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面向积极生活的建成环境量表比较研究

COMPARATIVE RESEARCH OF AUDIT TOOLS ON BUILT ENVIRONMENT FOR ACTIVE LIVING

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摘要

当前，慢性非传染性疾病严重影响社会整体公共健康水平，并已造成巨大的社会经济负担。大量研究表明，以促进体力活动的方式来提倡积极生活能够预防和治疗部分慢性疾病，而评测影响体力活动的潜在建成环境要素是通过环境规划设计实践促进积极生活的认知前提。本文聚焦与体力活动密切相关的建成环境量表，阐述了国际上度量体力活动的相关环境量表的编制背景、整体特征及研究现状，分析了26种环境量表的选项设置、主要度量要素、计算方式、适用范围，以及实际研究应用等，并分别对社区、开放空间、其他环境三种类型量表的具体指标内容进行说明。研究发现，虽然量表种类多样，但其编制和应用遵循特定模式，其中，设施、可达性、视觉质量、安全性是量表中常见的指标类型。通过梳理相关量表编制、分析、校验的国际经验，本文试图为中国同类环境量表的编制提供借鉴，进而为评估社区营造及健康城市建设提供参考。

关键词

量表；建成环境；体力活动；健康影响评价；城市设计；快速环境评估

ABSTRACT

Nowadays, chronic non-communicable diseases have impacted the overall public health level of societies and caused severe socio-economic burden. Empirical studies have revealed that physical activities can promote active living and help prevent and heal non-communicable diseases. Evaluation of built environment factors associated with physical activities is the precondition of promoting active living through environmental planning and design. This paper focuses on environmental audit tools related to physical activities, reviews the background, interests, and progress of international research, and compares the option forms, main measured factors, scoring methods, and application suitability of 26 audit tools. It then categorizes these audit tools into the ones for community, open space, and other scenarios, and examines their indicator items respectively. The paper concludes a preparation pattern across various audit tools, and identifies that facilities, accessibility, visual quality, and safety are the indicators most commonly measured. This paper attempts to introduce international experience of developing, analyzing, and verifying audit tools to inform Chinese research and practice and provide references for evaluating the design and construction of healthy cities or communities.

KEYWORDS

Audit Tool; Built Environment; Physical Activity; Health Impact Assessment; Urban Design; Quick Environmental Assessment

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1 引言

实现人民的身心健康是全面建成小康社会的重要内涵之一。然而，肥胖症、心血管疾病、抑郁症等慢性非传染性疾病（简称“慢性病”）已严重影响人们的生活质量。欧美国家相关部门于2000年后相继提出倡导积极生活的导则以应对健康危机，如美国提出的《积极设计导则》[1]、英国的《设计下的积极：为健康生活设计场所》[2]等。积极生活即是鼓励在日常生活中融入更多增加体力活动的生活方式，包含步行、骑自行车等慢速出行模式，或以休闲或健身为目的的运动行为等[3][4]。世界卫生组织（WHO）的调查显示，60%的慢性病的发病原因与个人生活方式有关，而体力活动的缺乏在人类过早死亡原因中排名第4，此外，中国人因体力活动不足而导致的医疗费用也呈逐年上升趋势[5]。斯科特·A·李尔发表于《柳叶刀》的研究显示，全球17个国家居民的较高体力活动水平与较低疾病风险相关，增强体力活动能够有效提升健康水平，并已成为一项简单易行、广泛适用、成本较低的全球战略[6]。

据WHO报告，公众缺乏体力活动与城市化发展及其影响下的生活方式有关[7]。在快速城市化过程中，由机动车主导的城市环境造成居民体力活动的减少，并对人的身心健康构成威胁[8][9]。19世纪爆发大规模传染性疾病的国家通过城市规划设计与管理有效控制了疾病蔓延[10]，显示出城市规划设计在维护公共健康方面的巨大潜力。如今，各种因缺乏体力活动而导致的健康问题同样可以依靠城市和建筑空间的提升得到缓解，城市规划设计者有义务且有必要对环境进行调控，从群体层面积极影响居民生活，从而提升社会的健康水平。

近年来，各领域学者已大量开展探讨建成环境与体力活动之间关系的研究，逐渐达成建成环境的品质显著影响体力活动的共识，并认可相关建成环境政策的积极干预潜力[11]~[17]。土地利用混合度、土地开发密度、目的地可达性、街道连通性，甚至设施的完备性等都是影响体力活动的潜在环境要素。度量、识别和诊断这些要素是理解其所具备的体力活动影响能力的前提条件，是结合建成环境进行积极生活干预的重要环节[18]，并逐渐成为健康影响评价的一部分。潜在环境要素的度量与识别需要着重留意并持续改进数据的可靠性、系统性、

1 Introduction

Promotion of a nation’s health level, both physical and mental, is significant for guaranteeing people’s well-beings. Chronic non-communicable diseases (chronic diseases for short) such as obesity, cardiovascular disease, and depression impact people’s life seriously. Since 2000, governments and institutions in developed countries have proposed guidelines for advocating active living to cope with such public health issues, including the Active Design Guidelines by the United States[1] and the Active by Design: Designing Places for Healthy Lives by the United Kingdom[2]. Active living embraces more physical activities, such as walking and cycling, or active recreation and fitness[3][4]. Reported by World Health Organization (WHO), 60% of chronic diseases are caused by unhealthy lifestyles, of which physical inactivity is the fourth leading factor for premature death worldwide and has resulted in a rise of Chinese people’s medical expenses[5]. Published in *The Lancet*, Scott A. Lear’s study of residents from 17 countries evidenced that a higher frequency of physical activity was associated with a lower risk of diseases; increasingly, physical activity has been proved a simple and low-cost method for promoting public health globally[6].

WHO also reported that insufficient physical activity is related to the lifestyles influenced by rapid urbanization[7], in which the urban environment has been dominated by motor vehicles, reducing people’s physical activity opportunities and threatening their mental and physical health[8][9]. In the 19th century, urban planning, design, and management played a critical role of controlling communicable diseases in many countries[10], demonstrating its great potential to safeguard public health. Nowadays, public health problems caused by physical inactivity can be mitigated through the improvement of urban fabrics and architectural spaces. Urban planners and designers ought to promote citizens’ active lifestyles with environmental interventions and to eventually improve the overall health level of the nation.

In recent years, a great number of studies among various fields together prove that the quality of built environment significantly influence people’s physical activities and recognize the potential positive effects of relevant environmental policies[11]~[17]. Specifically, environmental factors, such as mixed land use level, land development density, accessibility of destination, connectivity of urban road network, amenity / supporting facility coverage, might all impact physical activities. It makes the measuring, identifying, and diagnosing of these factors prerequisite[18] to effectively intervene physical activities with environmental approaches, which is

持续性[19]。当前国际学界主要采用自我报告、GIS及相关便携设备、建成环境量表（以下简称量表）三类工具来度量潜在环境要素[20]~[22]。其中，量表因在调研成本与数据技术门槛、度量的可靠性、适用性等方面拥有较好的平衡度而得到了广泛的发展和应用。一项对比研究表明，精确且系统的量表在理解错综复杂的环境—体力活动关系及作用方式方面具备优势[22]。同时，其相对标准化的指标体系和工作流程对于注重可行性与推广性的规划设计领域尤为重要。

然而，尽管中国学者已逐渐开始开展相关研究并呼吁将“健康”要素纳入城市规划的考量[23]~[26]，关于如何改善建成环境以促进体力活动的实证研究在城市规划领域依旧匮乏。通过全球最大的中文数据库中国知网（CNKI）检索关键词“体力活动”和“建成环境”，发现中国学者的相关实证研究主要发表于体育科学类与公共卫生类期刊，研究内容以居民主观感受为主，客观测度环境的研究较少，且所选指标系统性和精确性不足，其应用方式主要为改编[27][28]或直接引用[29][30]国际上已发展成熟的量表。鉴于此，分析和比较量表制定的目的、类型、结构、分析方法以及对于实践的指导意义，并理解这种工具体系的价值，有助于中国研究者进行对比和参照。

2 研究范围与研究方法

2.1 体力活动与建成环境的定义

体力活动是指任何由骨骼肌收缩引起的导致能量消耗的身体活动[31]，通常借助时间、频率、强度、类型和模式等刻画其特征。体力活动按强度可分为高强度、中等强度、低强度[32]；按类型可分为休闲性与交通性[33]。目前，相关研究常用体力活动水平来表征环境对健康的支持情况，并以此作为相关决策的制定依据。

建成环境是指人为创造的各类物质环境空间的总和，人的行为活动模式亦受其影响[34]。特里·皮克瑞基于社会—生态模型建立了整合建成环境要素与个体、群体体力活动水平的理论框架，从而将建成环境对居民健康的影响置于动态的但可被理解的复杂系统中，为通过干预环境促进体力活动的策略研究提供了理论基础。[35]

2.2 测度建成环境的量表工具

量表是一种综合了多项指标的测度工具，它建立在实证研究和经验性评估的基础上，以相对客观的角度、简单快捷的方法度量环境，具有严格的编制、检验和使用流程，为进行高效对比分析提供了数据基础。

本研究讨论的量表特指可系统而客观地度量影响体力活动水平的潜在环境要素特征的量表。自1998年詹姆斯·埃默里等人制定WABSA

also essential to the Health Impact Assessment. Measuring and identifying environmental indicators requires high reliability, comprehensiveness, and consistency of data[19]. In international academia, environmental indicators are often measured with Self-reports, GIS and related portable devices, and Built Environmental Audit Tools (audit tools hereafter)[20]~[22], among which the audit tools see a wider application because of their favorable equilibrium in cost, user-friendliness, reliability, and applicability. A comparative study shows that audit tools of a higher accuracy and systematism are more suitable for understanding the complicated relationship between built environment and physical activities as well as associated working mechanisms[22]. Furthermore, based on a standardized indicator system and workflow, audit tools show a high feasibility and great potential for a broader application in the field of urban planning and design.

Although health related topics have been receiving increasing attention among Chinese researchers and urban planners[23]~[26], empirical studies on promoting physical activity through the improvement of built environment are still insufficient. By searching the China National Knowledge Infrastructure (CNKI) database with keywords of “体力活动” (physical activity) and “建成环境” (built environment), gaps are found as follows: First, existing empirical studies are mainly discussed in the fields of Sports Science and Public Health. Second, most studies focus on describing residents’ subjective perception instead of scientific measurements. Third, the poor accuracy and comprehensiveness of indicators make these studies nothing but adaptations[27][28] or repeating applications[29][30] of internationally recognized audit tools and fail to conclude solid research findings. Therefore, a holistic analysis and comparison of the objectives, type, structure, analysis methods, and practical guidance of different audit tools will help Chinese researchers enhance and develop applications of audit tools.

2 Research Scope and Methods

2.1 Definitions of Physical Activity and Built Environment

Physical activity refers to human’s body movement by muscle contractions that consumes energy[31], usually measured by duration, frequency, intensity, type, and pattern. Specifically, it clarifies into vigorous-, moderate-, and low-intensity physical activity by intensity[32], or recreational and travelling physical activity by type[33]. In current studies, physical activity level is adopted as a main indicator to reveal the degree of environmental influence on human health, providing a basis for relevant planning and design decision-making.

① WABSA为量表的英文简称，全称为“步行与骑行可持续性评估”。WABSA为Active Living Research网址上最早发表的量表。POST量表的开发时间也较早，但具体时间无法确定，有网页显示其开发时间为1996年，但其开发文献于2004年才发表。这里以发表时间为准。

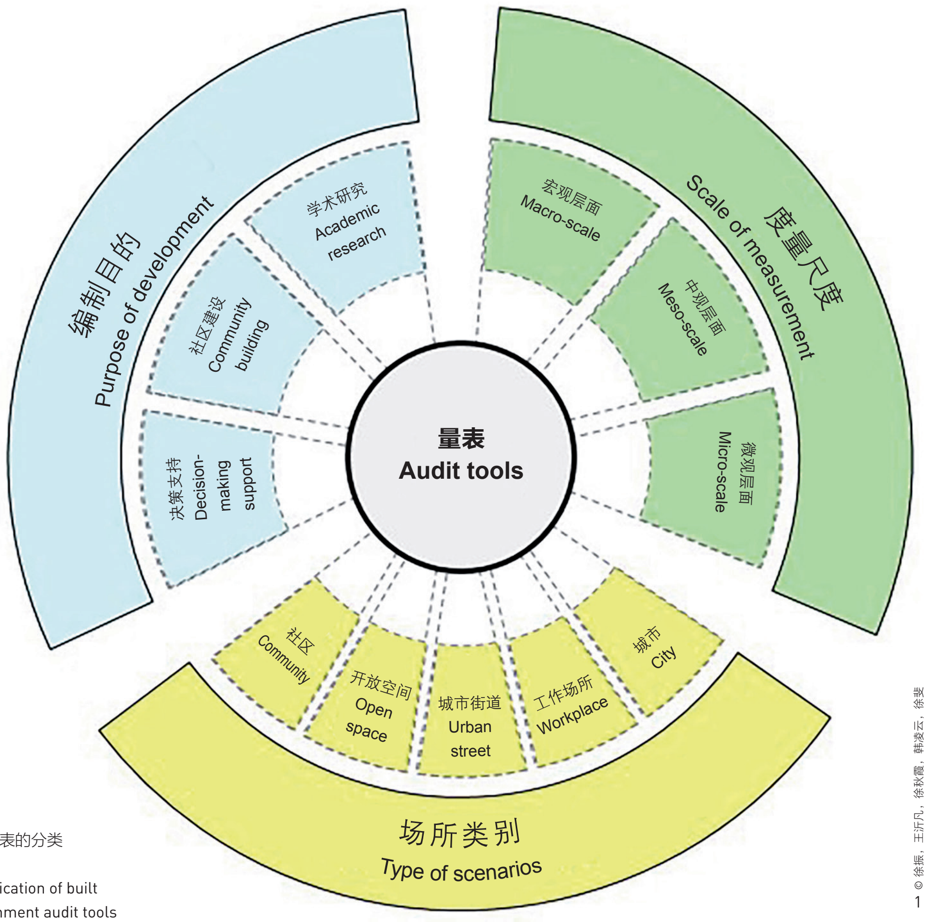
① WABSA (Walking and Bicycling Suitability Assessment) was the earliest audit tool published in the Active Living Research website. The development time of POST, although early (1996 shown in some websites), cannot be traced accurately, and this paper takes its official published time (2004) for the record.

后①[36]，公共卫生和城市规划领域学者逐步开发了适用于不同尺度、类别以及范围的建成环境量表。目前，面向体力活动的环境量表的数量已有上百个，从不同角度区分日益多样化的量表可以为了解其用途、功能差异与适应性提供参考（图1）。

从尺度上，宏观尺度量表关注整个街区、社区乃至城市的总体布局和构成[37][38]；中观尺度量表注重空间肌理，如尽端路口或交叉路口数量；微观尺度量表旨在从环境的细微特质中挖掘可能影响体力活动的要素，突出居民在空间中的体验感。[39]

根据编制目的，可将量表分为三类：一是用于学术研究，其精度要求较高且需检验和测度可靠性[40][41]；二是用于决策支持[42]，其涵盖全面且多关注宏、中观要素；三是用于社区建设，突出自下而上的作用，其内容简洁、易于理解，为实施积极干预提供明确的指导线索[43][44]。

量表涉及的场所类型包括社区、开放空间、街道、工作场所、城市等，其中社区和开放空间为研究重点。早期量表多用于学者在街道等中小尺度空间开展的研究，随后被应用于决策支持和社区建设管理层面，而城市尺度量表的研究则开展较晚[45]。



1. 环境量表的分类

1. Classification of built environment audit tools

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Built environment generally refers to all sorts of physical spaces that influence people's behavioral patterns within it[34]. Based on a social-ecological model, Terri Pikora proposed a theoretical framework integrating different factors of built environment to evaluate both individual and group physical activity levels, which interprets built environment's complicated influences on people's health in a dynamic and systematic way, providing a basis for developing strategies for encouraging physical activities through environment intervention[35].

2.2 Audit Tools for Built Environment Measurement

Based on empirical research and evaluation, audit tools integrate multiple items to measure the environment in a relatively objective, simple, and fast way with rigid procedures of preparation, verification, and application, quantifying environmental information for further comparative analyses.

Audit tools discussed in this paper particularly refer to the ones that can systematically and objectively measure the factors of built environment which would potentially influence the physical activity level. Since WABSA was developed in 1998 by James Emery et al.①[36], scholars in Public Hygiene and Urban Planning have developed hundreds of audit tools for built environment measurement at varied scales for different scenarios. An overall examination of existing audit tools will help scholars understand their application differences and suitability (Fig. 1).

In terms of scale, macro audit tools focus on the overall layout and structure of urban blocks and communities, or even whole cities[37][38]; meso-scale audit tools are often used to measure spatial fabrics, such as the number of cul-de-sacs and road intersections; while micro-scale ones are designed to discern the environmental factors that may have effects on physical activities by describing people' experience and perception in the spaces.[39]

With regard to the purposes, audit tools are developed mainly for three reasons: the ones for academic research require high accuracy and reliability[40][41]; the ones for decision-making purpose[42] usually cover all kinds of environmental factors on macro- and meso-scales; and the ones for community building are concise and easy to operate, providing guidance for active bottom-up practice[43][44].

As to application scenarios, audit tools are often used to measure communities, open spaces, streets, workplaces, cities, etc., and the first two are mostly studied. Early audit tools were mainly developed for meso- and micro-scale scenarios such as urban streets; they were then applied to support decision-making and community management. Studies of audit tools for city-scale scenarios were carried out relatively late[45].

目前，量表已衍生出不同形式的结构和指标体系。鉴于中国量表方面的研究仍处于初步阶段，且针对社区等特定场所类型已有相关研究[46][47]，本文主要基于场所类型分类阐述量表特征。

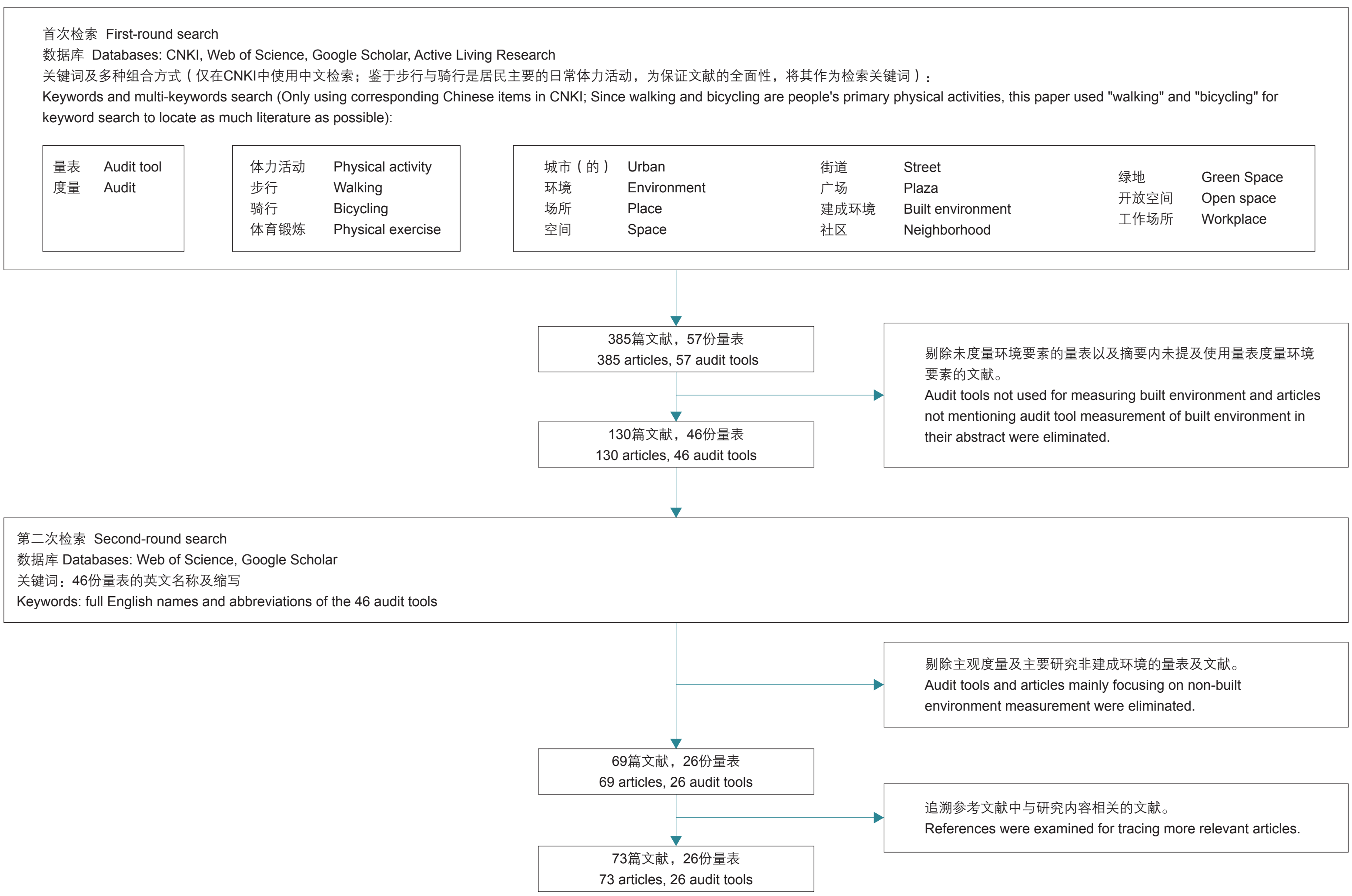
2.3 研究方法

笔者于2018年7月通过CNKI、Web of Science、Google Scholar数据库对图2所示关键词进行了检索，对检索结果的标题及摘要进行阅读以筛选出符合研究主题的文献，并追溯其参考文献作为补充。此外，鉴于由罗伯特·伍德·约翰基金会（RWJF）赞助的“积极生活研究”（Active Living Research）在学术界和决策者中具有一定的权威性和影响力，笔者也对该网站公布的量表研究成果进行了检索，共搜集了130篇文献与46份量表。在进行阅读及筛选后，将符合条件的量表的

Current audit tools see a diversity in structure and indicator system. Since relevant study in China is still staggering in its primary stage, and the existing research consists of individual studies such like community measurement[46][47]. This paper takes scenario type as a clue to review the characteristics of various audit tools.

2.3 Research Method

In July 2018, authors searched for journal articles with the keywords shown in Figure 2 in CNKI, Web of Science, and Google Scholar, reviewed their titles and abstracts to screen out irrelevant studies; the references of selected literature were further examined to source more relevant articles. Additionally, the research findings of audit tools from the Active Living Research website, an influential authority among academia and policymakers, sponsored by the Robert Wood Johnson Foundation (RWJF), were also included in this paper. By doing so, a total of 130 articles and 46 audit tools were collected, and the English names and their abbreviations of



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2. 文献检索策略及过程

2. Methods and process of literature search

② 街道、工作场所和城市的量表相对较少，为便于分析，将其归为一类。

② There are fewer audit tools for scenarios of streets, workplaces, and cities, which are grouped to a same category in this paper.

英文名称及缩写作为关键词，在Web of Science和Google Scholar数据库中再次进行检索。

本研究的检索范围为1988年1月~2018年7月公开发表的与体力活动相关的环境量表论文，对虽涉及量表但未提及其具体名称的研究或重点在社会环境、营养环境，或仅观测行为活动本身而不涉及建成环境的研究则不作分析。最终筛选出26份量表和73篇相关文献进行精读与分析（图2）。其中，26份量表分别源于美国（21份）、澳大利亚（2份）、加拿大（2份）与英国（1份）。

3 研究发现

3.1 概况

根据不同的场所类型（社区、公共开放空间、街道、工作场所、城市），上述量表可分为5类（表1）。其中，社区量表共10份，公共开放空间量表共8份，其他三类②量表共8份。表1从发表时间、起源地、指标数量、选项设置、主要度量要素、计算方式、信度检验、效度检验、评估者、导向群体等方面对各份量表进行了汇总。

纵观各份量表，不同研究目的、对象、尺度的量表指标数量差异较大（从14项至751项不等）[48]。其中，公共开放空间环境要素繁杂，指标较多；而道路类环境为单一专类场地，指标较少。指标较多的量表能对环境进行全面度量并更可能发现体力活动与环境之间的微妙关系，但需较多的调研和分析工作，并可能涉及无关指标；指标较少的量表结构清晰、使用省时省力，但尚未形成系统性框架，适用范围也较窄。

选项设置包括针对二元响应（选择有/无）、有序分类、无序分类的选择题，以及计数和开放式问题等。据此可将量表分为分析类与清单类。分析类量表多为包含多类选项的复合型量表，常用于学术研究；清单类量表设置较简单，选项仅为二元响应或有序分类选择题（如ANC），多用于帮助决策者或社区利益相关者对相关环境建立基础认识。

不同量表的使用时间成本也存在显著差异，其差距累计高达4小时[49][50]，其中TCOPPE时间成本最高，完成一次度量一般需要90分

eligible audit tools were used as keywords for further literature searching in Web of Science and Google Scholar.

This study searched for articles on audit tools for environmental measurement of physical activity published from January 1988 to July 2018, and excluded those not mentioning any names of audit tools, or studying social or nutritional environments, or merely observing physical activities without discussion about built environment. Finally, 26 audit tools — 21 from the United States, two from Australia, two from Canada, and one from the United Kingdom — and 73 articles were selected (Fig. 2).

3 Research Findings

3.1 Overview

The selected 26 audit tools can be classified by scenario type into five categories (Table 1): 10 audit tools for communities, 8 for public open spaces, and 8 for urban streets (including paths, trails, and roads), workplaces, and cities. The published year, country of origin, number of indicator items, option forms, main measured factors, scoring method, reliability and validity tests, auditor, and target group of the audit tools are examined.

The number of indicator items among the audit tools varies significantly from 14 to 751[48]. Environmental indictors of public open spaces are much more than others, while those for streets have fewer items because the environment of such scenarios is relatively simple. Tools with more indicators can be used to conduct a relatively comprehensive measurement for the environment to reveal its subtle associations between physical activities and the built environment, but would cost more time for data collection and analyses as well as interference screening. Audit tools with fewer items are easy and quick to operate, but often lack systematism and have limited applicability.

Option forms of audit tools include choice questions (e.g., yes / no question, ordered and unordered category choice question, etc.), counting questions, and open-ended questions, according to which, audit tools can be further divided into analytic and checklist ones. Analytic audit tools are usually in form of multiple options, usually for academic purpose, while checklist audit tools are often simply designed in form of binary response and ordered category choice questions (such as ANC), making it more suitable for decision-makers or community stakeholders to learn the basic profile of the targeted environment.

Average time spent with different audit tools fluctuates and the difference may accumulate up to 4 hours[49][50]. As the most time-consuming audit tool, TCOPPE costs 90 minutes for one

表1：衡量建成环境要素的量表信息
Table 1: Information of audit tools for measuring built environmental factors

量表名称（缩写）/发表时间/国家 Abbreviation of the audit tool / published year / country of origin	指标数量 Number of indicator items	选项设置 Option forms	主要度量要素 Main measured factors	计算方式 Scoring method	信效度检验结果 Results of reliability and validity test	评估者 Auditor	需求时间（单位：分钟） Average time spent (minutes)	是否为更新版本 An updated version or not	导向群体 Target group
社区类量表 **Community audit tools**									
步行及骑行环境系统性评估（SPACES）量表/2002年/澳大利亚 Systematic Pedestrian and Cycling Environmental Scan (SPACES) Instrument / 2002 / Australia	55	BR, OC, UC	基础细节特征、安全要素、美观要素、场所要素、设施、主观评估 Detailed basic characteristics, safety, aesthetics, destinations, facilities, and subjective assessment	无记录 NR	评估者间信度：1）PA≥70%：67%的指标，PA<70%：33%的指标；2）K>0.75：32%的指标，K为0.4~0.75：40%的指标，K<0.4：28%的指标 评估者内信度：1）PA≥70%：97%的指标，PA<70%：3%的指标；2）K>0.75：24%的指标，K为0.4~0.75：66%的指标，K<0.4：10%的指标 效度：不涉及 Inter-auditor reliability: 1) PA ≥ 70%: 67% of items, PA < 70%: 33% of items; 2) K > 0.75: 32% of items, K = 0.4 ~ 0.75: 40% of items, K < 0.4: 28% of items Intra-auditor reliability: 1) PA ≥ 70%: 97% of items, PA < 70%: 3% of items; 2) K > 0.75: 24% of items, K = 0.4 ~ 0.75: 66% of items, K < 0.4: 10% of items Validity: NA	相关专业人员 Professionals	无记录 NR	否 No	无区分 All groups
社区积极生活潜力量表（NALP）/2002年/加拿大 Neighborhood Active Living Potential (NALP) / 2002 / Canada	18	OR	活动友好度、安全要素、场所要素的密度 Activity friendliness, safety, and density of destinations	汇总指数或分别分析 Summary index or separate analysis	信度：ICC：0.76~0.83 效度：所有要素类型均与体力活动有相关性 Reliability: ICC: 0.76 ~ 0.83 Validity: All factors are related to physical activity	相关专业人员 Professionals	无记录 NR	否 No	无区分 All groups
老年人步行环境量表（SWEAT）/2005年/美国 Senior Walking Environmental Audit Tool (SWEAT) / 2005 / U.S.	188	BR, Counting	基础细节特征、安全要素、美观要素、场所要素 Detailed basic characteristics, safety, aesthetics, and destinations	无记录 NR	信度：K>0.6：67%的指标 效度：不涉及 Reliability: K > 0.6: 67% of items Validity: NA	无记录 NR	17	是 Yes	老年人 The aged
尔湾－明尼苏达环境量表（IMI）/2006年/美国 Irvine-Minnesota Inventory (IMI), 2006, U.S.	162	BR, OC	可达性、活动需求及舒适度、安全性 Accessibility, physical activity needs and comfort, and safety	无记录 NR	信度：PA≥80%：76.8%的指标 效度：所有要素均通过预测效度检验 Reliability: PA ≥ 80%: 76.8% of items Validity: All factors have undergone predictive validity test	相关专业人员 Professionals	10 ~ 20	是 Yes	无区分 All groups
步行环境指标测度（PEDS）量表/2007年/美国 Pedestrian Environment Data Scan (PEDS) Tool / 2007 / U.S.	84	OC, UC	人行道设施、道路属性、步行或骑行环境 Pedestrian facilities, road attributes, and environment of walking / cycling	无记录 NR	信度：1）PA≥75%：92%的指标，PA<75%：8%的指标；2）K≥0.4：72%的指标，K<0.4：28%的指标 效度：不涉及 Reliability: 1) PA ≥ 75%: 92% of items, PA < 75%: 8% of items; 2) K ≥ 0.4: 72% of items, K < 0.4: 28% of items Validity: NA	无记录 NR	5 ~ 12	否 No	无区分 All groups
PIN3研究项目社区环境量表（PIN3）/2009年/美国 PIN3 Neighborhood Audit Instrument (PIN3) / 2009 / U.S.	70	BR, OC, UC, Counting	居住区土地利用、非居住区土地利用、美观要素、可移动设施、交通和道路特征 Residential land use, non-residential land use, aesthetics, mobile amenities, and characteristics of traffic and road	无记录 NR	评估者间信度：K≥0.4：81%的指标 重测信度：两周后77%的指标，K≥0.4；一年后68%的指标，K≥0.4 效度：不涉及 Inter-auditor reliability: K ≥ 0.4: 81% of items Retest reliability: 77% of items after two weeks, K ≥ 0.4; 68% of items after one year, K ≥ 0.4 Validity: NA	无记录 NR	无记录 NR	否 No	无区分 All groups
微观步行环境量表（MAPS）/2015年/美国 Microscale Audit of Pedestrian Streetscapes (MAPS) / 2015 / U.S.	200	BR, OC, UC	环线特征、路段特征、交叉路口特征、尽端路特征 Routes, segments, crossings, and cul-de-sacs	加权组合模型 Weighted combination model	信度：K>0.80：50%的指标，K为0.61~0.80：25.6%的指标，K为0.40~0.60：11.3%的指标，K<0.40：13.1%的指标 效度：不涉及 Reliability: K > 0.80: 50% of items, K = 0.61 ~ 0.80: 25.6% of items, K = 0.40 ~ 0.60: 11.3% of items, K < 0.40: 13.1% of items Validity: NA	相关专业人员 Professionals	28.5	是 Yes	无区分 All groups

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表1：衡量建成环境要素的量表信息
Table 1: Information of audit tools for measuring built environmental factors

量表名称（缩写）/发表时间/国家 Abbreviation of the audit tool / published year / country of origin	指标数量 Number of indicator items	选项设置 Option forms	主要度量要素 Main measured factors	计算方式 Scoring method	信效度检验结果 Results of reliability and validity test	评估者 Auditor	需求时间（单位：分钟） Average time spent (minutes)	是否为更新版本 An updated version or not	导向群体 Target group
社区类量表 Community audit tools									
威斯康星州社会及建成环境评估（WASABE）/2014年/美国 The Wisconsin Assessment of the Social and Built Environment (WASABE) / 2014 / U.S.	115	BR, OC, UC	邻里特征、交通环境、场所要素、社会环境、连接性 Neighborhood characteristics, traffic environment, destinations, social environment, and connectivity	分别分析 Separate analysis	信度：PA≥90%：71%的指标，PA为80%~89%：12%的指标，PA＜80%：17%的指标 效度：不涉及 Reliability: PA ≥ 90%: 71% of items, PA = 80% ~ 89%: 12% of items, PA < 80%: 17% of items Validity: NA	相关专业人员 Professionals	4 ~ 8	否 No	无区分 All groups
分析量表和清单量表（AAT&CAT）/2003年/美国 Analytic Audit Tool and Checklist Audit Tool (AAT & CAT) / 2003 / U.S.	AAT: 143 CAT: 128	AAT: BR, OC, UC; CAT: BR	土地利用、交通环境、设施、美观要素、标识、社会环境 Land use, traffic environment, facilities, aesthetics, signage, and social environment	无记录 NR	信度：1）PA（AAT）≥75%：70%的指标，PA（CAT）≥75%：87%的指标；2）ICC（AAT）＞0.80：19%的指标，ICC（AAT）为0.61~0.80：28%的指标，ICC（AAT）为0.41~0.60：15%的指标；3）K（AAT）＞0.80：19%的指标，K（AAT）为0.61~0.80：27%的指标，K（AAT）为0.41~0.60：24%的指标 效度：不涉及 Reliability: 1) PA ≥ 75%: 70% of AAT items, PA ≥ 75%: 87% of CAT items; 2) ICC > 0.80: 19% of AAT items, ICC = 0.61 ~ 0.80: 28% of AAT items, ICC = 0.41~ 0.60: 15% of AAT items; 3) K > 0.80: 19% of AAT items, K = 0.61 ~ 0.80: 27% of AAT items, K = 0.41 ~ 0.60: 24% of AAT items Validity: NA	相关专业人员 Professionals	10.6	是（手机应用） Yes (App)	无区分 All groups
积极生活社区清单（ANC）/2007年/美国（本文未对该量表进行分析） Active Neighborhood Checklist (ANC) / 2007 / U.S. (ANC is not analyzed in this paper)	57	BR, OC, UC	土地利用、人行道特征、非机动车道特征、街道特征、整体环境质量 Land use, sidewalks, characteristics of non-motor vehicle lanes, street characteristics, and overall environmental quality	汇总指数 Summary index	信度：1）PA＞60%：87%的指标；2）K的均值为0.68（范围为0.21~ 1.00） 效度：不涉及 Reliability: 1) PA > 60%: 87% of items; 2) Mean value of K = 0.68 (ranging from 0.21 to 1.00) Validity: NA	相关专业人员、实践倡导者、社区利益相关者 Professionals, PAs, CSs	3~25（平均时间为11.7分钟） 3 ~ 25 (average: 11.7 mins)	否 No	无区分 All groups
开放空间类量表 Open space audit tools									
体力活动资源评估（PARA）量表/2005年/美国 Physical Activity Resource Assessment (PARA) Instrument / 2005 / U.S.	37	OC	基础特征、便利设施、不文明现象 Features, amenities, and incivilities	汇总指数 Summary index	信度：K＞0.77 效度：不涉及 Reliability: K > 0.77 Validity: NA	相关专业人员 Professionals	10	否 No	无区分 All groups
贝迪莫·伦格直接观察评估量表（BRAT-DO）/2005年/美国 Bedimo-Rung Assessment Tool — Direct Observation (BRAT-DO) / 2005 / U.S.	124	BR, OC, UC	可达性、美观要素、安全性 Accessibility, aesthetics, and safety	无记录 NR	信度：PA：67.6%~100% 效度：以文献数据或专家意见作为参照，系数为0.79 Reliability: 67.6% ~ 100%. Validity: the validity coefficient is 0.79 (taking literature data or expert opinions as a reference)	相关专业人员 Professionals	无记录 NR	否 No	无区分 All groups
社区公园量表（CPAT）/2010年/美国 Community Park Audit Tool (CPAT) / 2010 / U.S.	28	BR, UC, MC	公园信息、周边环境及可达性、活动区域、环境质量及安全性 Park information, surroundings and accessibility, activity areas, and environmental quality and safety	分别分析 Separate analysis	信度：1）PA≥70%；2）K＞0.4 效度：不涉及 Reliability: 1) PA ≥ 70%; 2) K > 0.4 Validity: NA	相关专业人员、实践倡导者、社区利益相关者 Professionals, PAs, CSs	32	是 Yes	青少年 Adolescents

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表1：衡量建成环境要素的量表信息
Table 1: Information of audit tools for measuring built environmental factors

量表名称（缩写）/发表时间/国家 Abbreviation of the audit tool / published year / country of origin	指标数量 Number of indicator items	选项设置 Option forms	主要度量要素 Main measured factors	计算方式 Scoring method	信效度检验结果 Results of reliability and validity test	评估者 Auditor	需求时间（单位：分钟） Average time spent (minutes)	是否为更新版本 An updated version or not	导向群体 Target group
开放空间类量表 **Open space audit tools**									
公共游憩空间环境评估（EAPRS）/2006年/美国 Environmental Assessment of Public Recreation Spaces (EAPRS) / 2006 / U.S.	744	BR, UC	道路特征、特殊功能场所、亲水性空间、活动设施和游乐元素 Characteristics of streets, routes, paths, and trails, places for specific uses, waterscapes, activity facilities, and recreational facilities	无记录 NR	信度：K＞0.6 效度：不涉及 Reliability: K ＞ 0.6 Validity: NA	相关专业人员 Professionals	10~258（平均时间为67.3分钟） 10 ~ 258 (average: 67.3 mins)	是 Yes	无区分 All groups
公园、儿童活动及休闲（PARK）量表/2015年/加拿大 The Parks, Activity and Recreation among Kids (PARK) Tool / 2015 / Canada	92	BR, OC, UC	公园活动、环境质量、公园服务、安全性、整体印象 Activities, environmental quality, services, safety, and users' overall impression	无记录 NR	信度：K＞0.77 效度：不涉及 Reliability: K ＞ 0.77 Validity: NA	相关专业人员 Professionals	10	否 No	青少年 Adolescents
公共开放空间质量量表（POST）/2004年/澳大利亚 Public Open Space Tool (POST) / 2004 / Australia	43	BR, UC, OC	公园活动、环境质量、安全性、便利设施 Activities, environmental quality, safety, and amenities	汇总指数与加权组合模型 Summary index, weighted combination model	信度：1）PA：6.4%~97.9%；2）ICC：0.36~0.93；3）K：0.19~1.00 效度：以专家意见为参照，确保效度 Reliability: 1) PA: 6.4% ~ 97.9%; 2) ICC: 0.36 ~ 0.93; 3) K: 0.19~ 1.00 Validity: assured by taking expert opinions as a reference	相关专业人员 Professionals	无记录 NR	是 Yes	无区分 All groups
自然环境评估量表/2017年/英国 Natural Environment Scoring Tool (NEST) / 2017 / UK	47	BR, OC, Counting	可达性、娱乐设施、便利设施、（非）自然环境的美观要素、不文明现象、自然特征、可使用性 Accessibility, recreational facilities, amenities, aesthetics of natural and constructed environment, incivilities, natural features, and usability	加权组合模型 Weighted combination model	信度：1）Person：0.78~0.96；2）PA：80%~83% 效度：不涉及 Reliability: 1) Person: 0.78 ~ 0.96; 2) PA: 80% ~ 83% Validity: NA	无记录 NR	16~28	否 No	无区分All groups
社区绿地量表（NGST）/2012年/美国 Neighborhood Green Space Tool (NGST) / 2012 / U.S.	39	无记录 NR	可达性、休闲设施、便利设施、自然特征、不文明现象 Accessibility, recreational facilities, amenities, natural features, and incivilities	加权组合模型 Weighted combination model	信度（ICC）：单个指标为0.58~0.95，整体为0.73 效度：不涉及 Reliability (ICC): 0. 95 ~ 0. 58 (single item); 0.73 (overall) Validity: NA	无记录 NR	7~15（平均时间为11分钟） 7 ~ 15 (average: 11 mins)	否 No	无区分 All groups
城市类量表 **City audit tools**									
乡村积极生活评估（RALA）量表/2009年/美国 The Rural Active Living Assessment (RALA) Tools / 2009 / U.S.	81	BR, OC, UC	城镇活力特征、休闲设施、项目和政策、街道特征 Town characteristics, recreational amenities, program and policy, and street characteristics	加权组合模型 Weighted combination model	信度：1）PA：91.9%；2）K：0.78 效度：不涉及 Reliability: 1) PA: 91.9%; 2) K: 0.78 Validity: NA	无记录 NR	3~25（平均时间为9分钟） 3 ~ 25 (average: 9 mins)	否 No	无区分 All groups
与步行性相关的城市设计质量评估量表（MIUDQRW）/2006年/美国 Measurement Instrument for Urban Design Quality Related to Walkability (MIUDQRW) / 2006 / U.S.	27	Counting	步行环境通透度、复杂度 Transparency and complexity	加权组合模型 Weighted combination model	信度：ICC：0.40~0.59 效度：不涉及 Reliability: ICC: 0.40 ~ 0.59 Validity: NA	相关专业人员 Professionals	无记录 NR	否 No	无区分 All groups

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表1：衡量建成环境要素的量表信息
Table 1: Information of audit tools for measuring built environmental factors

量表名称（缩写）/发表时间/国家 Abbreviation of the audit tool / published year / country of origin	指标数量 Number of indicator items	选项设置 Option forms	主要度量要素 Main measured factors	计算方式 Scoring method	信效度检验结果 Results of reliability and validity test	评估者 Auditor	需求时间（单位：分钟）Average time spent (minutes)	是否为更新版本 An updated version or not	导向群体 Target group
街道类量表 Street audit tools									
道路环境量表（PEAT）/2005年/美国 Path Environment Audit Tool (PEAT) / 2005 / U.S.	36	BR, OC, UC	交叉路口、便利设施、维护及美观程度 Road intersections, amenities, maintenance, and aesthetics	分别分析 Separate analysis	信度：ICC≥0.52：60%的指标 效度：以GPS数据作为参照，70%的指标系数＞0.4 Reliability: ICC ≥ 0.52: 60% of items Validity: 70% items ＞ 0.4 (refering to GPS data)	相关专业人员 Professionals	无记录 NR	否 No	无区分 All groups
步行与骑行可持续性评估（WABSA）/1998年/美国 Walking and Bicycling Suitability Assessment (WABSA) / 1998 / U.S.	步行：15 骑行：27 W: 15 B: 27	W: BR, OC, UC; B: BR, OC, Counting	步行街道基本特征、骑行街道基本特征、道路铺装、安全性 Basic street features for walking and cycling, pavement, and safety	加权组合模型 Weighted combination model	信度：ICC（W）=0.79；ICC（B）=0.90 效度：以专家意见为参照，步行和骑行系数分别为0.58和0.62 Reliability: ICC (W) = 0.79; ICC (B) = 0.90 Validity: the validity coefficients of walking and bicycling are 0.58 and 0.62, respectively (taking expert opinions as a reference)	相关专业人员 Professionals	无记录 NR	否 No	无区分 All groups
老年人步行路径量表（WRATS）/2009年/美国 Walking Route Audit Tool for Seniors (WRATS) / 2009 / U.S.	49	BR, OC, UC, OEQ	道路特征、交通安全、便利设施、人身安全 Road features, traffic safety, amenities, and personal safety	无记录 NR	信度：无记录 效度：不涉及 Reliability: NR Validity: NA	无记录 NR	无记录 NR	否 No	老年人 The aged
工作场所类量表 Workplace audit tools									
儿童肥胖、生活方式和环境的国际研究（ISCOLE）量表/2015年/美国 The International Study of Childhood Obesity, Lifestyle and the Environment (ISCOLE) Audit Tool / 2015 / U.S.	37	BR, OC, UC, Counting	步行和骑行环境、运动和游乐设施、美观要素、适宜度 Walking and cycling environment, sports and recreational facilities, aesthetics, and suitability	汇总指数 Summary index	信度K为0.80~0.96：42%的指标，K为0.61~0.79，56%的指标 效度：具备良好的结构效度 Reliability: K = 0.80 ~ 0.96: 42% of items, K = 061 ~ 0.79: 56% of items Validity: With good structural validity	无记录 NR	15~160（平均时间为57分钟） 15 ~ 160 (average: 57 mins)	否 No	儿童和青少年 Children and adolescents
TCOPPE学校环境量表（TCOPPE）/2013年/美国 TCOPPE School Environmental Audit Tool (TCOPPE) / 2013 / U.S.	无记录 NR	UC, OC	度量街道、度量学校场地、整体度量 Street audit, campus audit, map audit	无记录 NR	评估者间信度：1）ICC：0.60；2）K：0.84 重测信度：1）ICC：0.77；2）K：0.90 效度：不涉及 Inter-auditor reliability: 1) ICC: 0.60; 2) K: 0.84 Retest reliability: 1) ICC: 0.77; 2) K: 0.90 Validity: NA	相关专业人员 Professionals	90	否 No	无区分 All groups
工作场所步行性量表（WWAT）/2005年/美国 Workplace Walkability Audit Tool (WWAT) / 2005 / U.S.	14	OC	人行道设施、人行道与非机动车道的冲突、道路缓冲带、可达性、美观性、遮荫程度 Pedestrian facilities, pedestrian-vehicle conflicts, buffer between lanes, accessibility, aesthetics, and canopy ratio	加权组合模型 Weighted combination model	信度：K≥0.41：60%的指标，K为0.20~0.40：40%的指标 效度：不涉及 Reliability: K ≥ 0.41: 60% of items, K = 0.20 ~ 0.40: 40% of items Validity: NA	相关专业人员 Professionals	无记录 NR	否 No	无区分 All groups

注

1. 不同量表的开发文献记录指标数量的标准不同。本表中“指标数量”是指每份量表中指标的响应数量的总数，不包含标记信息（评估者编码、路段名称及编码等信息）。对于涉及复合响应的量表，指标计数以组合为单位。
2. 量表名称仅为其首次出现的名称，不包含之后修订版名称。
3. 量表的计算方式统计来源并非全部出自量表开发文献或量表正文，部分源于应用文献。
4. 本表所展示的需求时间为平均值和/或耗时范围，仅作为研究设计的参考。
5. 信度检验中未特殊说明的对象为评估者间信度的检验。同时，检验一般不包括量表中的开放性题目，具体情况以研究者实际检验而定。信度系数取值范围为0~1，越接近1则信度越高，通常，信度系数＞0.4时表示信度达到可接受水平。
6. BR表示二元响应；OC表示有序分类；UC表示无序分类；MC表示多项选择；OEQ表示开放式问题；PA表示百分比一致性；K表示kappa系数；ICC表示组内相关系数；Person表示皮尔逊一致性系数；PAs表示实践倡导者；CSs表示社区利益相关者；NR表示无记录；NA表示不涉及。

NOTES

1. The literatures of audit tools studied in this paper adopt varied methods for counting the number of indicator items. In this table, "Number of indicator items" refers to the total number of their responses. Tags (e.g., auditor ID, segment ID, codes, etc.) are excluded. The item is counted by combination response.
2. The audit tools listed in this table are recorded as their initiative names, while the names of their updated visions are not mentioned.
3. The scoring methods in this table are sorted from relevant literatures, official documents, and empirical studies.
4. This table shows the corresponding average and / or range of time spent of each tool to provide references for future studies.
5. Reliability in this table refers to inter-auditor reliability unless otherwise stated. Reliability test is conducted for specific research needs, where generally open-ended questions are not included. The reliability coefficient ranges from 0 to 1, and the closer to 1, the higher the reliability is. A coefficient higher than 0.4 means acceptable reliability.
6. Abbreviations used in this table include: BR = binary response; OC = ordered category; UC = unordered category; MC = multiple choices; OEQ = open-ended questions; PA = the percentage agreement; K = Kappa coefficient; ICC = intra-class correlation; Person = Person coefficient; PAs = practice advocates; CSs = community stakeholders; NR = not reported; NA = not applicable.

钟，而多数量表都可在20分钟内完成。这一差异通常与研究区域的面积及土地性质、指标内容与量表结构的繁简程度有关。

总体而言，量表在应用时需综合考虑研究对象、研究尺度、研究目的，以及评估者需求。

3.2 效度与信度分析

为确保测度结果有效且稳定，在应用标准化量表前通常要对其进行效度与信度分析，并根据分析结果调整量表指标与结构。

效度表示量表构建的要素与研究目的及假设的契合程度。上述26份量表中仅7份强调了效度分析。相对于发展较成熟的医学类量表，环境量表相关研究尚处于早期探索阶段，其效度分析难点在于缺乏合适的“金标准”作为衡量参考[51]，既有研究多基于专家经验或通过GPS数据设定一个相对标准作为参照。通过这种方式，个别研究将环境要素与积极活动相关分析进行了系统性的效度检验③。其余量表虽未强调效度，但基于大量文献综述、开放式定性调查、已发表量表等方式设置的各类环境要素，在一定程度上保证了量表对相关潜在环境要素的有效捕捉，从而确保了量表的效度。但不可否认，效度检验仍是环境量表需持续改进的方向。在不同地区进行大量基于量表的实证研究以获取相关要素，进行全面的理论研究以提炼概括共性要素，并不断修订、完善量表框架是推动量表效度研究的必经过程。

在使用量表对环境进行度量时，复杂的环境要素增加了实施标准化度量的难度，因此，度量结果的一致性即信度尤为重要。[52]由于不同评估者间存在评判差异，导致度量结果存在偏差，因此常采用评估者信度来检验量表的一致性。本文分析的所有量表除WRATS未查找到相关记录外，其他均进行了信度分析，且多采用多种方法解释信度。当使用Kappa系数（K）与组内相关系数（ICC）解释信度时，量表中大部分指标的信度系数都能达到可接受水平（K>0.4，ICC>0.4）；当使用百分比一致性解释信度系数时，基本所有指标也都呈现较好的信度（≥75%）。对比检验结果发现，客观且易于判别的指标信度高于主观的或复杂的指标信度[50][53]。同时，在研究中不可避免地出现与体力活动高度相关但不宜剔除的低信度指标（如树荫覆盖度、道路及其他设施维护情况），相关研究通常保留这些指标，同时通过对量表内的指标设置、层级结构进行调整，以及对评估者进行培训等方法来提高信度[50][54]。

measurement on average, while most of rest cost no more than 20 minutes typically. The average time spent is impacted by the size and land use of the targeted area, the indicator coverage and the complexity of audit tool's structure.

To sum up, audit tool applications require considerations on the study object, scale, purpose, and auditor's needs.

3.2 Validity and Reliability Tests

In general, standardized audit tools should go through validity and reliability tests before application, and their items and structure would be calibrated according to the feedback.

Validity represents to the extent of accuracy of an audit tool for reflecting its research purpose and hypotheses. Only 7 of the above 26 tools have conducted validity test. Compared with the proven audit tools in Medical Sciences, the validity test of audit tools on built environment is just primarily explored and lacks a consistent benchmark[51]: most of them are simply developed by experts' experience or with GPS data, only a few of which have systematically gone through validity test for correlation analysis of environmental factors and physical activity level③. The audit tools without formal validity tests often ensure their validity by identifying environmental factors through extensive literature reviews, open-ended qualitative surveys, referencing to published audit tools, etc. Enhancing and improving validity test for audit tools on built environment needs more efforts in strengthening empirical studies across regions to identify the commonly recognized environmental factors and to adjust and upgrade the frameworks of audit tools.

The consistency of the measurement results, i.e., reliability, is critical to the standardized application of audit tools on built environment.[52] Because of auditors' bias, scorer reliability is usually adopted to examine the consistency of audit tools. Except of WRATS, all the other collected audit tools have conducted reliability test with various methods. Tested with Kappa coefficient (K) and intra-class correlation coefficient (ICC), most items in the audit tools have acceptable reliability (K > 0.4, ICC > 0.4); the test results of percentage agreement also show good reliability (≥ 75%). A comparison of all the test results further reveals that the reliability of objective and simple items are higher than that of subjective and complicated ones[50][53]. Inevitably, some items see a low reliability yet are considered highly correlated to people's physical activities, such as canopy cover, maintenance status of roads and facilities. In this instance, researchers usually improve the overall reliability of audit tools by adjusting the indicator selection or structure, and auditor training[50][54].

③ 已进行了效度检验的量表及其检验结果请查阅表1。

③ Audit tools with validity test and the results can be found in Table 1.

3.3 计算方法

量表中常用的计算方法为分析单项指标，或将多项指标得分汇总以获取整体指数。在分析单项指标时，研究者需仔细甄别各项要素，再根据实际情况确定统计方法。该形式易于回溯和比较每个环境要素的状态，并据此提出相应改进措施，如安德鲁·T·卡钦斯基使用CPAT量表对美国堪萨斯市的公园环境要素进行度量，并使用逻辑回归分析每个指标与体力活动的关系，发现运动场、棒球场、游泳池、喷水池和湖泊等特定公园设施能不同程度地影响体力活动[55]。在分析整体指数时，研究者除了需考虑单项要素外，更要精心拟定计算模型——通常为简单汇总模型[56][57]和加权组合模型[58][59]。简单汇总模型能快速确定研究区域环境对体力活动的整体支持情况，加权组合模型则按照对于体力活动的支持程度强弱对各类环境要素赋予权重，使总指数更具科学性。据此模型得出的整体指数将环境对体力活动的支持程度分为不支持、较支持、支持三个等级。例如，安德鲁·L·丹嫩贝格[48]使用WWAT量表度量工作场所，詹姆斯·埃默里等[51]和威廉·汉森等[60]使用WABSA量表度量街道等均展现了整体指数表征环境对体力活动的支持程度。

3.4 各类环境量表指标及相关文献对比研究

即使针对同一类型场所，不同量表的环境要素及指标、结构与计算方法仍非常多样化。因此，选择或编制环境量表时不仅要关注场所类型及场所的整体特征，还应注意其中各类环境要素，才能更准确地挖掘环境对体力活动的潜在影响[61]。本文对不同类别量表的指标内容进行重新分类以构建相近的环境要素类别，并就社区、开放空间、其他环境三类分别进行对比。

3.4.1 度量社区的量表工具

社区类量表发展较早且已广泛应用，其各项指标重新分类后共可归纳为10类环境要素（表2），这10类要素中的指标几乎涵盖了所有能够促进体力活动的社区环境特征。将各量表中各类要素所包含的指标数量占比图示化（图3），根据要素出现频次可探讨各类要素的优先度，以此了解各量表的侧重方向。

3.3 Scoring Methods

Single item scoring and overall index analysis by summing up multiple item scorings are commonly used methods for the calculation in audit tools. For single item scoring, auditors should carefully examine the characteristics of each factor and determine statistical methods. This approach is suitable for a quick profile and comparison between the status of each environment factor, which helps researchers propose improvement approaches correspondingly. For example, by using CPAT to measure environmental factors of parks in Kansas City, USA and analyzing the association between each item and physical activity with logical regression, Andrew. T. Kaczynski proved that playgrounds, baseball fields, swimming pools, spray ponds, lakes, and other park facilities influence users' physical activities at varying degrees[55]. For overall index analysis, auditors should carefully select computational models — simple summary model[56][57] or weighted combination model[58][59]. The simple summary model can be used for a quick measurement of the environment's support degree to physical activities, while with the weighted combination model, various environmental factors are weighted according to their support degree to physical activities to gain a scientific overall analysis of index: not supportive, relatively supportive, or supportive. This model was applied in the study by Andrew L. Dannenberg[48] to measure a workplace with WWAT, and by James Emery et al.[51] and William Hansen et al.[60] to measure urban streets with WABSA.

3.4 Comparative Study of Audit Tool Items and Relevant Literature

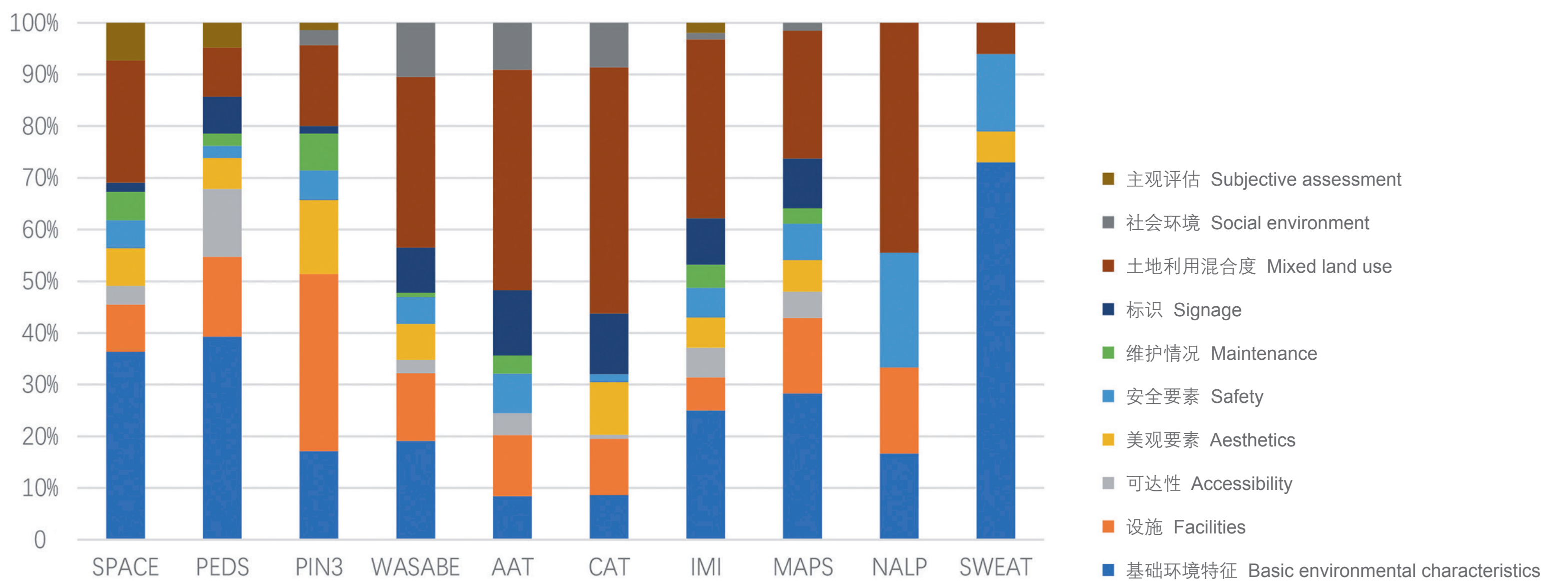
For a same scenario, the environmental factors and items, structures, and scoring methods of different audit tools may be varied. Besides of the type and overall characteristic of a given place, researchers should also investigate all the environmental factors to evaluate the potential effects of the environment on physical activities[61]. In this paper, indicators in different audit tools were reclassified to fit in audit tools for communities, open spaces, and other scenarios, and a comparison study is made.

3.4.1 Community Audit Tools

Community audit tools have a longer development history and a wider application, the indicators of which cover 10 categories of environmental factors that would promote physical activities in communities (Table 2). The distributions of indicators to various factors in each audit tool are shown in Figure 3. The occurrence frequency of factors evidences their priorities in each tool, from which audit tool's suitability can be learned.

表2：各类环境要素定义
Table 2: Definitions of environmental factors in different types

要素 Factors	具体解释 Interpretation	涵盖的指标（不完全列举） Items (only to mention)
基本环境特征 Basic environmental characteristics	指场所中基础环境要素的结构特征 Structural characteristics of basic environmental factors within a given study area	道路坡度、建筑高度等特征，还包括交叉路口的环岛形式、车道数量等交通环境 Road slope, height of buildings, and traffic conditions (e.g., the forms of roundabout, number of motorized lanes, etc.)
设施 Facilities	指特定场所中所有活动设施、服务设施、安全设施 All activity facilities, service facilities, and safety facilities within a given study area	健身活动设施、门廊、围栏、座椅、自行车架等 Fitness facilities, porches, fences, seats, bicycle stands, etc.
可达性 Accessibility	指人们能够轻易进出特定区域且使用其中特定设施的能力，包括促进和抑制可达性的指标 The accessibility to a given site and usage of facilities within it, including both positive and negative indicators	人行道连接度、高速公路和障碍物的存在 Connectivity of sidewalk, presence of highways and obstacles, etc.
美观要素 Aesthetics	特指增添或破坏环境吸引力的特征 Positive or negative factors to the environmental attraction of a given study area	特色建筑立面、特色雕塑与垃圾情况等 Featured building facades and sculptures, presence of garbage, etc.
安全要素 Safety	包含可能保障或威胁人身安全的环境指标 Factors to secure or threaten people's safety	是否有涂鸦和废弃汽车、充足的照明等 Presence of graffiti and abandoned cars, adequate lighting, etc.
维护情况 Maintenance	特指区域内所有环境要素和设施的维护状况 The maintenance status of a given study area (including facilities)	建筑、景观、人行道等是否良好维护 The maintenance status of buildings, landscape features, sidewalks, etc.
标识 Signage	主要度量特定区域内是否存在某些对体力活动有潜在影响的标识 Whether there are signs within a given study area that have a potential impact on users' physical activities	安全警告以及交通管制标语等 Safety warning signs, and traffic control streamers, etc.
土地利用混合度 Mixed land use	指从事有意义的个人或集体活动（如购物、社区活动）的目的地数量和种类 The number and types of places for programmed individual or group activities (e.g., shopping and community activities)	非住宅商业楼（饭店、咖啡厅、购物中心）、教堂、图书馆等 Commercial buildings (such as restaurants, cafes, and shopping malls), churches, libraries, etc.
社会环境 Social environment	本文特指建成环境之外可能影响体力活动的其他环境要素 Other relevant factors that may influence physical activities	人群开展的各类活动、车流量、空气污染、噪音等 All kinds of activities, traffic volume, air pollution, noise, etc.
主观评估 Subjective assessment	特指评估者对整个区域环境作出的快速简要的主观评价 Auditors' intuitive assessments on the overall environment	对整段道路步行和骑行难度的判断 An overall assessment of the suitability for walking and cycling along a road



3 © 徐振，王沂凡，徐秋霞，韩凌云，徐斐

3. 社区量表内指标占比分布图（因未搜索到ANC量表电子文献，本图未对ANC进行分析。）

3. Distribution of indicator items among community audit tools (ANC audit tool was not included because electronic literature of ANC was not found.)

如图3所示，所有社区类量表均包含土地利用混合度、基础环境特征与安全这三类要素，它们是最受重视的环境要素。其中，土地利用混合度与基础环境特征的指标数量占比最高，两者占比之和范围为33.33%（PIN3）~84%（SWEAT），大量实证研究也证明良好的安全要素和较高的土地利用混合度能够促进社区活力[62][63]。同时，提及最少的要素类别为主观评估，其次为社会环境。例如，由于步行吸引力等指标具有复杂性而难以被量化，因此研究者多使用主观评估作为附属评估要素。仅4份量表提及主观评估，占比很小，且普遍信度偏低[64][65]；社会环境要素在实际度量中也存在这一问题（如“噪音”的发生具有随机性，在不同时间段度量的结果有差异），且在大部分量表中占比偏低或为零，城市规划设计虽然不能直接主导其变化，却有望施以间接影响。

在各社区量表中，IMI和MAPS涵盖内容较全面、信度较高。IMI是应用最多的社区类量表[66]~[68]。MAPS不涉及主观评估，共有4个版本：完整版本（200个指标）主要度量微观尺度环境特征；使用缩略版本（54个指标）度量环境的研究最多[69]；迷你版本（18个指标）侧重从宏观角度用简单易测的指标进行度量，多为社区机构采用[43]；全球版本为国际间对比提供了可能，目前已在5个国家进行了信度检验[70]。NALP与SWEAT是涵盖要素最少的量表。NALP中指标多基于中观视角，较为精炼，适合快速了解环境支持积极活动的潜力[71]；SWEAT旨在度量社区环境对老年人活动的支持水平，指标针对性较好，尤其强调安全要素[53]。

3.4.2 度量开放空间的量表工具

在对8份开放空间量表的指标进行重新分类后，共得到10类要素，其中有8类与社区类量表相同，此处不予赘述，具有明显差异的两类要素为“周边环境”与“不文明现象”。其中，“周边环境”度量的是开放空间外部一定范围内所有的基本环境状况；“不文明现象”指场所中出现的不文明行为（乱扔垃圾等）或事物（宠物粪便等）。各开放空间量表中不同要素依据指标数量生成的分布如图4所示。

现有的大多数实证研究认为，影响居民使用开放空间的核心因素是开放空间的邻近度[72][73]，然而，通过图4可以看出，许多潜在要素能够预测并提高开放空间的使用水平，其中“设施”作为易于度量的要素为总占比最高的类别，例如在PARK量表中，设施类占比高达68%。

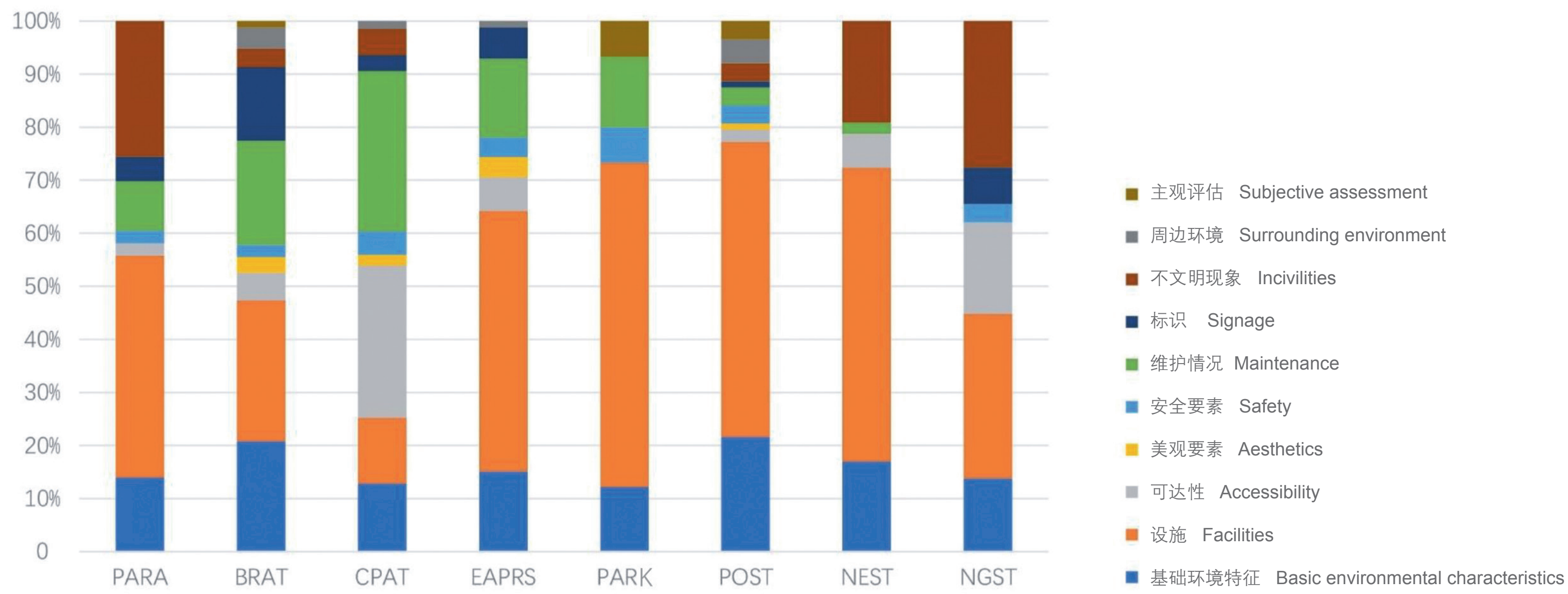
As is shown in Figure 3, indicators of mixed land use, basic environmental characteristics, and safety are commonly found across the community audit tools, where the number of the former two items predominates, ranging from 33.33% (PIN3) to 84% (SWEAT), with empirical studies proving a higher level of safety and mixed land use can increase the community vitality[62][63]. The least mentioned factor is subjective assessment. For example, indicators like “attraction of walking” are difficult to quantify, therefore sometimes supplementary subjective measurement is required. Subjective assessment is only included in four audit tools and sees a low reliability[64][65], so as the social environment factor (e.g., the noise occurs randomly and the measurement results vary at different periods of time) which is rarely adopted by most audit tools. Such social environment factors may be improved indirectly through urban planning and design approaches.

Among all the community audit tools, IMI and MAPS witness a widest coverage of indicators and a relatively high reliability. IMI is the most widely used community audit tool[66]~[68]; MAPS excludes subjective assessment and has four versions: the full version (including 200 indicator items) is mainly used for measuring micro-scale environmental factors; the abbreviated version (54 items) is mostly used in relevant studies[69]; MAPS-mini (18 items) is mainly employed for simple measurement and welcomed by nonprofessional auditors from community organizations[43]; MAPS-global allows for international comparison, whose reliability has been tested in five countries[70]. NALP and SWEAT cover the fewest indicators; specifically, items in NALP are concise and representative for quick assessment of the support degree of the given environment[71], and SWEAT is developed for the measurement of aged users’ physical activities and designed especially with safety considerations[53].

3.4.2 Open Space Audit Tools

After reclassifying items of the eight open space audit tools, two factor categories that are different from those of community audit tools were identified, namely surrounding environment and incivilities. Indicators of surrounding environment measure basic environmental factors within a certain range around an open space. Incivilities refer to the uncivilized behaviors (such as littering) or unpleasant things (such as pet’s excrement) observed in the open space. The distributions of indicators in each open space audit tool are sorted as Figure 4.

Most empirical studies have demonstrated that proximity is key to the usage of open spaces[72][73]. Besides, Figure 4 reveals many other potential elements, among which facility, as an easily



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4. 开放空间量表内指标占比分布图

4. Distribution of indicator items among open space audit tools

导致这一结果的原因可能是开放空间，尤其是公园中的设施类环境要素较其他场所中更为丰富，是最可能促进体力活动的环境要素类别。与社区类量表相同，每份开放空间量表中都包含基础环境特征要素（数量占比范围为12%~22%）；整体主观评估因属非客观度量范畴，依然是此类量表涉及最少的要素类别。同时，开放空间量表中涉及对周边环境评估的指标相对较少（仅BRAT、CPAT、EAPRS和POST中涉及），事实上，因居民去往公园途中需穿越不同城市空间，这些空间的特征对居民的行为或感知产生的影响应予以考虑[74][75]。

比较各开放空间量表发现，最全面的开放空间量表为BRAT与POST，其次是CPAT与EAPRS，这4份量表的指标数量相对较多，内容相对综合，可用于不同尺度的度量；涉及要素类别最少的量表是NEST与PARK（仅5类），两者都侧重对开放空间内部环境进行简单快速度量，而较少考虑周边环境；NGST与PARA两份量表所涵盖的要素数量属中间水平，不包括主观评价、美观要素及周边环境，均从直接促进活动本身的角度度量园内各种具备活动支持潜力的要素。鉴于CPAT和POST应用较多，前者于2016年发展出应用程序eCAPT[76]，后者分别于2010年和2018年发展出新西兰版本（NZ-POST）和应用App[77][78]，这些版本都在不同程度上拓宽了量表应用范围并简化了工作流程。

measurable one, accounting for a highest percentage, e.g., up to 68% in PARK audit tool — probably because its popularization in open spaces, especially in parks, can greatly help increase physical activities. Similar to those for community, all the open space audit tools measure basic environmental characteristics (accounting from 12% to 22%), and subjective assessment is least considered. Meanwhile, current studies less examine the indicators of surrounding environment (only involved in BRAT, CPAT, EAPRS, and POST), which should be taken into consideration since it would subtly influence people's behaviors within or perceptions of open spaces[74][75].

Among these audit tools, BRAT and POST have a greatest coverage of indicators, followed by CPAT and EAPRS. These four tools are applicable at various scales. NEST and PARK cover the fewest environmental factors (only 5 categories) and can be used for a rough and quick measurement of open spaces with little consideration of the surroundings. For the rest, NGST and PARA exclude considerations on subjective assessment, aesthetics, and surrounding environment and are often used for assessing the environment's direct influence on physical activities. Witnessing the widest application, CPAT developed the eCAPT version in 2016[76], and POST developed its New Zealand version (NZ-POST) in 2010 and mobile application in 2018[77][78]. All these new versions help popularize the audit tools and simplify workflows.

青少年为使用开放空间的主要群体，在8份开放空间量表中有2份主要面向青少年（CPAT与PARK），但二者差异较大：CPAT虽侧重青少年群体，但也适用于全年龄段人群；PARK则侧重度量吸引青少年进行体力活动的环境因素，相比其他量表更强调设施类要素，当前大量实证研究也证明了完善的设施对青少年体力活动具有促进作用[79]。

3.4.3 度量其他环境类型的量表工具

本研究中，其他量表针对的环境类型主要为工作场所、街道，以及城市总体环境。

工作场所是除住所之外人们进行日常体力活动的主要环境，近年来正逐渐引起重视。该类量表主要度量工作场所（如工业园区、校园等）户外空间内的休闲性步行路线及其周边环境，代表性量表有WWAT[48]和ISCOLE[80]。WWAT适用于各类工作场所的度量，含9个指标，操作简单，信度较高。尼古拉斯·D·吉尔森[81]以国际合作的方式使用WWAT对位于澳大利亚、加拿大、英格兰、北爱尔兰、苏格兰、西班牙和美国的10个校园内的主要步行路线进行了度量，发现不同的校园步行环境在体力活动支持程度上存在明显差异，典型的积极因素包括完整且舒适的人行道路、较少的步行与机动车交通冲突点、交叉路口有明显标识等，消极因素包括道路连接度低等。采用该量表对具体的指标信息进行测度和横向对比有助于厘清校园环境的差异，并提供具体的改进方向。ISCOLE仅度量校园这类工作场所中的环境要素，指标包含校内休闲设施、其他设施（如长椅及饮水设施）、美学要素，以及在学校操场内进行运动和一般类型活动的适宜性[40]。

随着可提供散步、骑行以及其他户外活动功能的街道越来越受欢迎[82]，规划实践者和环境决策者也开始审视人群户外活动所衍生出的旅游、零售、中心区复兴和休闲文化价值[83]。街道环境与体力活动的研究近年来显著增加，相关量表有PEAT、WABSA、WRATS。该类量表侧重度量道路本身的环境，包括基本特征、设施状况、道路维护水平，尤其关注交叉路口以及交通状况，原因是复杂的交通环境会影响人们的出行意愿。

Adolescents are a major user group of open spaces. Among the audit tools, CPAT and PARK are both youth-oriented but notably different: CPAT is suitable for all-age user measurement yet with an emphasis on teenagers, while PARK mainly measures the environmental factors especially facilities, encouraging adolescents' physical activities. A large number of empirical studies also have proved that sound facilities facilitate teenagers' exercise[79].

3.4.3 Audit Tools for Other Scenarios

In this paper, audit tools for other scenarios include the ones for workplaces, urban streets, and cities.

Workplace is a main scenario for physical activities besides communities and has received an increasing attention among researchers. Workplace audit tools are mainly used to measure outdoor walking spaces of a workplace (e.g., industrial and college campuses), represented by WWAT[48] and ISCOLE[80]. Containing 9 indicators, WWAT is suitable for all types of workplace with high user-friendliness and reliability. Nicholas D. Gilson adopted WWAT in an international cooperative study on major pedestrian routes of ten college campuses in seven countries and regions (Australia, Canada, England, Northern Ireland, Scotland, Spain, and the United States)[81], which discovered significant variations in support degree to physical activities among different campus environments: positive factors include pleasant sidewalks, less conflicts between walking and motor traffic, and conspicuous traffic signs, and passive factors include poorly connected road system. Such specific measurements and comparative studies can help clarify the distinctiveness of each campus and inform related improvement measures. ISCOLE, exclusively focusing on environmental factors of workplaces such as college campuses, measures recreational facilities and amenities (such as benches and drinking fountains), aesthetic factors, and the suitability for sports and general activities on playgrounds[40].

With an increasing popularity of pedestrian- and cyclist-friendly streets, routes, paths, and trails[82], planners and policymakers have started to value the significance in tourism, retail, downtown renewal, recreation, and culture propelled by outdoor activities[83]. Assisted by audit tools like PEAT, WABSA, and WRATS, recent studies on the associations between urban streets and physical activities have increased markedly. These tools are devised to measure streets' physical settings, including basic road characteristics, facilities, and maintenance status, particularly the traffic conditions of intersections which would affect people's willingness to travel.

城市作为一个巨系统，包纳丰富的环境要素，将整个城市作为研究对象需要量表反映城市整体特征且能够进行快速测度。RALA与MIUDQRW是两个典型的城市整体环境量表，均采用加权模型获取总指标并设定一个阈值作为健康城市的达标线或分级界线，利于对多个城市和同一城市不同区域的体力活动支持水平进行横向对比。RALA主要对土地利用、主观评估、娱乐设施、基本特征，以及政策实施和设施使用情况（如公立学校是否允许公众在非上学时间使用其活动设施）等要素进行评估；MIUDARW则侧重从使用者的角度出发，探讨能促进或抑制人群进行体力活动的环境要素（如标志性建筑、公共艺术品）的数量和占比。

3.4.4 小结

总体而言，社区环境量表强调整个社会—生态环境对居民生活态度潜移默化的影响，主要通过营造安全且具有较高土地利用混合度的社区促进积极生活；开放空间量表主要强调空间内部各类吸引居民前往并直接影响其体力活动的环境要素；工作场所和街道类量表更强调适宜步行和骑行的环境特征，城市类量表则为快速识别城市对体力活动的支持程度提供概略背景。

4 结论与讨论

4.1 现有量表特点总结与发展趋势

目前，度量体力活动相关建成环境要素的量表在美国、加拿大和澳大利亚等国已较为成熟并形成了一定的规程和体系，在学术研究、规划实践、政策制定等方面均已有所应用。

本文概述了26份建成环境量表的基本特征信息并对比分析了这些量表的具体指标内容，以呈现其在城市规划研究和实践中的适用范围和条件。现有量表虽然形式多样，但仍存在共同点。首先，量表的编制及应用均按一定模式进行（图5）。其次，可达性、安全性等指标因与体力活动支持关系密切而频频出现在各个环境量表中。第三，量表均具有操作简便、相对客观等特征，且便于调查者以相同或相近的口径快速收集和分析数据。近几年来，量表主要朝以下两个方向发展：

1）注重对细分人群的研究。例如，当前全球儿童及青少年的肥胖率逐年攀升，相关研究表明，该类人群的活动空间十分有限[84]。因此，

Cities are huge, complicated systems. Audit tools for cities should be able to quickly measure a city's overall characteristics. RALA and MIUDQRW, two representative tools, both develop overall index through the weighted combination model and regulate threshold(s) for Healthy City identification and grading, which facilitate comparative studies on the support degree to physical activities across cities or different areas within a city. RALA mainly measures factors of land use, subjective assessment, recreational facilities, basic characteristics, policy implementation, facility service condition (e.g., whether the facilities in public schools are available to the public in non-school hours), etc. MIUDARW is devised for measuring users' experience and perception, focusing on the quantity and proportion of environmental factors (landmarks, public art, etc.) that would encourage or discourage physical activities.

3.4.4 Summary

To be brief, community audit tools emphasize the influences of social-ecological environment on citizens' lifestyle, manifesting that active living could be supported by building safe communities with highly mixed land use. Open space audit tools examine various environmental factors that encourage people's physical activities. Workplace and street audit tools primarily explore the environmental characteristics suitable for walking and cycling, and city audit tools allow for a general and quick review of a city's support degree to physical activities.

4 Conclusion and Discussion

4.1 Existing Audit Tools and Development Trends

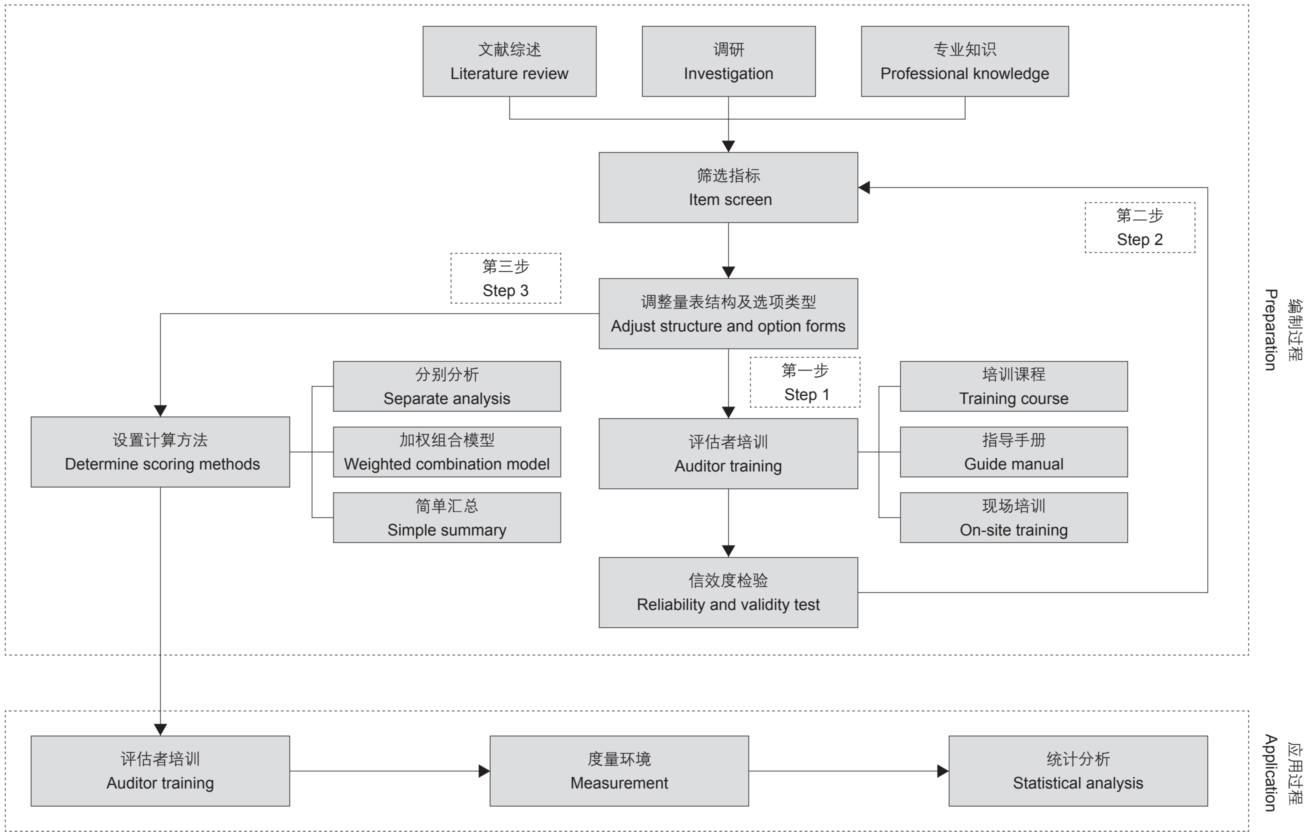
So far, audit tools for measuring built environment associated with physical activities in countries of the United States, Canada, Australia, etc. have developed systematic application procedures in academic research, planning practice, and policy-making.

This paper profiles the 26 audit tools for built environment measurement through a comparative analysis of indicator items to study their application suitability in urban planning research and practice. Diverse in forms, though, these audit tools have three aspects in common. First, these tools are all developed and applied in a same pattern (Fig. 5). Second, factors closely related to physical activities (accessibility, safety, etc.) appear with a higher frequency. Third, they are all easy to operate and sound in reliability, offering the same or similar measurement methods and indicator items for quick data collection and analysis. Recently, two trends of audit tools have emerged:

1) Subdivided research on user groups. For example, the obesity rate of children and adolescents keeps increasing

5. 编制及应用量表的过程

5. Process of the preparation and application of audit tools



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研究关注此类人群的行为模式和生活环境，并据此编制环境量表以针对性地促进该类人群的体力活动。

2）运用多源数据和新技术。为了增强量表的效度与信度，推进量表在环境评估和规划决策方面的应用，目前的研究正趋于在现场度量的基础上融合多源信息。已有研究证明，使用在线地图对特定区域进行初步度量有利于节省成本、提高后续现场度量的有效性[21][85]~[87]，并可为现场度量补充难以精确获取的数据（如无法直接进入的区域信息等）。此外，开发基于智能设备的量表程序对环境进行度量也是一大趋势[50][78]，其能够搜集、储存、导出数据，标记场景和地理位置或记录行动轨迹，有助于数据的拓展。

4.2 对构建中国城市环境评估体系的启示

中国城市规划设计者对于健康环境的探索处于萌芽阶段，在度量相关潜在环境影响因素方面缺乏系统性，尤其缺少对微观要素的度

globally, but there are inadequate places for them to do physical exercise[84]. Therefore, studies lay an emphasis on children's and teenagers' behavior patterns and living environment to develop targeted audit tools.

2) Multi-source data and new technologies. There are an increasing number of studies integrating multi-source data with field measurement to enhance audit tools' validity and reliability, and to promote their application in environmental assessment and planning decision-making. Studies prove that preliminary measurements with online maps see a lower cost in operation and a higher effectiveness in measurement[21][85]~[87], and can be used for the scenarios of difficulty in on-site measurement (the areas of poor accessibility, etc.). As another data source, mobile applications (Apps) based on smart devices show a promising future for audit tools[50][78], as they support data collection and storage, scene and location identification, and movement tracks.

4.2 Enlightenments on Establishing the Urban Environmental Assessment System in China

Healthy environment planning and design in China is at its initial stage. Auditing of environmental factors' influence on

量，因此有必要制定和推行符合中国国情的环境量表，构建较为全面的环境评估体系，从而指导健康城市设计。鉴于中国与欧美国家的社会背景、城市形态等存在差异，本研究建议中国学者在量表开发时特别考虑以下三点。

4.2.1 科学框架下的因地制宜

中国幅员辽阔，建成环境具有显著的地域差异和城乡梯度。因此，在度量城市潜在影响体力活动的环境要素时，跨城市及跨区域的横向比较非常必要。

本研究认为可通过两种途径推进量表构建，一是借鉴国际量表框架，并根据各地区实际情况对量表进行修订，以适应不同区域环境；二是通过现场调研以及进一步的文献梳理就某一类型的场地编制一份包含共性环境要素的量表，便于快速度量及进行城市/地域间的横向对比，以提供概略的基线对照。在进行指标筛选和设置计算方法时，应采用多利益相关方合作的方式对研究目标、研究对象、实地状况进行讨论，尽可能精准地选择指标，并对已构建的同类量表指标进行调控。例如，土地利用混合度在上述国外量表中权重较高，但中国的土地混合利用模式存在显著的城市形态差异，且封闭式小区等在一定程度上造成了碎片化空间和低使用率街道，可能使单纯的土地利用混合度指标对体力活动的预测性或解释程度非常有限。其次，在确定量表结构和指标前，需在不同时间、不同场景下进行度量，以充分校验量表——这是当前标准化度量中关键但又容易被忽视的环节。最后，可尝试将高效的机器学习算法引入标准化的度量过程，形成精细化、具体化且多层次的环境度量，并实现动态监测与反馈。

4.2.2 对动态环境的适应

中国自20世纪90年代开始的快速城镇化加速了社会经济环境背景的演变，以及城市内部结构与外部轮廓的变化。同时，与体力活动密切相关的城市形态在宏观、中观和微观层面变化迅速。在量表设计中，针对转型过程中的建成环境与人群年龄结构变化，应在指标设定、计算方法等方面进行动态调适，以有效反映建成环境对体力活动的支持或阻碍程度。此外，快速转型过程中的社会文化及环境转变极

citizens' health, especially those at micro-scale, is still insufficient and immethodical. It is essential to develop and promote audit tools adaptive to China's societal conditions and urban forms, and construct a wide-ranging environmental assessment system so as to steer health-oriented urban design throughout the country. Chinese researchers are expected to strengthen audit tool studies from the following three aspects.

4.2.1 Building a Scientific Framework on Locality

Given the significant regional diversity and urban-rural gradient throughout China, it is necessary to stress the comparative study on environmental factors to physical activities across cities and regions.

Two roadmaps are suggested here for the preparation of audit tools. One is to adapt the frameworks of proven audit tools to China's circumstance; the other is to develop an audit tool consisting of all the commonly-mentioned environmental indicators after field research and further literature review for quick measurement across cities and regions, providing a baseline for comparative studies. It is necessary to identify research objectives, objects, and site conditions through cooperation among different stakeholders by selecting proper scoring methods and indicators and adjusting the framework of existing tools. For example, the indicators of mixed land use that are highly weighed in foreign audit tools cannot be adopted to measure or interpret urban built environment in China, because the mixed land use level and pattern in Chinese cities vary considerably, where gated residential communities sometimes cause spatial fragmentation and low-usage streets. Also, cross validation is a key to determine an audit tool's structure and indicator items but is often ignored in current standardized measurements. Finally, machine learning algorithms could be introduced to make auditing more refined, targeted, and multi-scaled, facilitating dynamic monitoring and feedback.

4.2.2 Adaption to Dynamic Environment

The rapid urbanization since the 1990s in China has caused dramatic changes of socio-economic environment in urban structure, form, and fabric at varied scales, which has greatly impacted citizens' physical activities. These changes should be responded through dynamic indicator constitution and scoring method selection to improve environmental assessment of support degree to physical activities. In addition, social, cultural, and environmental changes should be considered, since they may influence people's perceptions and behaviors. For instance, the emerging square dancing enriches citizens' public activities, the increasing vehicle dependence has reduced people's walking hours, and frequent haze has dispelled people's willingness to travel[88].

有可能影响居民的主观感知和行为选择（如广场舞休闲活动的兴起丰富了公众活动类型、购车热潮使步行出行减少，以及频发的雾霾影响了相当数量居民的出行意愿和频率[88]等），这些因素对量表构建和积极活动空间的塑造提出了新的挑战，也应予以重视。

4.2.3 多学科、多部门参与相关规划决策

度量建成环境对体力活动的支持情况并对其进行积极干预有赖于多学科交叉研究成果，城市规划部门应加强跨学科、跨部门的有效协作，并促进相关决策的推进。

城市规划在总规、控规及详规阶段可分别对应使用宏、中、微观类量表。在总规阶段，将快速度量的潜在环境要素与公众健康水平进行叠合，可将这些环境要素对体力活动的影响水平进行跨城市或跨区的对比，为设计优化提供依据。在控规、详规和城市设计阶段，量表能为制定具体环境的设计导则提供参照，也能为评估规划设计的实施绩效提供参考。在后续管理阶段，量表可用于绩效监测与反馈，以便各部门进一步统筹兼顾，制定合理的管理决策。此外，推广量表能培养基层社区管理人员的健康意识、提升公众参与，自下而上地提高公众健康水平。

4.3 反思

整体而言，中国关于体力活动与建成环境的研究相对不成熟，研究的多样性和系统性尚未形成，这在一定程度上限制了该议题中的健康影响评价，也使得积极干预缺乏坚实可信的基础。本研究梳理并分析了面向积极生活的主要环境量表，对量表编制中值得借鉴的内容和方法进行了初步总结。鉴于量表的异质性，不同量表的效率及具体内容难以进行严格比较，本文可能会模糊量表间的具体差异，在今后的研究中，应考虑使用同类别量表在特定范围内进行实地度量，以实现全面而精确的比对。

本研究聚焦于量表本体与编制过程，限于篇幅，本文未对量表展开关于验证过程与调适方法的分析——这两个环节在基于本土的实证研究中不可或缺——亦未对量表度量的各类环境要素所产生的环境效益进行比较，今后有待对此进行具体阐述。LAF

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These factors need to be attached importance in audit tool development and design interventions for positive activity spaces.

4.2.3 Interdisciplinary and Multi-Department Collaboration in Decision-Making

Interdisciplinary research is indispensable for built environment auditing and positive design intervention. Cross-department collaboration should be enhanced to propel relevant decision-making processes.

Macro-, meso-, and micro- audit tools can be used to inform master planning, regulatory planning, and detailed planning, respectively. In master planning, by overlapping environmental factors and public health data, it would be helpful to compare the impacts of these environmental factors across different cities and regions, providing a basis for optimal design. In the stages of regulatory planning, detailed planning, and urban design, audit tools provide guidelines for site design and for performance evaluation of planning and design. For planning management, audit tools could be used for performance monitoring and feedback collection to improve the coordination of decision-making. In addition, the promotion of audit tools benefits to increasing community governors' health awareness, enhancing public participation, and improving public health level through bottom-up efforts.

4.3 Reflection

In China, empirical studies on physical activities and built environment are still inadequate in the diversity and systematism of research interests, which impedes the practice of health impact assessment and fails to offer intelligential support to positive intervention. This paper analyzes the existing audit tools for active living and summarizes the valuable knowledge and methods that can be used for developing audit tools. Given that it is difficult to comparatively study the efficiency and every indicator item among various audit tools, such differences are not examined in this paper. In the future, field measurements with same category audit tools should be conducted for more comprehensive and specific comparative studies.

Concentrating on reviewing the indicator items and the preparation and development of audit tools, this paper does not include discussions about the validation process and adjustment method of the audit tools — two indispensable steps in local empirical research to given study areas — neither compare the environmental benefits of different factors. Further efforts are expected in future studies. LAF

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