

# 城市建成环境对居民身体活动的影响 研究进展与启示

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**摘要:**城市建成环境与身体活动关系是城市系统人地关系在健康领域的一种现实表现,两者之间的良性互动关乎城市公共健康的发展与管理水平,是健康地理学新近研究热点。论文基于地理学空间视角,从空间组织、空间格局、空间功能3个维度论述了国内外城市建成环境对居民身体活动影响的研究进展。结果表明,国外研究取得了诸多成果:①理论与方法上,社会生态理论应用最为广泛,不断被修正和拓展。而基于移动-活动行为理论的建成环境与身体活动关系研究日益成为新视角。同时,一些复杂计量回归模型、空间回归模型得到较多应用。②实证研究上,重点关注城市建成环境空间组织、空间格局、空间功能一系列特性对不同人群身体活动水平、类型的影响。空间组织上主要集中在交通组织、绿地网络等组织类型,以及可达性、连通性等空间联系的影响研究。空间格局上强调能级差异下建成环境要素集聚多寡,空间外部几何形态表征、指示对身体活动产生的相应影响研究。空间功能上多探究混合性、单一功能构成和主客观功能品质的影响研究。国内相关研究主要集中在地理学、城市规划学、体育学等领域,尚处于初步介绍国外相关研究成果和少量实证研究阶段,缺少基于本土的理论提升及典型案例研究。最后,论文从理论、方法、实证上探讨地理学视角下未来研究重点:基于“天人合一”理念的理论提升;基于多源数据融合和时空计量的研究新方法;基于虚实交互空间和本土语境下的实证研究。

**关键词:**建成环境;身体活动;城市空间;影响机制;公共健康

当前世界城市化水平已超过54.0%(联合国, 2017)。城市化的发展很大程度上改善了人们的生活水平与质量,但机动车交通过度依赖、体力劳动量大幅减少等生活方式导致的身体活动不足,已加剧肥胖、心血管疾病、糖尿病等慢性疾病的发生,而慢性疾病又与全球70%的死亡密切相关(世界卫生组织, 2018)。为解决城市化进程中因身体活动不足导致的公共健康问题,西方国家通过环境卫生、城市交通、街道布局规划和社区建设等诸多实践对身体活动进行了多层次、全方位干预(萧明, 2016),并已取得显著成效。当前发展中国家在城市无序蔓延加剧、居民体质下降、慢性疾病发病率持续增

长的情况下,对于如何通过有效改善城市建成环境达到提升身体活动质量、促进居民健康水平,正面临一系列严峻挑战(Day et al, 2013)。

身体活动主要指由骨骼肌肉产生的需要消耗能量的任何身体动作,包括工作性、家务性、交通性、休闲性等活动(世界卫生组织, 2018)。大量研究认为身体活动不仅受个体生理、心理特征影响,还受其所处环境的影响,其中城市建成环境被证明是影响身体活动的关键因素(王兰等, 2016)。早在20世纪90年代,针对城市蔓延对身体活动的限制,国外学界便关注城市建成环境对身体活动的影响。早期以社会生态理论为基础,主要审视微观环境因

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子的影响(Corti, 1998),随着建成环境测量方法的发展及身体活动调查范围的扩大,大量实证研究发现城市形态特征与身体活动存在相关或因果关系(Handy et al, 2002; Saelens et al, 2008)。当前研究则主要通过引入行为地理、环境心理的理论与方法,探究活动暴露环境、环境感知与身体活动的关联(Ivory et al, 2015; Perchoux et al, 2016),更加注重身体活动实际所涉及建成环境的影响。总体来看,国外城市建成环境对身体活动的影响研究已形成涵盖健康科学、行为科学、交通运输、城市规划、地理学、政策研究等领域的全面分析框架。

目前中国城市化的快速发展显著改变了城市系统的人地关系。一方面,城市建成环境的改善提供了便利的生活环境;另一方面,快节奏的生活方式也使得居民日常身体活动与以前有很大不同,其中机动出行方式盛行、运动锻炼时间减少已导致居民体质下降、慢性疾病持续增长等问题凸显(萧明, 2016)。在此背景下,《“健康中国2030”规划纲要》强调通过普及健康生活、建设健康环境等提高人民健康水平(中国共产党中央委员会等, 2017),表明建设能够促进居民身体活动健康效应的建成环境是提高人民健康水平的重要手段。而当前实践领域仍缺少全面、有效的积极生活规划和政策支持(张莹等, 2014)。国内地理学、城市规划学、体育学等领域虽已初步介绍国外相关研究成果并进行了少量实证研究(韩西丽等, 2011; 温煦等, 2014; 张莹等, 2014; 林雄斌等, 2015; 鲁斐栋等, 2015; 孙斌栋等, 2016; 吕和武等, 2017; Zhou et al, 2017; 周素红等, 2017),但基于本土的理论提升及典型案例研究仍显不足。本文在概述当前相关基础理论及研究方法的基础上,挖掘和突出现有研究的空间视角,从建成环境空间组织、空间格局、空间功能3个维度系统性梳理和分析国内外城市建成环境对身体活动影响的实证研究,为进一步探索相关理论与实践研究提供有益借鉴和启示,并将城市建成环境对身体活动的影响研究置于以人为本的城镇化发展及当前中国社会经济主要矛盾这一语境下,探讨地理学视角下未来可能开展的研究方向。

## 1 基础理论与方法

随着身体活动研究在地理、城市规划、行为科学、公共健康等学科间的交叉与融合,产生了较多

城市建成环境与身体活动关系研究的基础理论,为一系列相关实证研究提供了基础分析框架和理论支撑。其中影响较大的有社会生态理论模型、城市健康模型和基于活动的健康行为模型等,并涌现出大量相关定量分析模型,重点关注空间视角下建成环境对居民身体活动的影响以及强调建成环境的可干预性。

社会生态理论模型最早由Sallis等(2002)引入身体活动研究中,通过借鉴生态学观点,着重关注不同层级影响因素对个体身体活动行为的共同影响。这一理论假设环境和支持可促进身体活动行为的提升与改变,反之则会增加提升与改变的阻力。其核心理念认为行为是多因素影响的结果,环境是多方面与复杂的,行为与环境的互动不断变化且可在不同组织层面表达。社会生态理论模型提供了全面、跨学科的分析框架,拓宽了身体活动相关因子分析的研究思路,在揭示城市建成环境对身体活动影响机制的实证研究中得到了广泛应用。

Sarkar等(2017)等基于现代流行病学研究和相关政策需求,以“生态位”(eco-niche)概念为基础,提出“城市健康位”(urban health niche)这一概念。它假定个体在城市中的健康位受到微观(个体身体免疫力或遗传)、中观(个体生活方式)、宏观(社会环境、自然环境、建成环境)3个层面风险的影响,且这一影响不断发生着时空演绎。同时,进一步提出可应用于城市规划和管理的“健康城市模型”(health city model),强调将多层次空间中的风险因素整合到一起,形成囊括3个并行系统(个体-群体系统、家庭-邻里-城市系统、管治和决策系统)的研究模型。与社会生态理论模型不同,“城市健康模型”进一步引入建成环境影响的时空维度,并试图引导公共健康与城市规划的专业化干预。

社会生态理论和“城市健康模型”构建了居民身体活动的多层次影响因素,但尚未映射或概念化各种因素之间的相互关系和相对重要性,难以有效揭示建成环境对身体活动影响的复杂性。Saarloos等(2009)提出基于活动的健康行为模型,强调应将基于系统分析的方法论转变为基于主体的分析,观察、理解不同环境背景下整个系统的行为,捕捉环境对行为的影响过程,以及个体在互动过程中的适应性和响应性。理论核心在于试图理解不同个体身体活动行为如何交织在一定的空间和时间上,进

而模拟和预测环境的影响。这一模型通过引入行为地理学的活动分析理论构建了建成环境与身体活动关系研究的新框架。

此外,城市建成环境对身体活动影响的研究方法不断涌现。早期研究认为建成环境与身体活动之间存在一种相关关系,因此,一系列简单线性回归模型得到广泛应用。随着学界对建成环境和身体活动时空属性的深入挖掘,简单线性模型难以精确度量两者之间的复杂关系,一些研究中逐渐出现混合线性、结构方程、多元线性等复杂回归模型和探究两者关系空间非均衡性的空间回归分析模型,如地理加权回归分析等(Feuillet et al, 2015; Perchoux et al, 2015; Matisziw et al, 2016)。此外,一些学者在研究社区环境自我选择中,借鉴计量经济模型思想,通过一系列统计控制、工具变量分析、样本选择模型、联合离散选择模型、结构方程模型、准实验研究设计及地理加权泊松回归等,减少建成环境与身体活动之间估计关联偏差,试图对身体活动量开展预测(Feuillet et al, 2016)。

2 实证研究主题与内容

随着身体活动与建成环境关系的健康效应被越来越广泛、深入地认知,健康问题的解决途径不

仅仅关注人的主体地位,而且从理论与方法上更强调以空间为主要特征的建成环境客体对人的影响,认为建成环境是居民身体活动的空间载体,并通过一系列相关环境要素的组合对身体活动产生促进、制约等空间效应,有效指导和推进了大量相关实证研究的开展。因此,为了更好地梳理与体现空间视角的研究范式,从空间组织、空间格局、空间功能3个维度概括现有城市建成环境对居民身体活动的影响研究(图1)。

2.1 建成环境空间组织对身体活动的影响

建成环境空间组织是对建成环境要素空间关系的安排,现有研究多从组织类型、空间联系2方面解读建成环境空间组织对身体活动的影响。

2.1.1 组织类型的影响

正如社会生态理论模型或城市健康模型所强调的,居民身体活动不仅受核心活动范围内建成环境要素特征的影响,也会受到更高层级城市建成环境组织的影响。目前国内外关于建成环境空间组织对身体活动的影响研究,重点关注城市层面交通组织、绿地网络2种组织类型的影响。

(1) 城市交通组织。城市组织发展不同主导交通方式显著影响居民身体活动类型和水平。一些研究指出城市以小汽车为主导交通发展模式,容易增加空气、噪声等污染,限制绿地空间发展,减少日

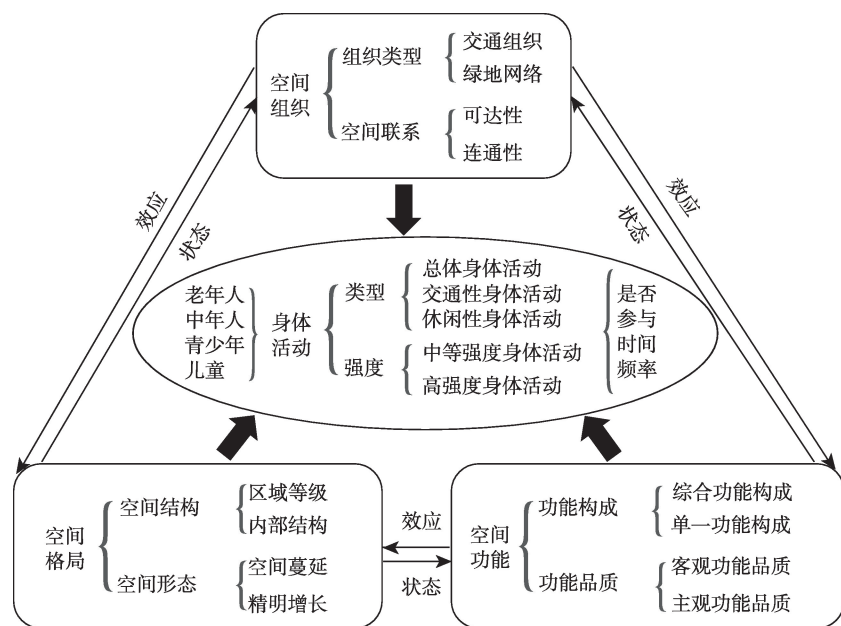


图1 空间视角下城市建成环境对身体活动影响的实证研究概况

Fig.1 Summary of empirical research on the influence of urban built environment on residents' physical activity in the perspective of space



常积极出行机会,导致城市身体活动不足问题凸显(Waygood et al, 2015)。而另一些学者则提出减少城市中小汽车使用,发展公共交通网络,通过连接城市活动系统、提供慢行交通环境吸引居民开展更多交通性、休闲性身体活动(Lachapelle et al, 2011)。同时,也指出这种交通发展模式有利于减少交通拥堵,改善空气质量,以及辐射更多人群,提升城市整体身体活动水平(Wey et al, 2013)。

(2) 城市绿地网络。一些研究已发现整合大范围地区的绿地资源(包括公园、绿道等)可提高城市整体环境质量,吸引更多居民开展休闲性身体活动(Irvine et al, 2013)。他们认为,由城市不同绿道、公园等构成的生态网络可在自然环境和建成环境间达到平衡,为居民提供贴近自然的、连续的、网络化的休闲公共空间,有利于增加居民尤其老年人身体活动的意愿和实际休闲性身体活动的概率(Calogiuri et al, 2017)。借助运动APP大数据,Liu等(2016)验证了深圳城市绿道网络的使用可显著提高居民身体活动的多样性和水平。

### 2.1.2 空间联系的影响

基于居民日常出行、活动需求,建成环境要素空间联系便利与否、可选择路径多寡直接影响居民身体活动类型选择与时间安排。当前建成环境空间联系对身体活动的影响研究多体现在交通联系方面,重点关注居民日常身体活动空间范围内交通可达性和连通性的影响。

(1) 可达性。借助GPS追踪与活动日志调查,通过挖掘身体活动的空间属性,一些研究指出居住地与公交或地铁站点间的可达性越好,越有利于增加通勤者、老年人日常步行/骑行通勤或出行的机会(Barnett et al, 2016; Yang et al, 2017),且经常步行或骑行到公交或地铁站点可促使居民形成积极生活方式,增加到其他目的地步行或骑行的可能性(Lachapelle et al, 2016)。此外,研究发现与目的地(包括公园绿地、学校、工作场所、商业设施等)间的距离越近,可达性越好,一般越有利于增加交通性步行或骑行机会(Ito et al, 2017),以及休闲性步行和中等强度身体活动量(Duncan et al, 2005; Churangarit et al, 2011),但也可能存在负向影响(Toftager et al, 2011)。同样,主观感知可达性与居民身体活动水平呈现正相关,即居民对公共交通站点或目的地可达性感知距离越好,越有可能增加步行或骑行机会(Kondo et al, 2009)及休闲性身体活动频率

(Carrollscott et al, 2013),但也可能减少身体活动频率(Dyck et al, 2013)(表1)。

(2) 连通性。现有研究多通过测度邻里街道长度、面积、交叉口密度、街道密度等指标考察连通性与步行或骑行行为之间的关系,发现邻里街道连通性越好,出发地和目的地之间的距离越短,越有利于增加成人或儿童交通性步行或骑行(Helbich et al, 2016)、老年人休闲性和交通性步行的机会(Troped et al, 2017),以及预测行人交通量。此外,成人对邻里街道连通性感知越好,将步行或骑行作为交通方式的概率越高(Liao et al, 2015),越放心青少年采取积极交通方式上下学(Carlson et al, 2014)。但也有研究指出街道连通性与积极出行、休闲性步行存在弱正相关(Rodriguez et al, 2008)。另一些研究则发现街道连通性和身体活动间可能存在负向关系(Mecredy et al, 2011)。

## 2.2 建成环境空间格局对身体活动的影响

建成环境空间格局主要是建成环境单要素空间分布或多要素空间关系的呈现,直观表现为空间结构和空间形态2个方面对身体活动影响的研究。

### 2.2.1 空间结构的影响

空间结构一般表现为规模等级结构和功能组合结构,由于区域城市间及城市内部的等级决定了建成环境要素集聚多寡,现有研究多比较不同等级城市及城市内部不同空间位置建成环境差异对居民身体活动的影响。

(1) 城市区域等级。重点比较大、小城市间建成环境差异对身体活动的影响,研究表明不同规模城市间建成环境差异显著影响居民步行水平。一些研究发现大都市地区或大城市通过提供便利的休闲性资源、较完善的公共交通系统、多样化的土地利用等,促使居民交通性步行水平明显高于小城市(Doescher et al, 2014)。但也有研究指出,与大城市相比,小城市街道交通速度放缓,居民主观感知良好,反而有利于增加休闲性步行水平(Stewart et al, 2016)。

(2) 城市内部结构。城市内部分区结构尤其是中心-外围结构对不同人群身体活动具有差异化影响。一些研究指出,与郊区或农村低密度、低土地混合利用等较差的环境质量相比,居民在城市中心地区更倾向选择积极交通方式,开展休闲性身体活动,且更容易满足身体活动推荐标准(Shores et al, 2010; Doescher et al, 2014)。但另一些研究则发现

表1 建成环境要素可达性影响概要

Tab.1 Summary of the influence of accessibility of the built environmental factors on residents' physical activity				
研究人群	涉及建成环境要素	对身体活动的影响	主要研究国家或地区	主要文献来源
儿童	公共开放空间可达性	正向影响高强度身体活动时间	澳大利亚墨尔本	Timperio et al, 2008
	公共服务设施(如学校)可达性	正向影响积极交通方式选择	北美、欧洲、澳大利亚	D'Haese et al, 2015; Ito et al, 2017
	公共开放空间、商业服务设施(如邻里公园、游乐场地、体育场馆)可达性感知	正向影响休闲性身体活动频率	美国	Carrollscott et al, 2013
青少年	公共开放空间可达性	正向影响身体活动参与	马来西亚	Danis et al, 2014
	商业设施(如体育设施)可达性	正向影响健身行为(中高强度身体活动)	欧洲	Vanhelst et al, 2013
	公共服务设施(如学校)可达性	负向影响交通性骑行量	比利时	Dyck et al, 2009
成人(主要以中、青年样本为主,部分文献包含老年样本)	公共服务设施(如公交站点)可达性	正向影响交通性步行参与	美国、澳大利亚、英国	Mccormack et al, 2008; Heesch et al, 2015
	公共开放空间可达性	正向影响步行、中高强度身体活动量;负向影响休闲性步行量	澳大利亚墨尔本、丹麦	Toftager et al, 2011; Koohsari et al, 2013
	商业设施可达性	正向影响身体活动总量与频率、积极交通方式选择	捷克、泰国	Churangarit et al, 2011; Sigmundová et al, 2011
	工作地可达性	正向影响积极通勤方式选择	欧洲	Yang et al, 2017
	公共开放空间(如邻里大型公园)的可达性感知	负向影响身体活动频率与水平;正向影响休闲性步行可能性	墨西哥、澳大利亚阿德莱德	Dyck et al, 2013; Sugiyama et al, 2013
老年	公共服务设施可达性	正向影响交通性步行频率	新加坡	Nyunt et al, 2015
	商业设施可达性	正向影响步行频率与总量、交通性步行时间	澳大利亚、比利时	Cauwenberg et al, 2012; Nathan et al, 2012
	休闲设施、公共服务设施可达性感知	正向影响交通性步行、休闲性步行频率与总量	中国香港	Barnett et al, 2016

在低城市化或农村地区也可能会显著增加成人、儿童的休闲性身体活动量(Sandercock et al, 2010; Thielman et al, 2015)、成人与青少年积极通勤概率(Dyck et al, 2009; Feuillet et al, 2015)。

2.2.2 空间形态的影响

现有空间形态对身体活动的影响研究多关注城市用地的外部几何形态如何表征、指示建成环境对身体活动的影响,着重关注城市空间蔓延式和紧凑式扩展形态的影响。

(1) 空间蔓延。研究发现城市空间蔓延对居民总体及交通性、休闲性身体活动水平均具有消极影响(Plantinga et al, 2007)。城市空间蔓延带来的街区规模大、街道连通性差、用地类型之间严格分割、机动化出行方式流行等问题,容易增加居民到达一些目的地(如商店、公园等)的步行距离,减少日常积极出行和休闲活动的机会(Scott et al, 2009)。翁锡全等(2014)指出,城市空间蔓延导致居民职住分离,闲暇时间过多消耗在通勤上,加之过度依赖机动车交通,容易减少总体身体活动量。但在城市空间蔓延对休闲性身体活动影响的实证分析中,未发现显著负向结果(Ewing, 2005)。

(2) 精明增长。精明增长通过紧凑式规划,提供多样化交通选择和安全环境促进居民积极出行和开展休闲性身体活动(Handy, 2005)。其构成要素包括紧凑型邻里、公交导向型发展、步行及骑行友好型设计等。研究指出这些要素有利于培育活动、步行友好型环境,提升身体活动水平。如Durand等(2011)通过梳理一系列文献指出5类精明增长因素(房屋类型多样性、土地混合利用、居住密度、紧凑式发展模式、开放空间水平)可显著增加身体活动和步行水平。但由于城市精明增长是一个综合性、宽泛性概念,鲜有实证构建全部指标体系衡量其对身体活动的影响程度。

2.3 建成环境空间功能对身体活动的影响

建成环境空间功能即是建成环境要素通过空间组织安排产生的空间作用,现有研究多从空间功能构成和空间功能品质对身体活动的影响展开研究。

2.3.1 功能构成的影响

功能构成对身体活动的影响研究不仅关注功能类型构成多寡的影响,也关注功能构成对特定人群身体活动的影响。

(1) 综合功能构成。现有研究多采用混合性指标表征用地综合功能特征。一些研究发现邻里土地利用混合性显著增加交通性步行和骑行量(Christiansen et al, 2016)、步行频率和身体活动量(Li et al, 2008; King et al, 2015)、中高强度身体活动量(Matisziw et al, 2016),且这种正向影响在一些长期动态观察上也较稳健(Chen et al, 2017)。其中一些研究指出居住、商业、办公、娱乐等用地的混合利用可显著增加交通性步行量;公共开放空间、体育设施等用地的组合利用可有效增加休闲性步行量(Christian et al, 2011)。但一些研究也指出邻里或工作地土地利用混合性与身体活动水平呈现非相关性(Nathan et al, 2012; Wang et al, 2016)、与积极出行选择呈负相关(van Heeswijck et al, 2015),可能与高混合土地利用带来繁忙交通削弱居民开展积极交通、休闲性身体活动的意愿相关(Sung et al, 2013),也可能与土地利用类型选择和计算方式有关(Christian et al, 2011)。

(2) 单一功能构成。研究发现身体活动类型及时间的安排取决于邻里用地类型。其中,邻里配置水域用地有利于增加成人骑行和休闲性步行量或老年人开展其他身体活动的可能性(Perchoux et al, 2015; Chen et al, 2017; Zhou et al, 2017),商业用地提高成人休闲性步行水平(Hahm et al, 2017),体育设施用地增加年长者、成人中高强度身体活动量(Cranney et al, 2016; Jansen et al, 2016),居住用地提高成人交通性步行概率(Oliver et al, 2007)。公园用地作为邻里重要公共开放空间之一,可提供一种低成本活动环境,显著影响不同年龄阶段人群休闲性身体活动水平,如增加成人休闲性步行水平(Chaix et al, 2014)和中高强度身体活动量(Joseph et al, 2016)、儿童或青少年身体活动量(Babey et al, 2015; Sanders et al, 2015)、老年人休闲性步行水平(Cherniavsky, 2013)和身体活动量(Pleson et al, 2014),但面积较大的公园也有可能减少成人步行频率(King et al, 2012)。

### 2.3.2 功能品质的影响

建成环境功能品质不仅指建成环境物质实体的客观功能质量,也包括居民由于自身社会经济水平差异而带来的对建成环境的主观感知,也就是说功能品质将从主客观2个方面对身体活动产生影响。

(1) 客观建成环境品质。重点关注步行环境综

合功能品质和单一公共开放空间功能品质的影响。研究发现邻里步行环境质量越高,越容易增加儿童积极出行概率(Molina-Garcia et al, 2017)和减少青少年身体活动不足风险(Laxer et al, 2013),增加老年人积极出行可能性(Berke et al, 2007)、身体活动量(Winters et al, 2015)和休闲性身体活动量(Gao et al, 2015)、成人交通性步行或骑行水平(Clark et al, 2014)和中高强度身体活动量(Dyck et al, 2010)。但也有研究发现邻里步行性水平与成人中高强度身体活动量呈负向关系(Thielman et al, 2015)。此外,一些研究指出公共开放空间尤其公园的吸引力、安全性、便利性、保养性、多样性等品质特征显著影响身体活动水平(Koohsari et al, 2015),但影响结果存在差异性(Timperio et al, 2008)。

(2) 主观建成环境品质。在探究客观建成环境空间品质影响基础上,基于个体日常身体活动与建成环境要素间的互动,一些学者将个体主观感受纳入分析,重点考察邻里建成环境可步行性、美学、安全性、保养性等感知的影响(Cerin et al, 2006)。研究发现建成环境感知与身体活动间存在相关性(Bracy et al, 2014)。大多数研究表明居民对邻里或特定公共开放空间可步行性、美学感知越强,休闲性活动水平越高,更容易达到身体活动推荐量(Nathan et al, 2014; Spanier et al, 2014)。而与犯罪、交通相关的安全要素感知,可能会影响居民在户外活动的意愿,进而影响其交通性和休闲性活动水平(Foster et al, 2008; Bracy et al, 2014; Jack et al, 2014)(表2)。

## 3 结论与启示

城市建成环境对身体活动的影响研究经过近30 a的发展,形成了比较丰富的理论体系,基础理论从系统分析转变为基于主体的分析;借助于更加多维的调查数据以及“3S”技术获取的空间数据,研究方法也从传统的简单线性相关分析拓展为多层次回归分析和空间计量分析。实证研究上多从空间组织、空间格局、空间功能等空间维度切入建成环境对身体活动的影响研究,并不断趋向多维、融合、精细。

总体而言,国外关于建成环境对身体活动的影响研究起步较早,进行了较为系统的分析,理论和实证研究相对成熟,取得了大量成果,而国内仍处



表2 建成环境要素空间功能品质感知影响概要

Tab.2 Summary of the influence of perceived built environmental factor qualities on residents' physical activity				
感知群体	感知要素	感知特性	对身体活动的影响	主要文献来源
儿童	步行环境	可步行性	无影响	Hager et al, 2013
	交通	安全性	正向影响身体活动量	Grow et al, 2008
青少年	步行环境	友好性	更容易达到身体活动推荐量和更少的静坐活动	Kopcakova et al, 2017
		犯罪安全性	正向影响身体活动参与	Nichol et al, 2010
		交通安全性	正向影响积极出行频率	Carlson et al, 2014
成人(主要以中、青年样本为主,部分文献包含老年样本)	步行环境	整体质量	对骑行倾向无影响,对骑行频率有影响	Foster et al, 2008; Bringolf et al, 2010; Dyck et al, 2013; Bracy et al, 2014; Jack et al, 2014; Nathan et al, 2014; Ma et al, 2015; Vanwollegghem et al, 2016
		犯罪安全性	正向影响交通性、休闲性步行量;无影响;负向影响整体身体活动量	
		交通安全性	正向影响儿童、青少年采取积极交通上下学以及高强度身体活动量	
		美学	正向影响休闲性活动参与	
	公共开放空间(如公园、步行空间等)	安全性、美学	正向影响休闲性步行和总体步行频率、时间;无影响	Bringolf et al, 2010; Cohen et al, 2010; Leslie et al, 2010
老年	交通	安全性	正向影响交通性步行、高强度身体活动量	Jack et al, 2014
	步行环境	美学	正向影响休闲性、交通性步行量	Spanier et al, 2014
	交通	安全性	正向影响交通性步行量	Cauwenberg et al, 2012

于初始阶段,缺少基于本土的理论提升及典型案例研究。当前,在城市建成环境对身体活动影响的研究领域,仍存在以下不足之处:在研究理论方面,虽然当前从行为活动的维度反观建成环境对身体活动的影响,突出了人的主体性,但一定程度上忽略了身体活动与建成环境这一特殊人地关系其实具有同一性,追求的是互利共生、相互促进,最终基于短期健康效应对建成环境的调整可能并不会带来健康效应的最优化;在研究方法方面,更多还是依托访谈、调查问卷等半定量、小数据技术手段,融合大数据等多源数据的获取与分析方法应用还不多,还不能很好地兼顾尺度和精度问题;在实证研究方面,当前更多的还是在实体空间框架下探讨建成环境对身体活动的影响,忽视了ICT技术影响下虚实空间的交互影响效应,也较少关注中国当前城市化进程中健康相关新老问题的叠加。因此,未来城市建成环境对身体活动的影响研究,需在理论、方法、实证等方面进一步加强与深化。

(1) 基于“天人合一”理念的理论提升。突破现有社会生态理论把人作为普通系统要素,行为地理学把人作为单一主体的思维框架,认为身体活动与建成环境互为主客体,两者之间互相映射与塑造,以两者动态良性交互为途径,以健康效应的整体达成目标,追求“天人合一”,相互提升,共同营造,将建成环境对身体活动的影响研究推向日常生活

中整合建成环境、身体活动、生活方式等全时空要素互动的整体健康效应研究,以期达到可持续的、真正的以人为本,从而科学有效指导健康城市规划与设计。

(2) 基于多源数据融合和时空计量的研究新方法。弥补大小数据之间结合的鸿沟,构建能够同时兼顾多尺度、高精度的时空分析模型,并借鉴机器学习等人工智能领域的新方法、新理念,提取建成环境对身体活动的影响模式及机制,进而科学合理地模拟、预测不同建成环境影响下身体活动的健康效应。

(3) 基于虚实交互空间和本土语境下的实证研究。ICT快速发展一方面开拓了城市建成环境对身体活动影响的新途径,推动了建成环境对身体活动影响的新内容;另一方面也加剧了不同人群间感知利用新型中介手段介入城市建成环境对身体活动影响过程的能力分异。当前亟需加强虚实空间交互带来的对身体活动新的影响效应,特别是关注虚实交互空间里的可介入性、公平性。此外,随着中国社会发展主要矛盾的转化以及新型城镇化的转型升级,导致建成环境对身体活动的影响更加复杂化和综合化,应开展宏微观多尺度、全要素多维度、需求引导多情景、实践考虑多阶段、响应兼顾多群体、规划设计多交互、案例分析多对比的系统性研究。

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## Influence of urban built environment on residents' physical activity: Review and implications

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**Abstract:** The relationship between the built environment and urban residents' physical activity is a reflection of the human-environment relationship of urban systems in the field of health, and is related to the development and management of urban public health. In recent years, such relationship has become a new research topic in health geography. Based on the spatial perspective of geography, the progress of research on the influence of urban built environment on residents' physical activity in China and internationally was examined from the three aspects of spatial organization, spatial pattern, and spatial function. The analysis shows that there are many achievements internationally: 1) Social-ecological system research methods are most widely applied and are constantly revised and expanded in theory. Besides, studies based on the theory of mobility and activity behavior are emerging. Some complicated statistical regression models and spatial regression models are gradually applied. 2) In existing studies, the analysis of the influence of a series of characteristics of urban built environment, such as spatial organization, spatial pattern, and spatial function, on the level and type of physical activity of different resident groups has received more attention. Among these, the influence of spatial organization mainly concerns traffic organization, green space network, and other organizational types, as well as the impact of accessibility, connectivity, and other spatial links. The influences of spatial pattern such as structure, form, and spatial function were also examined. However, the research within China is still focusing on introducing international studies and concentrated in a few disciplines such as geography, urban planning, and sports, and lacks theoretical development and case studies in the Chinese context. Therefore, future research should focus on the following: theoretical development based on the ideas of unity of human and nature; application of multi-source data and spatial statistical methods; and new empirical studies based on virtual reality interaction and local context.

**Keywords:** built environment; physical activity; urban space; mechanism of influence; public health