步行和公共交通网络之间进行辨识是更优的方式。因此，研究应利用网络的GIS数据和网络连通工具，如空间设计网络分析软件（sDNA）<sup>[6]</sup>和空间句法理论<sup>[9]</sup>。

## 2.7

在多种空间尺度进行网络可达性的测量和分析是解决MAUP的方法之一（此方法亦可解决网络分析中类似的问题）。这也是获取绿色基础设施的多重效应的一个很好的方式。例如，在非常局部的尺度，行道树可能会为非通勤目的的步行几率带来可测量的积极效应；然而在较大的尺度上进行测量，则不会获得通勤目的的步行的可测量效应。同样，公园用地的密度在较大尺度的分析中与更多的步行存在正相关性，但与局部尺度的步行存在负相关性，因为大型公园会让人产生不安全感，也不便于步行活动。

设计一种在方法论层面上强有力的研究调查和研究技能一样，都是概率事件。但是，这一点目前在有理有据的景观－健康研究中有所体现。大多数得到资助的健康研究都规模庞大：因为它们的资助者要求这些研究得到可观的统计数据。目前公共卫生和流行病学方面的科学家们对健康环境领域显示出了浓厚的兴趣。这似乎使得景观假设可以融入大规模的医学队列研究之中。我们认为这是一种尝试为绿色植被、健康与福祉之间的关联提供实证的研究方法。

## 3 绿地与健康的假设因果关系有哪些？

前文陈述了城市中的绿色植被的有益于健康的多种假设。在本章节中，我们将对一系列重要的假设和观点进行探索，下文将从14个方面来解析健康的绿色植被这一广为认可的学说。这些方面并不互斥，因为绿色植被对健康的影响是诸多相互关联而各异的因素共同作用的结果。本

individuals, whatever their similarity to the mean profile of the group. The so-called modifiable area unit problem (MAUP), arises because a set of statistical correlation results is always specific to the spatial unit of aggregation used to organise data. Aggregating individuals by a finer or a coarser spatial framework is likely that the model coefficients will be different. “How different?” is the question. Both methodological problems can be avoided by modelling individual effects. That is, creating a study database of individual variables and avoiding, where possible, aggregate data.

## 2.6

To measure associations between health and greenery, you have to quantify accessibility. This is traditionally done using Euclidean distance. The more detailed the geographical scale of analysis, the less likely this is to be accurate. It is far better to measure distance from identified access points on a network, since urban movement happens on a network. It is even better to distinguish between car, pedestrian and public transport networks. Studies should therefore use network GIS data and network connectivity tools such as sDNA<sup>[8]</sup> and Space Syntax<sup>[9]</sup>.

## 2.7

Conducting the network accessibility measurements and analysis at multiple spatial scales is one way of addressing the MAUP (and its equivalent in network analysis). It is also a good way of capturing the multiple impacts of green infrastructure. For example, at a very local level, street trees may have a measurable positive effect on the odds of walking for non-commute purposes; while measured at a coarser scale, they may have no measureable effect on commute-based walking. Similarly, the density of park land may be associated with more walking at a coarse level of analysis but have a negative impact on local walking because big parks prevent barriers to safe and convenient pedestrian movement.

Designing a methodologically robust research investigation is a matter of chance and opportunity as much as research skill. However, the scene is currently set in favour of well-founded landscape-health studies. Most funded health studies are large: they need to be to achieve the statistical power required by the funders. There is currently a lively interest in healthy environments among public health and epidemiological scientists. This makes it likely that landscape hypotheses can find their way into large medical cohort studies. This, we suggest, is the way forward for studies attempting to establish evidence for the associations between greenery, health and wellbeing.

## 3 What Are the Hypothetical Causal Pathways Linking Green Space and Health?

The literature is replete with hypotheses about the health-giving benefits of greenery in cities. In this section we deconstruct the received doctrine of healthy greenery by exploring a set of principal hypotheses

章节的主要目的是明确城市绿色植被可能影响城市个体和公共健康的主要途径。本文接下来的章节将根据已发表的科学研究继续思索绿色植被和各种健康之间的直接关系。

## 3.1

绿地可以调节极端大气温度，从而降低了极端大气温度可能带来的健康风险。绿地不仅可以减少局地的城市热岛效应<sup>[10]</sup>，其调节范围还能延伸至周边几百米<sup>[11]</sup>。举例来说，在针对英国默西塞德的一项研究中，植被覆盖率大于50%的地区比植被覆盖率小于15%的城市地区温度平均低7°C。<sup>[12]</sup>近期有关特拉维夫的一项研究表明，树木具有显著的冷却气温效应：树木可以使一条繁忙的街道的气温降低1°C，可以使一个0.15hm<sup>2</sup>的小花园的气温降低4°C。<sup>[10][13]</sup>在很多国家，城市热浪成为了夏季居民死亡的原因，而且长期热应激还会对健康产生其他影响。

## 3.2

绿地可以通过蒸发降温来提升热舒适性。雷姆·科德尔的报告称，一块面积约为809m<sup>2</sup>的住宅用地，如果其植被覆盖率达30%的话，那么其蒸发降温的效果相当于两台中央空调<sup>[14]</sup>。此外，17%的建筑制冷可以通过树木的蒸散作用来实现。城市森林具有显著的城市降温效果<sup>[15]</sup>，绿地也已被证明能够减少热应激<sup>[16]</sup>。城市绿色植被也已被证明能够为诸如北京等干燥城市的降水量带来积极影响<sup>[17]</sup>。尽管效果会受到植被类型（树木的蒸散作用>木本灌木>草本植物）、一年中的时节、绿地规模和构成等因素的影响，但蒸发作用可以通过降低大气温度和减少过度使用空调所产生的有害排放，对健康带来重要的积极影响。

## 3.3

绿色植被可以减少炎热气候条件下城市空间中的眩光，也或许能够促进眼部健康。眩光不仅来自于太阳直接辐射，还来自于具有玻璃或浅色材料的建筑物对太阳光的反射。树木在遮挡日光和提供荫蔽方面尤为重要。<sup>[18][19]</sup>

## 3.4

树木可以引导气流，减少风的影响。<sup>[20]</sup>风量受风速、风廓线和湍流度的影响。<sup>[19]</sup>树木可以对风进行阻挡，从而减弱风在冬季对人类——尤其是对寒冷气候条件下的老年人——健康的威胁，以及夏季风在沙漠

and assertions, organized under fourteen headings. These are not mutually exclusive as the impact of greenery on health is multifaceted with many factors interacting with each other in combination and opposition. The main aim of the section is to identify the principal paths by which urban greenery might influence the individual and public health of cities. The following section goes on to consider the direct relationships between greenery and different kinds of health as reported in published scientific studies.

## 3.1

Green spaces can moderate extreme atmospheric temperatures, thereby lowering attendant health risks. They can reduce urban heat island effects<sup>[10]</sup> not only within a particular space, but several hundred metres outside<sup>[11]</sup>. In a study of Merseyside, UK, for example, temperatures were found to be 7°C lower on average in areas where vegetation cover was >50%, compared to urban areas where the vegetation cover was <15%.<sup>[12]</sup> Recent research in Tel Aviv showed that the presence of trees resulted in a significant cooling effect of air temperature ranging between 1°C in a heavily trafficked street to 4°C in a small garden of 0.15 hm<sup>2</sup>.<sup>[10][13]</sup> Urban heat waves are responsible for summer deaths in many countries and long-term heat stress has other impacts on health.

## 3.2

Green spaces can enhance thermal comfort through evaporative cooling. Coder reports that as much heat is dissipated on a fifth of an acre house lot (approximately 809m<sup>2</sup>) with 30% vegetation cover, as running two central air conditioners<sup>[14]</sup>. Moreover, a 17% reduction in building cooling can be achieved by active evapotranspiration from trees. Urban forests have a distinct cooling effect on the city<sup>[15]</sup> and green spaces have been shown to reduce heat stress<sup>[16]</sup>. Urban greenery has also been shown to positively influence precipitation in dry cities such as Beijing<sup>[17]</sup>. Although effects vary with vegetation type (evapotranspiration in trees > woody shrubs > grass), time of year, and size and configuration of the green space, active evaporation makes an important contribution to health both by reducing atmospheric temperature and by reducing the amount of harmful emissions produced from the excess usage of air conditioning units.

## 3.3

Greenery reduces glare in urban spaces in hot climates and may be expected to have benefits in respect of ocular health. Glare is not only a problem of direct solar radiation, but of reflections of the sun from buildings constructed of glass and light coloured materials. Trees in particular are important in screening and creating shade.<sup>[18][19]</sup>

## 3.4

Trees can direct airflow and mitigate the effects of wind.<sup>[20]</sup> Wind flow is a function of wind speed, wind profile and turbulence.<sup>[19]</sup> Trees block winds that can bring winter health hazards, especially for the

气候条件下对人类健康的威胁。树木也可以防止漏斗气流。无论是垂直方向还是水平方向上的叶片密度都可以改变气流运动。在天气寒冷的地区，树木可以通过策略性地种植在建筑物周围，以起到防风林的效果；树木通过阻挡风雪，可节省高达25%的供热成本<sup>[21][22]</sup>。老年人往往会减少取暖以降低成本，因而，这种能够如此显著地降低取暖需求的做法可能在某些时候会起到救命的作用。

### 3.5

城市绿色植被能够为城市生产生命所必需的O<sub>2</sub>。植物能够吸收空气中的CO<sub>2</sub>，在日间产生O<sub>2</sub>，这使得空气得到了净化。单位面积产氧量取决于植被密度、种类、叶片直径、植被健康状况和生长率。据估计，美国城市绿色植被每年可产生O<sub>2</sub>约6 100万吨，这相当于2 / 3美国人口的年耗氧量。<sup>[23]</sup>一个普通成人每年消耗O<sub>2</sub>约175k g，而举例来说，一棵健康的成年白蜡树（约9.0m高）每年可以生产O<sub>2</sub>近113k g，这意味着两棵树便可以提供一个成年人的年需氧量。<sup>[24]</sup>

### 3.6

绿色植被可以减少空气污染物和颗粒物<sup>[25]</sup>。城市森林，例如中国的“绿色长城”三北防护林，可以通过降低气流速度使颗粒物沉降到地面，来改善城市空气质量。城市森林还可以通过叶片气孔吸收正常气体成分来减少空气中的气态污染物。据估计，落叶树可以吸收空气中9%的微粒，而常绿树可以吸收13%的微粒。树木还可吸收空气中的部分氮氧化物、二氧化硫、一氧化碳、二氧化碳、臭氧和直径小于10μm的颗粒。此外，绿地在吸收甲烷方面也扮演着重要角色。<sup>[26]</sup>

### 3.7

绿色植被有助于“捕获”空气、土壤和水中的污染物，以便它们可以得到有效治理。植物修复，即“利用植物来净化或修复被污染的土壤、污泥、沉积物和地下水”<sup>[27][28]</sup>，已在过去的20年中在欧洲和北美地区得到了广泛应用，以解决原工业和采矿场所的污染问题。相较于其他净化技术而言，植物修复作为一种自然、被动的环境治理形式，兼具美学和经济优势。

elderly in cold climates, and block summer winds in desert climates. They can also be planted to funnel airflow. Both vertical and horizontal concentrations of foliage can change airflow movement. In cold weather areas, trees can be strategically placed around buildings to act as windbreaks, and against wind and snow to reduce heating costs by as much as 25%<sup>[21][22]</sup>. Elderly people are prone to reduce heating to cut costs, so such significant reduction of heating demand is likely to be lifesaving in some circumstances.

### 3.5

Urban greenery generates vital oxygen for the city. Plants have a vital role in absorbing carbon dioxide from the air and producing oxygen during the daytime, contributing to the process of air purification. The amount of oxygen produced per acre depends on factors such as density, species, foliage diameter, plant health and rate of growth. Urban greenery in United States is estimated to produce approximately 61 million tonnes of oxygen annually, which is considered to be enough to offset the annual oxygen consumption of approximately two-thirds of the U.S. population.<sup>[23]</sup> A typical adult consumes 175kg of oxygen annually, while a healthy mature ash tree (approx. 9.0 m high), for example, can produce nearly 113kg of oxygen annually, which means that two trees can supply the annual oxygen demand of an adult person.<sup>[24]</sup>

### 3.6

Greenery can reduce air pollutants and particulates<sup>[25]</sup>. Urban forests, such as China’s Great Green wall, (Three-North Shelter Forest Program, 三北防护林), improves the urban air quality by slowing air flow and allowing particulate materials to settle to the ground. They can also remove gaseous pollutants by absorbing them with normal air components through leaf stomata. It has been estimated that 9% of particulates can be removed when air passes across deciduous trees and 13% when it passes across evergreen trees. Pollutants that may be partially controlled by trees include nitrogen oxides, sulphur dioxides, carbon monoxide, carbon dioxide, ozone and small particulates (<10 microns). Green spaces have also been noted as making significant contribution to methane uptake.<sup>[26]</sup>

### 3.7

Greenery can help capture air, soil and water borne contaminants so that they can be treated effectively. Phytoremediation, “the use of plants to clean up or remediate contaminated soil, sludges, sediments, and ground water through contaminant removal, degradation”<sup>[27][28]</sup> has been widely used in Europe and North America in the last 20 years, to address problems of polluted former industrial and mining sites. As a natural and passive form of environmental remediation, it can have both aesthetic and economic advantages when compared to other clean-up technologies.

### 3.8

一定距离的绿色叶片（以及粗糙地表）能够使噪音衰减，对听觉和心理健康都有所裨益。树墙可以阻隔噪音，<sup>[29]-[31]</sup>而且通过反射和吸收噪音，30.48m宽的林带可以使噪音降低7分贝（同等宽度的实体墙可以降低15分贝）。<sup>[14]</sup>此外，树木在对噪声的感知方面亦有很强的效应<sup>[32]</sup>。风吹过树叶的时候也会产生白噪声，它可以掩盖人为的声音并舒缓压力。阿尼塔·戈道夫-冈纳森和艾维·奥斯多姆发现，更多地接触绿地可以减少长期噪音滋扰，这将增加福祉并减少与压力有关的心理疾病患病率。<sup>[33]</sup>

### 3.9

绿地可以维护动植物的生物多样性，并带来相关的心理健康和福祉效应。英国第一批维多利亚式的公园——例如建于1847年的伯肯黑德公园和建于1854年的水晶宫公园——旨在营造一种可供人们休息、放松的，丰富多样、趣味盎然的自然环境，成为工业城市中居民的避世之所<sup>[34]</sup>；这一愿景已在世界各地的城市公园中广为效仿。<sup>[35][36]</sup>不幸的是，许多公园都以观赏效果为管理目的（引入了许多外来物种），这抑制了生物多样性和生态相关性。与公园所营造的自然环境接触、保护自然生态的愿望，以及对于可持续原则（“绿色环保资质”）的个人信仰，都有助于提升幸福感。自20世纪70年代的生态运动开始，人们逐渐运用基于生态的景观手法来处理城市场地，这其中包括目前众多关于对冗余基础设施进行适应性再利用的景观都市主义的方案和项目。城市中自然景观（例如森林、河道等）的边角地区、公共地区中无法达到的区域（例如沿着大型公路和铁路的廊道），以及运动场所中的景观区域（例如高尔夫球场），这些也可以增加城市的生态多样性，尤其是当这些场所被串联为一个城市绿地网络时。<sup>[37]</sup>

### 3.10

绿地能够营造出一种自然的氛围，将连接生物物理世界与城市环境联系到了一起。观察植物生长和季节更替中的自然循环，尤其是叶生叶落、春华秋实，能够实实在在地为城市居民带来心理健康和福祉。相反，不经常接触这些自然的环境和过程可能导致儿童出现“自然缺失症”，以及抑郁症、肥胖和主注意力涣散等疾病。<sup>[38]</sup>绿地可以令孩子们积极地玩耍，并与自然环境互动，能够促进儿童精神健康以及日常健康。诸如造“小房子”等活动对儿童的行为/运动体能发展尤为重要<sup>[39][40]</sup>，然

### 3.8

Green foliage (and rough ground surface) attenuates noise over distance, providing both audio and mental health benefits. Walls of trees act as noise isolators,<sup>[29]-[31]</sup> and by reflecting and absorbing sound,forest trees can decrease noise by 7.0 dB per 30.48 m width (compared to 15 dB for solid walls).<sup>[14]</sup> They have also been found to have a strong effect on the perception of noise<sup>[32]</sup>. Wind passing through tree leaves also provides white noise, which can mask man-caused sounds and relieve stress. Gidlof-Gunnarsson and Ohstrom<sup>[33]</sup> found that better access to green space reduced exposure to long-term noise nuisances which promoted well-being and reduced the prevalence of stress-related psychosocial symptoms.

### 3.9

Green spaces preserve floral and faunal biodiversity, with plausible mental health and well-being effects. Britain’s first Victorian parks, such as Birkenhead Park (1847) and Crystal Palace Park (1854), were built as a facsimile of nature to provide rich, stimulating places for rest and relaxation as a refuge for inhabitants of the industrial city<sup>[34]</sup>; a vision that has been repeated in public parks in cities around the world.<sup>[35][36]</sup> Unfortunately, many parks are managed for ornamental effect (with many exotic species), which suppresses biodiversity and ecological relevance. Contact with the perceived naturalness of the park, underpinned by desires to preserve the natural ecology, and personal beliefs in sustainable principles (green credentials), all contribute to feelings of well-being. Since the Ecological Movement in the 1970s there has been an increasing interest in ecologically based landscape treatments for urban sites, which now encompass many landscape urbanism proposals and projects for the adaptive reuse of redundant infrastructure. Remnant areas of natural landscape (forests, river corridors, etc.) in the city, vegetation in publicly inaccessible areas such as along major road and rail corridors, and landscape based sports grounds such as golf courses, also add to the ecological diversity of the city, especially where these can be linked within a network of urban green spaces.<sup>[37]</sup>

### 3.10

Green spaces provide a sense of nature, linking the biophysical world with the urban environment. Seeing plants grow and observing the natural cycle of life in the rhythm of the seasons, particularly deciduous tree leaf growth and fall, flowering and fruiting, plausibly brings mental health and wellbeing benefits to urbanites. Conversely, limited exposure to these natural environments and processes can result in a “nature-deficit disorder” associated with depression, obesity and limited attention capacity in children.<sup>[38]</sup> Green spaces allow children to play energetically and interact with a natural environment, enhancing mental well-being, as well as day-to-day health. Activities such as building “dens” are especially important for behavioural / motor fitness development<sup>[39][40]</sup>, though the “touching nature” experience so often denied to high density urban children. Significant benefits to mental and physical health from

而这种“触摸大自然”的经验却是高密度城市中的孩子们常常无法获得的。有证据表明，与树木接触会明显促进精神和身体健康，对精神和身体残疾者来说尤为如此（这开启了生态疗法/园艺疗法/树辅助疗法等思路）。<sup>[41][42]</sup>

### 3.11

城市绿地越来越多地成为食品生产的景观。园艺是一种治疗活动，城市居民可以从他们与自然的接触，以及更积极的可持续生活中获得社交和心理裨益。城市农场为在城市中进行健康、活力的户外活动创造了宝贵机会。利用城市中的边角空间开展都市农业正在西方城市中日益流行，其在东欧和北美锈锈地带（美国北部衰败或萧条的工业区）的萎缩城市中更为普遍。在中国城市中，快速的城市扩张往往使新城区出现大片大片的农田，在过渡期内这种现存的农村社区将会与新城并存。

### 3.12

绿地对于意识形态和精神层面也具有重要意义，这可能影响身心健康。“景观是文化上的价值观、理想、愿望、希望和梦想的象征。人们创造并解读景观中的文化意义，它所隐含的哲理，以及其自我认知。景观是文化及其希望与梦想的实体表现”<sup>[43]</sup>。当谈到绿地元素的象征意义时，约翰·洛赫认为，绿地在历史上一直是冥想和沉思的象征性场所。精心管理的绿地历来象征着财富和权力（例如私人屋苑、皇家公园、教堂和庙宇场所），相比之下，城市周边的零散的自然景观——例如森林——即使在今天仍被普遍认为是缺乏安全感的地方。<sup>[43]</sup>

### 3.13

绿地被认为可以减少压力以及因压力引起的偶发过激行为，而这可能影响心理健康和福祉。绿色植被有助于人们放松和精神恢复，并从而减少攻击和暴力行为。安格尼斯·范登伯格等人指出，亲近绿地可以降低压力程度<sup>[44]</sup>。绿地也使得人们在户外聚集，从而增强了监督并抑制了违法犯罪行为的发生。尽管公园已被视为反社会行为（吸毒、卖淫、暴力袭击）的潜在发生地，并会使得女性产生恐惧。<sup>[45]</sup>然而，大面积的城市绿地可以增强社会安全感和社区氛围<sup>[46]</sup>，并有助于提升社会包容性。<sup>[47]</sup>对伦敦的一项研究发现，那些可以提高城市生活的积极品质、创造各种机会和不同环境、提升社交能力和文化多样性的开放空间最具价值。<sup>[48]</sup>此外，房屋和公寓周边精心维护的花园空间可以提高地区占有性，也说明当地的业主和居民注重并监管自己及他人财产，这能够起到

contact with trees have been recorded, particularly for the mentally and physically disabled (leading to the ideas of eco-therapy / horticultural therapy / tree assisted therapy).<sup>[41][42]</sup>

#### 3.11

Urban green spaces are increasingly being seen as landscapes for food production. Gardening is a therapeutic activity, and urban dwellers can derive social and psychological benefits from their interaction with nature and more positive association with sustainable living. Urban farms create valuable opportunities for healthy, vigorous outdoor activity in the city. Urban farming in residual spaces is a growing movement in western cities. The movement is on a larger scale in the shrinking cities of Eastern Europe and rust-belt North America. In Chinese cities, rapid urban expansion often leaves tracts of farmland marooned within the new city, and for a transitional period the extant rural community co-exists with the new city.

#### 3.12

Green spaces have ideological and spiritual importance, which may impact on mental and physical health. “Landscape is seen as a symbol of the values, ideals, aspirations, hopes and dreams of a culture. People encode and decode landscape meanings about the culture, its underlying philosophies, and its self-perception. The landscape is the physical expression of the culture, and its hopes and dreams”<sup>[43]</sup>. When it comes to the symbolic meanings of green spaces elements, Motloch suggests that green spaces have historically been symbolic places of meditation and contemplation. Managed green space has traditionally been symbolic of wealth and power (private estates, royal parks, church and temple grounds), compared to remnant natural landscapes near cities, such as forests, which even today are commonly considered as places to fear.<sup>[43]</sup>

#### 3.13

Green spaces are thought to lessen stress and casual aggressive behaviour resulting from it, with possible impacts also on mental health and wellbeing. Greenery helps people to relax and renew, which consequently reduces aggression and violence. Van den Berg et al.<sup>[44]</sup> noted that proximity to green space reduces stress levels. Green spaces also bring people together outdoors, increasing surveillance and discouraging criminal acts. Parks have been seen as possible venues for anti-social behaviour (drugs, prostitution, physical assault) and found to generate fear in women.<sup>[45]</sup> However, large areas of urban green space have been noted to increase feelings of social security and sense of community<sup>[46]</sup> and to contribute positively to social inclusion.<sup>[47]</sup> A study in London found that the most highly valued open spaces were those that enhanced the positive qualities of urban life; the variety of opportunities and physical settings; and sociability and cultural diversity.<sup>[48]</sup> Furthermore, the well-maintained and groomed appearance of garden spaces surrounding houses and apartments enhances territoriality and is a cue to criminals that owners and residents care about their property and watch over it and each other, which has been

震慑犯罪分子、提高安全性的作用。<sup>[49]</sup>弗朗西斯·郭和威廉·苏利文在他们的研究中称，生活在更绿色的环境中的居民感到恐惧的程度较低，他们的不文明行为，以及发生攻击性和暴力行为的经历也较少。<sup>[49]</sup>

### 3.14

在路旁或中央隔离带种植的树木可以减少事故的发生。最近的观点认为，城市行道树所形成的树墙可以使道路更加明确，在指示方向和引导驾驶者的行车方面非常重要<sup>[50]-[52]</sup>。行道树可以有于司机估算他们的行驶速度，并有助于界定车道边界，从而起到降低车速的作用。树木在车辆和行人之间形成了一种环境上的分隔，提高了行人的安全感。即使在驾驶失误的情况下，行道树也可以起到使车辆转向或停止的作用，从而避免人员伤亡。很多对街道安全的研究表明，有行道树的街道在发生道路交通事故和整体碰撞时，其严重程度要远远低于没有行道树的街道。<sup>[53]-[55]</sup>

上述研究提供了大量证据证明绿色植被的普及，乃至其具体构成，和与城市居民健康相关，及有益于城市居民健康的多种表征、现象之间存在可测量的关联。

## 4 何种绿地与健康直接相关的科学实证得到了建立？

一项就世界卫生组织欧洲健康城市网络所涉及的城市所进行的调查表明，不同的城市中绿地的可达性存在巨大差别。在对选定城市的一项国际性研究中，布鲁塞尔、哥本哈根和格拉斯哥这些北欧城市中的几乎所有居民都可以在15分钟内到达附近的绿地，而在布拉迪斯拉发市和基辅市，这项数据只有47%<sup>[56]</sup>。相较于公共绿地已成为城市规划主流时所建造的新城来说，那些较古老的城市中绿地率往往较低。这些城市中公共和私人绿地、大型和小型公共绿地的比例差异也非常之大。例如，伦敦私人绿地的比率很高，而且伦敦的诸多大型公园（面积大于20hm<sup>2</sup>）也使得其拥有了很高的公共绿地率。<sup>[57]</sup>在下文中，我们对一部分研究进行了梳理，这有助于我们发现景观干预对健康的影响的系统性科学实证基础。

在对澳大利亚昆士兰州罗克汉普顿市1 281名居民的身体活动进行的一项研究中，迈克尔·邓肯和凯瑞·马默里指出，相对于那些距离最近的公园小于600m的居民来说，距离最近的公园超过600m的居民每天的身体活动量达到建议水平的比例要高出41%<sup>[58]</sup>。此外，相对于那些无法

shown to deter criminals and increase safety.<sup>[49]</sup> In their study Kuo & Sullivan reported that residents living in greener surroundings report lower levels of fear, fewer incivilities, and less experience of aggressive and violent behaviour.<sup>[49]</sup>

### 3.14

Trees in roadside planting strips and medians can reduce accidents. Recent arguments<sup>[50]-[52]</sup> suggest that urban street trees can create vertical walls that frame streets and are important in give directional cues and in guiding the movement of motorists. They help drivers to assess their speed and provide a defined edge to the carriageway that leads to speed reductions. Trees create a better distinction and separation between the motorists’ environment and that shared with pedestrians, improving feelings of pedestrian safety. Even in the case of driving errors, street trees help deflect or stop the motorist from taking human life. Many studies of street safety comparisons indicate significant reductions in run-off-the-road crashes and overall crash severity when street tree sections are compared with equivalent treeless streets.<sup>[53]-[55]</sup>

Studies such as these provide a wealth of evidence supporting the proposition that prevalence of greenery and even its specific configuration has measurable association with multiple phenomena that may be expected to correlate with and contribute to the health of city dweller.

## 4 What Scientific Evidence Has Been Established in Directly Linking Green Space to Health?

A survey of cities participating in the WHO European Healthy Cities Network has highlighted the stark cross-country disparity in accessibility to green space. In an international study of selected cities, almost all of the Northern European residents of Brussels, Copenhagen and Glasgow could access neighbourhood green space within 15 minutes, while only 47% of those in the cities of Bratislava and Kiev could do so<sup>[56]</sup>. Older cities tend to have a lower proportion of green space than those that have been laid out since public green space has been main stream in urban planning. The balance between public and private green space and large and small public green space can vary greatly. London, for example, has a very high proportion of private green space and a significant proportion of the public green space is associated with large parks (>20 hm<sup>2</sup>).<sup>[57]</sup>In the following, we survey a selection of studies that help found a more systematic scientific evidence base of the health effects of landscape interventions.

In a study of the physical activity of 1,281 residents of Rockhampton, Queensland, Australia, Duncan and Mummery reported that respondents having the nearest parkland beyond a network distance of 0.6 km had a 41% higher odds of achieving recommended levels of daily physical activity compared to those with parkland within that distance<sup>[58]</sup>. Conversely, respondents with direct route connectivity to the nearest parkland were 41% less likely to achieve sufficient levels of

直接达到疏林草地的居民来说，可以直接达到最近的公园的居民达到充足身体活动量的比例却要低41%。

贾尔斯·科尔蒂等人还发现，拥有良好可达性的公共开放空间对人们步行起到了促进作用<sup>[59]</sup>。

在对南加利福尼亚州来自12个社区的3 173名9~10岁的儿童进行的一项跟踪调查中，詹妮弗·沃奇等人报告称，儿童居住地500m范围内的公园空间的面积，以及10km范围内的娱乐项目的数量，都会对儿童的体重产生影响<sup>[60]</sup>。

托马斯·尼尔森和卡斯滕·汉森采用自我报告的方式，对其自身与8类绿地的距离，以及前往它们的频率进行了记录<sup>[61]</sup>。他们称，前往那些公共可达的绿地，以及私人花园或住宅周围的公共绿地，与减少压力和降低肥胖发生概率存在关联。然而，在该研究中，使用绿地的频率无法说明绿地和健康之间存在关联。这表明，部分类别的绿色植被的健康价值至少具有某种“保留价值”——可享用，却无法实际使用。这一未经彻底研究的假设对景观设计来说具有潜在的重要意义。

一个与此相关的潜在问题是，绿地中的休闲活动往往是被动的，即步行，而且出行中的往返路段可能会是重复的。公共开放空间的邻近度和吸引力并不一定与公共开放空间可否步行有关。<sup>[62]</sup>此外，有组织的体育运动（主动休闲）往往不发生在绿地中。在诸如香港等高密度城市中，主动休闲很少出现在绿地中的原因是休闲空间要求坚硬的地表。

安德鲁·斯基等人对公园作为身体活动场地和作为相互邻近的多用途场地之间的关系进行了研究。研究发现多种使用形式会妨碍公园的使用<sup>[63]</sup>。报告称，相较于那些空间利用多样性高、设施多的社区公园来说，那些空间利用多样性低但拥有较多设施的公园更多地被人们用于身体活动。

一些研究发现了绿色植被与步行倾向之间的关联。乔兰达·马阿斯等人指出，如果人们1~3km范围内拥有更加绿色的环境（包括农业绿地和自然绿地），他们则具有更高的自我感知健康状况<sup>[64]</sup>。据观察，绿地和健康之间的关系在社会经济地位较低的人群，以及青年和老年人群中体现得更加明显。

菲利普·特皮得等人采用归一化植被指数（NDVI）的平均值，通过卫星图像对受访者住宅1km范围内的景观绿色区域进行了测算<sup>[65]</sup>。有趣的是，其绿色区域分值与身体活动呈现负相关性。由于高密度和错综复杂的城市形态，绿地对身体活动的相对影响在该研究中显得并不那么显著。

詹娜·提尔特等人采用客观测量和自我评估的方式对目的地可达性

physical activity than those who resided in areas having indirect route connectivity to parkland.

Giles-Corti et al. also found that good access to large attractive public open space was an encouragement to walk<sup>[59]</sup>.

In a longitudinal study, conducted over a period of eight years on 3,173 children aged 9 to 10 from 12 communities in Southern California, Wolch et al. reported that both the area of park space within a 500 m buffer and the number of recreation programmes within a 10 km buffer of children’s homes were beneficially associated with weight outcomes<sup>[60]</sup>.

Nielsen and Hansen employed self-reported measures of distance to eight categories of green areas, as well as frequency of visits to them<sup>[61]</sup>. They reported that proximity to publicly accessible green areas, as well as access to a private garden or a shared green area at the dwelling was associated with less stress and lower likelihood of obesity. However, the frequency of utilization of green areas in the study could not explain the association between green areas and health. This suggests that the health value of some kinds of greenery at least is a kind of “reservation value” — it is enjoyed without actually being used. This unexplored hypothesis has potentially important implications for landscape architecture.

A related underlying issue is that recreation in green spaces tends to be passive, i.e. walking, which may be duplicated in the journey to get there. The proximity and attractiveness of public open spaces is not necessarily associated with public open space related walking.<sup>[62]</sup> In addition, organized sports (active recreation) are often not in green spaces. In high density cities like Hong Kong, active recreation is seldom in green spaces as the intensity of use of recreational spaces demands hard surface covers.

Kaczynski et al. studied the relationship between the potential of a park being used for physical activity and adjacent land-use diversity and found that land-use mix may act as a disincentive to park use<sup>[63]</sup>. They reported that parks located in neighbourhoods with low land-use diversity but with a higher number of facilities were significantly more likely to have been used for physical activity compared to those having high adjacent land use diversity and high facilities.

Several studies have found associations between the amount of greenery and propensity to walk. Maas et al. noted that people with a greener environment (including agricultural and natural green) within a 1.0 ~ 3.0 km radius enjoyed better self-perceived general health<sup>[64]</sup>. The relationship between green space and health was observed to be stronger for people with a low socio-economic status, as well as for youth and the elderly.

Troped et al. measured the landscape greenness within a 1.0 km buffer of a respondent’s home in terms of the average Normalized Difference Vegetation Index (NDVI) score calculated from satellite imagery<sup>[65]</sup>. Interestingly, their greenness score was inversely associated with physical activity. The relative influence of green space upon physical activity was perhaps subordinated in this study by the presence of highly dense and intricately connected urban form.

Tilt et al. examined the impact of both objectively measured and self-

及植被情况对步行出行和体重指数（BMI）的影响进行了研究<sup>[66]</sup>。对绿色区域客观测量的基础依旧是NDVI分值。可达性的客观测量和绿色区域的主观评价结果都与每月步行出行呈现正相关性。数据显示，居住在高可达性和高NDVI值绿色区域的受访者BMI较低。

虽然这些研究都倾向于对被人所感知到的绿色植被和客观测量的绿色植被之间的差异进行研究，但它们在绿地与步行倾向上得出了一致的研究成果。对绿色（通常指道路上可见的绿色区域）的感知评估已被认为是城市居民是否有意愿进行身体活动的一个很好的预测指标。<sup>[67]</sup>

除了能够促进身体活动，证据表明，接触绿地亦可以通过缓解压力、提供恢复机会，提升心理健康，以及身体活动和社会凝聚力的水平。<sup>[68]-[70]</sup>

在荷兰城市中进行的一项研究，斯耶普·德弗里斯等人的报告称，社区环境中的绿地量每增加10%，病症数量就会有所下降，但发病年龄会降低5岁。<sup>[71]</sup>

在一项针对3 114名年长市民关于绿色公共区域和长寿之间的关系的 研究中，其结果显示居住环境中拥有可步行的绿地与在此地居住5年后的长寿情况存在正相关性。<sup>[72]</sup>

在另一项研究中，通过对来自9个瑞典城市的受访者进行了953次随机取样，帕德里克·格里恩和乌尔里卡·斯蒂斯多特尔在排除了受访者的年龄、性别和社会经济状况后，对城市绿地的使用和自我评估的压力体验之间的独立相关性进行了研究<sup>[73]</sup>。在这项研究中，距离公共城市开放绿地的远近和花园的可达性被确定为关键因素。

朱勒思·佩蒂等人指出了在绿色环境中运动的重要性，令人愉悦的环境比其他任何地方都能更有益于由血压反映出的心血管健康和心理健康<sup>[70]</sup>。拥有更多氧气的绿色环境更能促进主动及被动休闲活动，而且这些绿地比起城市中可以进行同类休闲活动的其他场所来说也更为清静。

一项对澳大利亚阿德莱德市1895名成年人进行的研究报告称，对居住在能够被较好感知的绿色区域的受访者的身体活动和心理健康的促进水平分别是感知较弱区域的受访者的1.37倍和1.60倍。这一专项调查结果 为绿地具有“保留价值”的观点提供了很好的佐证：无法被感知的绿色植被与较差的健康状况之间存在紧密关联，而对能够被感知的绿色区域却没有与良好的健康状况之间存在非常紧密的关联。在这项研究中，可被感知的绿色区域与以休闲为目的的步行、社会资本和当地社区感存在独立相关性。<sup>[74]</sup>

一项在英国进行的大规模研究显示，接触更加绿色的环境的人口具

reported destination accessibility and vegetation upon walking trips and Body Mass Index (BMI)<sup>[66]</sup>. Objective measurement of greenness was again based on NDVI scores. Both objective accessibility and subjective greenness were positively associated with walking trips per month. Respondents residing in areas of high accessibility and high NDVI measured greenness reported lower body mass index.

Although such studies are subject to discrepancies between perceived greenery and objectively measured greenery, there is a consistent finding of associations between amount of green space and propensity to walk. Perceived measures of green (typically what is visible from the road) has been found to be a good predictor of intention to engage in physical activity for urban residents.<sup>[67]</sup>

Besides promoting physical activity, evidence suggests that exposure to green spaces also contributes to improved mental health outcomes via diminishing stress and providing opportunities for recovery, as well as enhanced levels of physical activity and social cohesion.<sup>[68]-[70]</sup>

In a study conducted in Dutch cities, de Vries et al. reported a decrease in the number of symptoms comparable with a decrease in age by five years with every 10% increase in quantity of green space in the neighbouring environment.<sup>[71]</sup>

A study of the relationship between green public areas and longevity among 3,114 senior citizens reported that living in areas with walkable green spaces was positively associated with longevity over the subsequent five-year period.<sup>[72]</sup>

In another study, comprising 953 randomly sampled respondents from nine Swedish cities, Grahn and Stigsdotter reported independent association between the utilization of urban open green spaces and self-reported experiences of stress after adjusting for the respondent’s age, gender and socio-economic status. The distance to public urban open green spaces and access to a garden were identified as the key factors in the study.<sup>[73]</sup>

Pretty et al. highlighted the importance of green exercise, reporting that exercise in pleasant environments has a greater effect on cardiovascular health measures of blood pressure and measures of mental health than exercising elsewhere<sup>[70]</sup>. More oxygen within green environments make them a better place for both active and passive recreation, and green spaces tend to be much less contested than other spaces available for recreation in the city.

A study of 1,895 adults in Adelaide, Australia, reported that better perception of neighbourhood greenness was associated with 1.37 and 1.60 times higher odds of reporting improved physical and mental health respectively in reference to respondents having poorer perception of neighbourhood green. This direction-specific finding sits well with the idea that green space is valued for its “reservation value”: the perceived absence of greenery correlated with poorer reported health, while the perceived presence of greenery did not correlate so strongly with positive reported health. In the same study, perceived greenness was independently associated with walking for recreation, social capital and local sense of community.<sup>[74]</sup>

A large-scale study, conducted in England, reported that the

有较低的因无收入带来的健康不平等性所致的全因死亡率和循环系统疾病死亡率较低。<sup>[75]</sup>在绿色区域最少的地区中，最贫困的无收入群体的全因死亡率的相对发病率指数是那些贫困程度相对较好的人群的1.93倍，而在绿色区域最多的地区中，该指数，为1.43倍。

在哥伦比亚波哥大市进行的一项针对老年人的研究报告中，生活在公共公园空间中的人们的自评健康程度要相对高出8%。<sup>[76]</sup>

乔·巴顿和朱勒思·佩蒂对在英国进行的共涉及1 252名受访者的10项研究进行了一项综合分析，报告称短时间内在绿色环境中进行运动，在自尊心和情绪上都具有重要裨益，且不受运动持续时间、运动强度、运动地点、运动者性别、年龄及健康状况的影响。<sup>[77]</sup>

在威尔士南部的卡菲利市进行的一项针对老年人的为期12年的前瞻性研究中，在对土地使用、街道网络可达性和个人程度协变量等因素进行校正后，并没有发现街道网络与最近的绿地之间的距离，其与BMI之间存在紧密的关联性。<sup>[78]</sup>一项横向研究发现，平均NDVI指数下500m范围内的绿色区域，仅与降低心理抑郁风险之间存在微弱的相关性；然而在对建成环境变量进行校正后，二者之间便不再存在相关性。<sup>[79][80]</sup>

## 5 结语：推进中国景观规划中的实证基础

通过前文的综述，我们可以得出的一个结论是，我们的城市需要更多的绿色植被和更多的绿地。这其中关键的是需要建立一种实证基础——正如前文所述的那些研究一样——但仅仅建立实证基础还是不够的。哪些是实证会带给我们的，而广为人知的定论所不能的？

首先，在公共健康和流行病学研究方面的更强大有力的证据基础，可以激发公共健康机构和其他利益相关群体参与到更加绿色的城市的创建中来。如果将城市景观看作是一种公共健康干预措施，以及一种规划或设计考量，那么我们可能会在城市中看到更多的绿色植被。仅从这一点来看，我们有着充足的理由来推动更为成熟的研究议程，以探究“绿色植被”和“健康”之间的关联。在更大的政策层面上，这种分析需要在健康经济学和城市经济学方面施以进一步措施。例如，我们想要知道：在抵消掉可测量的健康收益的经济价值后，创建更多的绿色植被和绿地的成本将会是多少？

由于已建成城市中用地空间紧张，因而很难在很大程度上提升其绿地量，所以我们需要为多种改造干预措施提供实证。这些措施包括：在新区和全面再开发的区域（在许多快速扩张的中国城市中或许会出现）中规定最少绿地量；通过提升我们现有绿地的品质、可持续性、可达性

populations exposed to greener environments exhibited lower levels of income-deprivation-related health inequalities in all-cause mortality and mortality from circulatory diseases.<sup>[75]</sup> The incidence rate ratio for all-cause mortality for the most income-deprived quartile was 1.93 times higher as compared to the least deprived in least green areas, while the same ratio was relatively low, only 1.43 times higher, in the greenest areas.

Older adults, in a study conducted in Bogotá, Colombia, reported a beneficial association between self-rated health and more than 8% of the land being covered by public parks paces.<sup>[76]</sup>

In a meta-analysis of ten UK studies involving 1,252 respondents, Barton and Pretty reported that acute short-term exposures to facilitated green exercise had a significant beneficial effect on both self-esteem and mood, independent of duration, intensity, location, gender, age and health status.<sup>[77]</sup>

A 12-year prospective study of older adults of Caerphilly, South Wales found no significant association between street network distance to nearest green space and BMI subsequent to adjusting for land use, street network accessibility and individual-level covariates.<sup>[78]</sup> A cross sectional study found that greenness measured by mean NDVI within a 500 m buffer was only mildly associated with lower risks of psychological distress; however, the association was lost after adjusting for built environment variables.<sup>[79][80]</sup>

## 5 Conclusions: Improving the Evidence-base for Landscape Planning in China

One conclusion from this review is that we need more greenery and more green spaces in our cities. This is important to establish from evidence such as that reported in the kind of studies reviewed above, but it is not the end of the story. Where might better evidence take us that received doctrine cannot?

For a start, a stronger evidence base that draws on public health and epidemiology studies may draw public health agencies and other interests into the call for greener cities. If urban landscape is seen as a public health intervention as much as it is a planning or design consideration, then we may expect to see more greenery in our cities. This alone is a good reason to pursue an ever more sophisticated research agenda, looking at the associations between “greenery” and “health”. For even greater policy purpose, the analysis needs to be taken further in terms of health economics and urban economics. For example, we want to know: what are the costs of providing more greenery and green space, offset against the economic value of the measurable health benefits.

As it is seldom possible to increase significantly the amount of green space within an established city due to competing demands for space, we need evidence for a variety of re-engineering interventions. These include: mandating minimum amounts of green space within new and comprehensively re-developed districts (as may be found in many rapidly expanding cities in China); making the green space we

及立体性，使之更为有效；提升城市整体绿地系统的功能性、效率、规模和连通性——例如新加坡的公园连接道网络<sup>[81]</sup>，并在为建筑物增加绿色植被的必要基础设施方面进行有意义的投资。例如，香港最近规定所有新建建筑物的植被覆盖率不得小于20%，这对于大多数场地来说只能通过绿色屋顶和垂直绿化的形式得以实现。<sup>[82]</sup>

实证还需要不仅仅关注绿地总量与人均绿地量。事实上，无论是绿地总量还是人均绿地量，在积极健康导向型绿色植被方面都采用的是粗略的测量指标。我们来想象一下两种极端情况：如果一个城市中的所有绿地实际上仅为一座大公园的话，那么距离问题将限制能够有益于积极健康的绿地的数量，其只便于公园附近的居民享用。而另一种极端情况是，如果同等绿地总量以众多小型绿地的形式分布在城市中，且每个绿地仅能容纳少量人的话，那么尽管绿地总量相同，但全市的绿地将由于品质不高的问题而可能仅产生最少的健康效应。

因此，分布便成为了一个重要问题。在一项新的开发、一个社区或整座城市中，应该如何将一定的绿色植被量进行分配呢？目前一项由本文部分作者进行的研究发现，在控制了其他影响因素的情况下，伦敦的步行出行率与绿地密度呈现负相关性。在拥有越多绿地的局部地区中，居民越少步行。这项研究将继续就对肥胖的直接影响进行研究，我们期待可以论证局部绿地密度与肥胖呈现正相关性：在控制了其他影响因素的情况下，绿地密度越高，肥胖的概率较高（BMI较高）。我们认为，该关系反映了大型公园对于步行的影响结果。伦敦周边地区的疏林草地区域抑制了步行活动，是因为单独行走在这些地区中是不安全的，而且其间的路径也时有时无。相反，在我们对伦敦的研究中，行道树的密度与步行率呈现正相关性。在另一项对英国的研究中，我们发现控制了其他影响因素的情况下，老年人居住得离绿地越远，其肥胖率越低。我们认为这很大程度上是由于英国的老年人一般不前往公园进行身体锻炼；他们来到公园后更倾向于坐下来，欣赏美景和观看社交活动。对于这部分人群来说，前往公园带来的与肥胖有关的效益似乎主要来自于往返公园的步行过程。

所以，通过对证据进行更详细的研究后发现，城市绿地和健康之间存在着微妙的关联性，在绿地的空间分布和面积分布方面尤为明显。指导城市设计师、规划师和景观设计师工作的人均绿地量测量方法一直以来都是一个非常粗略的绿色植被效益指标；事实上，它们甚至可能无法很好地运用于更具体的健康导向型景观干预措施中。让我们来思考一下人均绿地指标实际上意味着什么：如果一个拥有30万人口的城市有一个3k m<sup>2</sup>的公园，那么人均绿地量是10m<sup>2</sup>。这一结果没有任何行为意义可

have more effective by improving its quality, sustainability, accessibility, and three-dimensionality; improving the functionality, efficiency, size, and connectedness of a city’s entire green space system, for example, Singapore’s Park Connector Network<sup>[81]</sup>, and investing meaningfully in the infrastructure necessary to support greenery on buildings. Hong Kong has recently mandated 20% green cover on all new building developments, for example, which for most sites can only be in the form of green roofs or vertical greening.<sup>[82]</sup>

Evidence also needs to go beyond a focus on aggregate and per-capita quantities of green space. Indeed both total and per capita green space measures are rather blunt indicators of actively health-inducing greenery. Imagine two extremes. If all the green space in a city were found in just one large park, then the amount of actively-health enhancing green space would be significantly limited by the friction of distance. It would be limited to those living near the big park. At the other extreme, if the same total quantity of green space were distributed in many small green spaces, none of which on its own is big enough for more than a few people to sit out in, then in spite of the quantity, the city’s green space might have minimal health-inducing effects because of quality issues.

So distribution becomes an important issue. How should a given amount of greenery be distributed through a new development, a neighbourhood or an entire city? A study currently underway by some of the authors has found that the probability of making a walking-based trip in London is inversely related to the density of green space, controlling for other influences. The more green space within a local area, the less likely Londoners are to walk. This study will go on to measure the direct effect on obesity, and we expect that we may find that the density of local green space has a positive relationship with obesity: the higher the density, the higher the probability of obesity (higher BMI), controlling for other influences. The pattern is a result, we think, of the effect of large parks on walking. Large parkland areas on the edge of London inhibit walking because they are insecure places in which to walk alone and are crossed only by intermittent paths. By contrast, we have found in our London study, that the density of street trees is positively associated with the probability of walking. In another UK study, we found that the further away elderly people live from green space, the lower the odds of being obese, controlling for other factors. This, we think, is because elderly people in the UK do not generally walk to a park to exercise. They are more likely to sit down once they have arrived and enjoy the view and the social activities. The obesity-related benefits of a visit to the park for these people seem to come principally from walking to and from the park.

So a more detailed scrutiny of the evidence shows that there are subtle and nuanced associations between urban green space and health, especially important being the spatial-distribution and size-distribution of green spaces. The per capita measures that have long guided urban designers, planners and landscape architects are only a very coarse indicator of the received benefits of greenery. They may not even be a good indicator for more specific health-inducing landscape interventions.

言。一个大型城市公园通常是一个城市中最重要的公共产品之一，这实际上意味着，这个城市公园是一个能够让很多人同时共同使用的资产，而且个人的享用不会对其他人的享用造成削减。实际上，这30万人使用的是整个3k m²的公园，而不是按比例来使用。后者（按比例使用）仅在公园完全拥挤的情况下成立：例如，在伦敦的部分中心公园中，或受欢迎的度假胜地的海滩上，每个人所使用的不过是躺椅及其周边的一点行动空间而已。线性公园道的人均绿地量是非常可观的，但因其狭长的形状而无法开展很多项目。每年定期举办的巴黎海滩活动——在塞纳河河岸上营造人工沙滩——也由于其非常拥挤，随着时间的推移而逐渐被划分成供私人使用的空间，包括付费使用的户外餐厅、躺椅、娱乐空间等。可见，按比例指标的测算只有在拥挤的“公共”场所中才成立。

这将我们引向了健康和绿色植被的另一个重要的研究领域：应该如何对绿地进行管理以使其健康效益最大化。（通过公园及其他绿地的设计和建造来）提供绿地是一回事；对持续的健康效益而言，另一个同样重要的问题是所有权与管理，二者都可以影响绿地的功能和绩效。在中国，许多城市的开放空间都供给过剩。可以说，在过去30年间建造的大面积硬质和绿色公共空间是不可持续的。它们的维护成本过于高昂，它们的规模、构成和品质反映了市领导和设计师超过城市人口的需求的宏大愿望。这种局面将发生改变。这些空间也将发生改变。公共领域将萎缩，私人领域将扩大。我们如何在未来30年对中国的城市公共领域中的适应性、致密化和私有化过程予以更佳的指导？并将以何种与健康的城市人口相一致的方式进行？**LAF**

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| <b>注释</b> |
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“城市创作实验室”是香港大学建筑学院的研究和推广课程的新的“商标”。其汇集了景观的学者、建筑师、规划师、城市设计师、保护学者、房地产和施工管理者的研究和教学力量，探讨如何更好地理解、设计、生产、控制和管理21世纪的城市。而位于亚洲的城市化现象最突出的地区之一，“城市创作实验室”高度关注高密度城市的研究，并与香港大学医学系合作，致力于提出一种重要的研究议程——正如本文所述。我们与其他优秀的研究中心建立了合作伙伴关系，以探索绿地与其他城市设计及形态学上的元素对个体健康之间的可测量的关联性——是通过详细的城市设计与构成进行测量，而非粗略的数量和品质效应。在这一过程中，我们正在研发成熟的城市网络模型，从而对各种可测量的方面——包括绿地的密度、距绿地的距离、绿地的形状、绿地的均质性、绿地的绿色程度，以及绿色的类型——对健康的影响进行辨别。我们致力于运用非常大量的研究课题；医学研究人员提供的医学数据；经由卫星和其他遥感来源所得的细微尺度上的景观数据；通过道路、步行和公共交通网络的拓朴模型，对建成环境的构成和可达性进行客观测量；建筑物、基础设施和地形的3D模型；健康与建成环境的时序数据；以及在多种空间尺度下对可达性进行测量。所有这些都依赖于定量研究。因此，我们——以及我们在世界各地的合作伙伴——的目标是为健康的绿色城市提供实证基础，这将就塑造21世纪及未来的亚洲高密度城市方面，为设计师、开发商、决策者、投资者和城市管理者提供指导。我们欢迎与有意向的群体在真正开创性的城市研究方面展开合作。

Indeed, they may not even be a very good indicator of general health inducing interventions. Consider what a per-capita green space index actually means. A 3.0 km² park in a city of 300,000 provides 10 m² per person. The measure means nothing of any behavioural significance. A large urban park is typically one of a city’s most important public goods, technically meaning an asset that is co-consumed by many people at the same time such that one person’s enjoyment does not diminish the enjoyment of others. Technically, all 300,000 people consume the entire 3.0 km², not a pro-rated portion of it. The latter (pro-rata consumption) would only be the case if the park were completely congested; such is the case in some central London parks, for example, or popular holiday resort beaches where each person ends up with a space not much more than that necessary for a deck-chair and a bit of surrounding circulating area. Likewise linear parkways can be very sizeable but have far less range of programs due to their narrow shape. The seasonal Paris Plage, an artificial beach on the banks of the River Seine, has, due to its congested nature, over time been progressively partitioned into privately-consumed spaces allocated by user-fees for out-door restaurants, deck-chairs, entertainment spaces and so on. Only with congested “public” spaces does it make sense to measure supply by pro-rata indicators.

This leads to another important area of research in health and greenery: how should green spaces best be managed to optimize their health benefits. Supply (by design and construction of parks and other green areas) is one thing; another and equally important issue for sustained health benefits is ownership and management, both of which can affect functionality and performance of green open space. Many cities in China have an oversupply of open space. The vast tracts of hard and green public spaces built in the past 30 years are arguably not sustainable. They are too expensive to maintain and their size, configuration and quality reflects the aspirations of city leaders and designers more than the needs of the urban population. This will change. These spaces will evolve. The public realm will shrink and the private realm will expand. How best to guide this process of adaptation, densification and privatisation of China’s massive urban public realms over the next 30 years? And how to do this in a way that is consistent with a healthy urban population? **LAF**

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| <b>NOTE</b> |
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HKUrbanLab is the new “trading name” of the University of Hong Kong’s Faculty of Architecture research and outreach programs. It draws together the research and teaching energies of landscape scholars, architects, planners, urban designers, conservation scholars, real estate and construction managers to explore how to better understand, design, produce, govern and manage cities of the 21st century. Being located at one of the epicentres of the Asian urbanization phenomenon, it has a strong emphasis on high density city research and we have joined forces with Faculty of Medicine, The University of Hong Kong, to develop the important research agenda reviewed in this paper. We invite partnership with other centres of excellence as we explore the measurable associations that green space and other urban design and morphological elements have on individual health, not only in terms of gross quantity and quality effects, but in terms of detailed urban design and configuration. In doing this we are developing sophisticated network models of cities to identify the influence of all kinds of accessibility measures on health, including density of, distance to, shape of, homogeneity of, greenness of, and type of, green space. We aim to work with research studies using very large numbers of subjects; medical data sourced by medical researchers; landscape data at a fine scale derived from satellite and other remotely-sensed sources; objective measures of built environment configuration and accessibility modelled from topological models of road, pedestrian and public transport networks; 3D models of buildings, infrastructure and terrain; time-series data for both health and built environment; and accessibility measures taken at multiple spatial scales; all supported by qualitative studies. As such, we aim, with our partners around the world, to lay down an evidence base for healthy green cities that will guide designers, developers, policy-makers, investors and urban managers in shaping the high-density cities of Asia for the 21st Century and beyond. We welcome expressions of interest to cooperate in truly path-breaking urban research.

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