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Clinical medicine as a model for scientific rigour in urban design

Mohammad Javad Koohsari[1,2,3*], Andrew T. Kaczynski[3], Ayse Ozbil Torun[4], Emily Talen[5] and Koichiro Oka[2]

*Correspondence:
Mohammad Javad Koohsari
koohsari@jaist.ac.jp
[1]Urban Design Science for Health Laboratory, Japan Advanced Institute of Science and Technology, 1 Chome-1 Asahidai, Nomi Ishikawa 923-1211, Japan
[2]Faculty of Sport Sciences, Waseda University, Tokorozawa, Japan
[3]Department of Health Promotion Education and Behavior, Arnold School of Public Health, University of South Carolina, Columbia, USA
[4]School of Architecture and Built Environment, Northumbria University, Newcastle upon Tyne, UK
[5]Social Sciences Division, University of Chicago, Chicago, USA

Abstract
The field of urban design has generated a substantial body of scientific research across areas such as health, walkability, sustainability, and space syntax. However, the field still lacks a systematic and formalised framework to support cumulative scientific progress. Its interdisciplinary nature is sometimes misperceived as a barrier to strengthening its scientific rigour. This paper explores how clinical medicine, as an interdisciplinary field with established standards of scientific rigour, can provide lessons for urban design. Clinical medicine maintains rigour through peer review, evidence hierarchies, professional organisations, patient feedback, and expert leadership. Although the two fields are distinct in scope and disciplinary foundation, this paper uses clinical medicine as an illustrative example to show how selected principles of scientific rigour can help urban design become a more evidence-based field and less dependent on creativity and artistry.This paper does not characterise urban design as unscientific, and it recognises the substantial rigorous scholarship already present in the field. It calls for stronger mechanisms to consolidate knowledge and support accountable and cumulative progress across urban design research and practice. Setting a clear direction and advancing bold proposals for the field is nevertheless difficult, particularly because the undefined interdisciplinary nature of urban design often leaves it unrecognised among other spatial disciplines. We therefore anticipate criticism and encourage urban design scholars to engage with this discussion and contribute alternative perspectives and refinements.

Keywords Science-based urban design, Interdisciplinary field, Medical science model, Evidence-based urban design practice

1 Introduction

Urban design emerged in the mid-20th century, with major development in the 1960s and 1970s [1, 2]. Despite the existence of different definitions, scholars generally agree that urban design is an interdisciplinary field [3–5]. In this paper, cities are treated as socio-spatial systems in which built form, public spaces, and transport networks interact with social and institutional processes [6, 7]. The term 'urban design' is used to refer to professional work that guides the physical configuration of the public realm in cities, including streets, blocks, and public spaces, across spatial scales [8–10]. Urban design is also recognised as context-dependent and delivered within local governance and

regulatory constraints [11, 12]. Its interdisciplinary nature is sometimes misperceived as a barrier to achieving 'scientific rigour' in urban design due to differences in terminology, standards of evidence, and methodologies across disciplines [13, 14]. However, interdisciplinarity does not preclude rigour. Scientific rigour can be achieved through several paradigms (e.g., naturalistic and interpretive), but this paper specifically focuses on scientific rigour as understood in empirical and evidence-based terms. Elements of scientific rigour are evident in urban design research (for example, in space syntax, walkability studies, and health-related research), which have increasingly informed practice. However, we argue that the field lacks a more systematic and formalised scientific approach to consolidate knowledge and support cumulative progress. Hardy [15] stated that when modernist architects founded urban design in the 1960s, they did not prioritise scientific research, missing a chance to build consensus through careful studies. Although urban design is recognised to encompass multiple dimensions (e.g., functional and temporal) [16], some professionals often prioritise aesthetics and individual creativity, especially in urban design practice, rather than drawing on scientific methods [17]. As a result, urban design struggles to achieve cumulative progress and advance in practice despite the substantial existing research.

There have been several calls to enhance the scientific rigour in urban design [18–24]. In one of the attempts at advancement, Talen and Ellis [19] used the example of urban form to highlight the necessity for clear and normative principles to guide the profession. They critiqued the profession's tendency to avoid definitive commitments to what creates good city form and criticised the relativistic (less scientific) approaches that dominate the field. Similarly, Inam [23] criticised the urban design field as vague, with a superficial emphasis on the aesthetics of physical form. Klaasen [24] stated that urban design should overcome the misconception that creativity conflicts with science, and proposed "research by design" as a way to make designing a form of scientific research. Marshall [22] also argued that urban design theory often relies on untested hypotheses and lacks systematic validations. He called for a more rigorous approach to integrating scientific knowledge into urban design theory. In another notable effort, Talen [20], in her book 'City Rules: How Regulations Affect Urban Form', explained how codes can be used to regulate urban form and make urban design practices trackable and assessable within an evidence-based framework. The codes can also act as a constraint to the designers' and builders' personal preferences and creativity, which are not always based on science-based evidence, thereby protecting the public realm. Romice et al. [21] called for redefining urban design as a more systematic discipline grounded in an established, measurable knowledge base. In another recent attempt, Koohsari et al. [18] argued that urban design can be a science, particularly in relation to public health. Nevertheless, these authors have addressed limited aspects of scientific principles in urban design. To expand these ideas, the current paper explores how urban design can maintain scientific rigour, drawing on lessons from clinical medicine. While urban design and clinical medicine differ substantially in ontology, epistemology, and discipline heritage, this paper does not seek to conflate the two. Health can provide a clear common ground for both fields. Current evidence increasingly suggests that urban design influences health behaviours and outcomes through multiple behavioural and environmental pathways [25]. For example, residents tend to walk and cycle more if the streets are well-connected, and thus they can reach their daily destinations easily [26]. It was also found that several urban design

elements, such as land use patterns and building density, have an impact on urban heat [27], which can directly affect residents' health [28]. Further, the availability of green spaces was linked with various physical and mental health outcomes [29]. Perceived aesthetic quality may also contribute to health-related outcomes [30, 31]. For instance, a systematic review found evidence for a positive association between neighbourhood aesthetics and physical function [30]. Therefore, this paper does not argue against built environments' aesthetics as one pathway to health. Instead, it critiques an exaggerated focus on aesthetics as an end product in urban design and viewing urban design only as a means to achieve that product. Given their similar connections to health, clinical medicine was chosen as a heuristic model because it successfully integrates interdisciplinary approaches to address key health issues while maintaining scientific rigour. The intent is to show transferable principles, rather than to bring in clinical methodologies or impose universal design rules that do not account for local contexts.

2 Clinical medicine: a successful interdisciplinary model with scientific rigour

Clinical medicine is a branch of medicine that focuses on diagnosing, treating, and preventing diseases through direct patient care [32]. The word 'clinical' is usually linked with the care given at the patient's bedside and may involve a sense of urgency to act [33]. This setting supports the use of a firm protocol and standardised measures in practice. Clinical medicine reflects the nature of an interdisciplinary field by integrating knowledge and methodologies from disciplines such as biology, chemistry, pharmacology, engineering, and social sciences [34]. This combination allows clinical medicine to comprehensively deal with intricate health issues [35, 36]. In the context of health, urban design can be preventive at the population level by determining exposures and behaviours that lead to health before disease occurs. It can also be rehabilitative by reducing built environment barriers to support people living with disease, disability, or functional limitation. These could include inclusive design in new projects and modifications to existing environments, such as retrofitting. Clinical medicine can require rapid action, whereas urban design usually operates through a longer timeframe. Clinical medicine maintains scientific rigour through several mechanisms, as explained below.

2.1 Peer review with an emphasis on systematic reviews

Peer review maintains the scientific integrity and quality of clinical medicine by identifying flaws, biases, and potential conflicts of interest [37]. Through the peer review process, experts evaluate research before publication to ensure the accuracy, reliability, and scientific validity of the studies. Clinical peer review is a specific type of peer review that focuses on the evaluation of clinical practice to ensure adherence to standards of care [38]. Science-based practices and research in clinical medicine are developed through these rigorous peer review evaluations.

Another key component of scientific rigour in clinical medicine is the concept of 'pyramid of evidence'. It is a hierarchical model that organises different types of research evidence according to their methodological quality and reliability [39, 40]. The base layer of this pyramid consists of primary studies, such as cross-sectional and longitudinal studies, which offer initial perspectives. More robust evidence, including systematic reviews and meta-analyses, is placed at the top of the pyramid. This pyramid of evidence

approach synthesises findings from multiple studies to provide the foundation for evidence-based clinical medicine.

2.2 Professional organisations

Professional organisations and regulators support licensure systems and ensure that healthcare professionals meet high standards of practice [41, 42]. Examples include the General Medical Council in the UK, the American Medical Association in the USA, the Health Professions Council of South Africa, and the Singapore Medical Council. These organisations set professional and regulatory standards through education, ethical training, and clinical competence. Such a system only permits the practice of clinical medicine by qualified individuals [43], protects patients, and builds trust in healthcare systems.

These organisations also publish science-based guidelines to direct treatments and interventions in clinical medicine. One such case is the American Diabetes Association's publication, known as the Standards of Medical Care in Diabetes [44]. These guidelines offer clinicians, researchers, and policymakers key elements of disease care, treatments, and evaluation tools to assess the quality of care.

2.3 Patient feedback in a science-based framework

A successful clinical medicine practice requires effective communication with patients [45]. Medical treatment plans should be adapted based on patient feedback and needs. This is because each patient has their unique circumstances, diseases, and responses to medical procedures. This patient-centred approach improves the quality of care and treatments based on individual needs [46].

Clinical medicine uses innovations and creativity that are grounded in a robust, science-based framework to accommodate patient feedback and needs. For instance, oncologists may customise chemotherapy treatments based on a patient's genetic markers and previous treatment responses while adhering to evidence-based clinical guidelines [47]. Clinical medicine, therefore, has developed several frameworks to integrate patient feedback into practice under scientific principles. For instance, the SHARE Approach, developed by the Agency for Healthcare Research and Quality, helps clinicians align treatments with patient preferences within a scientific framework [48]. Clinician-patient interactions within a science-based framework represent an area of progress in clinical medicine over time.

2.4 Expert leadership in clinical medicine

Although clinical medicine is inherently interdisciplinary, leadership of specific projects is typically delegated to the experts most relevant to the project's main focus. For example, the interdisciplinary team for a project focused on developing a diabetes treatment plan might include endocrinologists, dietitians, psychologists, and primary care physicians. Each team member provides essential expertise, with the endocrinologist usually taking the lead [49]. Similarly, in a cardiac care team, the cardiologist leads the treatment plan for heart disease, collaborating with nurses, nutritionists, and rehabilitation specialists to provide care [50].

This team structure keeps the leadership with the clinical expert most suited to the project's primary goal and benefits from a range of expertise. It recognises that

interdisciplinary collaboration is valuable, but that not all expert opinions carry the same weight in every aspect of a project. It allows the most knowledgeable professionals to guide critical decisions and scientific rigour in their projects.

3 Adopting scientific rigour to urban design

Through the following sections, we explore how the interdisciplinary field of urban design can enhance its scientific foundation by considering selected principles from clinical medicine. The purpose is to highlight transferable principles, not a call for standardisation in urban design (a field that obtains knowledge from various heterogeneous sources). The intention is a more flexible, context-sensitive evidence framework appropriate for urban environments.

3.1 Consolidating science-based evidence

Urban design has, for a long time, been concentrating on architectural styles and aesthetic aspects, often driven by the vision and creativity of individual designers. A visible expression of this tradition can be seen in urban design competitions and awards. We recognise that urban design research and competitions are not equivalent and that competitions represent only one segment of the broader urban design practice. Their importance may be limited compared to regulatory and policy mechanisms, yet they still influence urban design professional discourse, education, and norms. While some differences have been acknowledged between architectural and urban design competitions [51, 52], in practice, most of these competitions still treat urban design in the same manner. The peer review procedures for these competitions tend to focus on artistic and aesthetic aspects [53, 54], which are usually within a non-science-based framework. They often disregard the different social, economic, environmental, and health impacts of urban design, reducing it to a tool to produce a product, typically a square, part of a street, or a multi-task high-rise complex. Such a simplistic view of urban design and its reduction to drawing and visual rendering skills (or even to decorative paintings in some cases) also discourages students and researchers from engaging in producing science-based urban design evidence.

There is ongoing criticism that several aspects of urban design could benefit from a more rigorous scientific foundation that consolidates the existing evidence-base. Several systematic reviews and meta-analyses have already been conducted on various urban design topics [55–57], but coverage is uneven, and many design-related problems face a lack of synthesis that could be a direct guide for practitioners. For instance, the optimal configuration of street layouts for mental health benefits or the most effective street designs for reducing car accidents is yet to be systematically determined [58, 59]. Although there have been some studies on these topics, they are often isolated, and there are limited systematic reviews and meta-analyses to provide robust evidence. To address these gaps, urban design can adopt a structured approach to evidence generation, similar to the pyramid of evidence in clinical medicine. The word 'structured' is not meant to imply a strict standardisation that leaves no room for the local context. It refers to inclusive, transparent, and sensitive to context evidence-based processes to support urban design practice. This can also help in the creation of urban design proposals, not just in evaluating their impacts, allowing principles to be evaluated after implementation [15]. For example, the economic, social, health, and environmental impacts of different

urban form metrics could benefit from extensive systematic reviews and meta-analyses of existing studies, similar to the approach used in clinical medicine. However, one challenge is that some professionals continue to view urban design as a 'traditional art' form and consider themselves as 'artists' [60]. This position may intensify when urban design practice does not demand rapid feedback and accountability comparable to clinical medicine, which can make the need for evidence consolidation less immediate. These professionals may also be reluctant to restrict their creative innovations to a transparent, accountable, and evidence-based scientific framework. Forsyth [4] noted that architecture and landscape architecture, which dominate much of urban design education, often regard a research emphasis as either irrelevant or a threat to professional excellence. As a result, there have been appeals to integrate urban design more closely with urban planning, with a social science framework rather than an artistic one, to better serve the public interest [61, 62].

3.2 Establishing relevant professional organisations

Unlike clinical medicine, which benefits from well-established organisations and regulators that set strict standards and guidelines, urban design, while practised at the intersection of licensed fields such as architecture and engineering, often has limited comprehensive oversight and uniformity. Several organisations, such as the American Planning Association and the Royal Town Planning Institute, have made significant contributions to the field of urban design. These bodies are primarily associated with urban planning. They are referenced here because, in many settings, urban design is often delivered through such institutions due to the absence of dedicated urban design licensing and oversight structures. These prominent examples are also from the USA and UK, whereas most of the world's largest urban regions are in Asia, and many of the fast-growing cities are in Asia and Africa. Variation in regulations and limited formal recognition remain challenges to establishing standardised practices and professional development. This is unfortunate but not unexpected for an interdisciplinary field whose existence and recognition are still overlooked, primarily by architecture and, to some degree, by planning. In the private sector, architects commonly take charge of urban design, leading to master plans, whereas in the public sector, it is primarily the domain of planners, whose work is generally based on policy with little impact on the key design issues [21]. Top-down change can occur through public-sector requirements. Public procurement and development approval processes can require evidence-based methods and accountability for urban design decisions.

Development of professional bodies offering certification, accreditation, and evidence-based guidelines can enhance the scientific basis of urban design. Such a body could be initiated through a joint task force between existing built environment-related institutes and public agencies, with input from stakeholder groups. They could certify that practitioners meet high standards of urban design competence and ethical practice. Such organisations could also develop and enforce consistent terminology, methodologies, and guidelines to ensure uniformity in urban design practice. For example, standardised guidelines for public space design in different geographical and cultural contexts, informed by systematic reviews and meta-analyses, could improve the scientific quality of urban design projects and improve the quality of life for users. Generalisability across different regions requires context-specific adaptation of these guidelines.

3.3 Stakeholder feedback in a science-based framework

Similar to clinical medicine, urban design also involves many stakeholders whose feedback and needs must be considered. Effective urban design requires understanding and integrating the needs and preferences of these diverse groups through public consultations, participatory design workshops, and community feedback sessions. While participatory approaches have been widely discussed in the urban design literature [63, 64], their consistent and systematic application in practice remains limited. In some projects, stakeholder input may be simplified or inadequately incorporated, prioritising designers' creative visions or a project's constraints. This approach undermines the potential for creating spaces that truly serve their intended purpose.

Urban design can draw lessons from clinical medicine, which demonstrates effectiveness in balancing patient feedback with scientific evidence. Stakeholder input in an urban design project should be gathered from the local community that will be affected by the project. At a minimum, the processes should involve the residents, local commercial or educational facilities, and vulnerable groups, including seniors, children, and persons with disabilities. A standard feedback process can define who is consulted, how input is documented, and how it is linked to urban design decisions and post-implementation evaluation. In clinical medicine, patient input is systematically integrated into treatment plans within a science-based framework. In contrast, standardised methods developed to collect, analyse, and incorporate stakeholder feedback into urban design remain limited. One of the few examples is the 'Our Voice' initiative that shows how structured citizen science can collect community feedback and translate it into actionable improvements in a scientific framework [65–67]. In this practice, residents use a mobile application to document neighbourhood barriers and facilitators using geolocated photographs and narratives. The observations can then be discussed in group meetings and communicated to decision makers. Beyond any single tool, regular updates of urban design guidelines based on stakeholder input and scientific evidence can meet the evolving needs of urban design users.

3.4 Leading expertise in urban design practice

Practical urban design projects benefit considerably from having the most relevant experts lead specific aspects of the project. However, ongoing issues persist where professionals without specialised training in urban design lead urban design projects. These professionals contribute valuable expertise, such as in building design, engineering, or policy, but they may not always have the necessary understanding of urban design principles. Here, the term 'urban designers' refers to individuals with formal education in urban design or closely related training with a clear urban design specialisation, and, where such a system exists, recognised professional accreditation. This clarification is important because, in most contexts, 'urban designer' is not a protected professional title, and the label is used without agreed competency standards. As a result, it is challenging to determine who should be in charge of major urban design judgements within interdisciplinary projects, since anyone can self-identify as an urban designer regardless of whether they have been formally trained or not. In practice, urban designers work across private consultancies and local government, with some also based in universities where evidence is developed and translated for practice.

Developing standards of leadership in urban design, like the protocols followed in clinical medicine, can help ensure that the most knowledgeable professionals guide critical decisions. In this analogy, the equivalent of the clinical specialist is the professional whose expertise best matches the project's primary aim, and this professional should lead the core decisions. For example, if there is a specific project about building a new commercial tower in a neighbourhood, architects can take the leadership role while collaborating with urban design experts. However, in a neighbourhood gentrification project with numerous urban form, social, and economic issues to be addressed, urban designers should take the lead, as they have the training to deal with these complexities. In a project that applies an Our Voice-style process, public health or community-engagement specialists may lead stakeholder recruitment and data collection, and urban designers lead the translation of findings into spatial urban form decisions. Adopting such leadership practices limits the dominance of professionals who may not possess the full extent of expertise required for urban design. It promotes a more interdisciplinary and scientifically rigorous approach to redesigning urban spaces.

4 Conclusions

Urban design addresses issues that directly influence people's lives and health. Advancing its scientific basis is necessary to support the development of urban practices that are less arbitrary, trackable, and assessable. Otherwise, the creativity and artistic preferences of individual practitioners will shape our cities with minimal regard for scientific principles. In this paper, we have identified key characteristics of clinical medicine that can be adopted to enhance scientific rigour in urban design. Nevertheless, the downsides of a heavily rational approach in urban design should be acknowledged. For example, the modernist urbanism movement also claimed that its designs were scientific and rational. The term modernist urbanism refers to mid-20th century approaches that relied on universal standards, functional zoning, and large-scale development [68]. However, its strong emphasis on technology and grand planning often led to many disastrous outcomes [69]. One example is the post-war wave of urban expressway schemes, justified through traffic engineering and large-scale planning. Unfortunately, such projects led to the displacement of the residents and community severance for a long time, as well as environmental degradation [70, 71]. In this context, technology means decision tools and technocratic and top-down solutionism that privilege engineering performance metrics and systems. The overly technology-focused strategies of modernist urbanism frequently resulted in dehumanising urban environments that failed to consider residents' social and emotional needs. Therefore, advocating for scientific rigour in urban design must be balanced with attention to human-centric design principles to avoid repeating past mistakes.

This paper is also not meant to suggest a direct equivalence between urban design and clinical medicine. Clinical medicine is grounded in natural science methods, whereas urban design draws on social science. The two fields operate under different ontologies, epistemologies, and disciplinary logic. For example, it is more challenging, and perhaps impossible and unethical, to conduct randomised controlled trials in urban design practice as is done in clinical medicine. A further difference concerns the time component. Clinical medicine is inherently focused on delivering fast health results, whereas urban design mostly focuses on medium- to long-term outcomes with slower decision and

implementation cycles. Additionally, this paper acknowledges that medical research, while rigorous, is not without flaws. For instance, scholars have criticised its dependency on capitalist systems that reproduce inequalities and tend to align research trends with corporate interests [72, 73]. Here, capitalist systems can be understood as funding and market incentive structures that shape research agendas and influence which evidence is prioritised for implementation [74, 75]. Clinical medicine tries to deal with these influences by using governance measures, such as disclosure requirements and audit processes that bring more transparency to how decisions are made [76]. Comparable pressures, including procurement timelines and financial expectations, can also affect urban design processes and favour decisions that are readily marketable. Furthermore, in contrast to clinical medicine, which aims to improve human health, urban design often lacks a clear goal. To apply selected lessons from clinical medicine to urban design, a consensus around normative theory (what ought to be) needs to be established in the field of urban design. Finally, this paper does not intend to dismiss the value of humanistic approaches in urban design, nor does it imply that such efforts fail to serve the public interest. On the contrary, artistic and humanistic scholarship has contributed significantly to addressing ethics, justice, and community-based decision-making in urban contexts. Mentioning a few of the professionals who consider urban design a traditional art form is not meant to generalise all creative efforts but to highlight instances where personal innovation may conflict with transparent, scientific frameworks. Evidence-based standards can define aims, performance metrics, and evaluation processes. Creativity can then focus on developing context-sensitive urban design alternatives that meet these criteria and respond to local needs.

After several decades since its formal modern origin, it is time to publicly and seriously advance efforts to strengthen scientific rigour in the field of urban design. Without scientific rigour, some professionals will persist in designing buildings and complexes to showcase their creativity and artistic vision, mislabelling it as urban design. There will be no means to systematically evaluate the merits and drawbacks of any urban design claims, proposals, or projects. Ultimately, we risk having a field in name only, with limited responsibility, weak scientific principles for evaluation, and an unclear disciplinary identity. To emphasise, this paper does not characterise urban design as unscientific, and it recognises substantial rigorous scholarship in the field. It only calls for stronger mechanisms that consolidate knowledge and support accountable and cumulative progress across urban design research and practice, given the rise of artificial intelligence (AI). However,tracing a clear direction and proposing bold new directions for a field can be difficult, particularly when the undefined interdisciplinary nature of urban design often leaves the field unrecognised amidst other spatial disciplines. It is, therefore, inevitable to run into criticism and we encourage urban design scholars to actively engage in this discussion and contribute alternative perspectives and refinements.

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MJK: Conceptualisation and writing the original draft. ATK, AOT, ET, and KO: Manuscript revisions.

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