



# Objective assessment of walking environments in ultra-dense cities: Development and reliability of the Environment in Asia Scan Tool—Hong Kong version (EAST-HK)

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## ABSTRACT

The 91-item Environment in Asia Scan Tool—Hong Kong (EAST-HK) was developed to objectively assess aspects of the neighbourhood environment hypothesised to affect walking in Hong Kong and similar ultra-dense Asian metropolises. Reliability was assessed by four pairs of raters auditing 422 street segments, 204 on two occasions. Seventy-one items showed sufficient variability and reliability. These can be used to estimate neighbourhood walkability in Hong Kong. Fourteen items showed good reliability but limited variability and may be used in a more variable context. Auditing of only 50% of street segments may be sufficient to obtain representative estimates of neighbourhood walkability.

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## 1. Introduction

There is increasing evidence that aspects of the neighbourhood built environment may influence residents' physical activity (Handy and Clifton, 2007; Heath et al., 2006; Transportation Research Board, 2005; Saelens and Handy, 2008) which, in turn, affects their health (Leitzmann et al., 2007; Manson et al., 1999). The built environment encompasses three main dimensions: land use patterns, urban design and the transportation system (Handy et al., 2002). Land use patterns refer to the spatial distribution of land devoted to different purposes (e.g., commercial or residential). Urban design includes the arrangement and appearance of built and natural features in a community (e.g., landscaping and building architecture), while the transportation system encompasses facilities, infrastructure and services that link locations. All three dimensions of the built environment have been found to be related to physical activity. For example, land use mix and residential density were consistently positively associated with walking for transportation (Saelens and Handy, 2008). Presence of parks and environmental aesthetics were predictive of higher levels of leisure-time physical activity (Humpel et al., 2002). Street connectivity (Saelens and Handy, 2008) and well-maintained

footpaths (Pikora et al., 2006) were associated with higher levels of walking.

To understand the potential effects of the built environment on physical activity, it is of paramount importance to develop valid and reliable measures of both exposures and outcomes. Studies on the environment–physical activity relationships have used three types of measure of the built environment: interviewer- or self-administered questionnaires, archival data analysed using Geographic Information Systems (GIS) and systematic observations or environmental audits (Brownson et al., 2009). While environmental audits and GIS databases provide objective data on neighbourhood attributes, questionnaires record residents' perceptions of their local environment. These methods provide complementary and equally important information, which can contribute to a better understanding of how the local environment shapes physical activity behaviours (Hoehner et al., 2005; McCormack et al., 2008).

Several observational measures have been developed and validated (Brownson et al., 2009), most of which represent community audits of fine-grained street-scale attributes characteristic of relatively low-density urban and suburban areas of North America (e.g., Checklist Audit Tool (Brownson et al., 2004), Neighbourhood Active Living Potential (Craig et al., 2002)) and Australia (Systematic Pedestrian and Cycling Environmental Scan; SPACES, (Pikora et al., 2002)). The applicability of these instruments to urban locations differing in culture, urban form, climate

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and landscape is doubtful. Audit tools should contain core items that enable cross-location comparison and, at the same time, be sufficiently geographically specific to capture important environmental idiosyncrasies that may impact on residents' physical activity behaviour. With this idea in mind, Millington et al. (2009) developed and validated an audit tool appropriate for the assessment of neighbourhood walkability in Scottish urban areas (Scottish Walkability Assessment Tool; SWAT). The instrument was conceived to reflect the higher density residential patterns, lower levels of car ownership, more consistent use of pavements and on-street parking typical of European cities as compared to their North American and Australian counterparts. To these authors' knowledge, SWAT is the first and only validated audit tool appropriate for measuring neighbourhood walkability in urban and suburban areas outside the USA and Australia.

Although suited to a more-dense urban environment, SWAT was purposefully developed for use in Scottish and other European cities. Therefore, its applicability to ultra-dense and culturally and topographically diverse urban areas of Asia is likely limited. For example, in urbanised areas of Hong Kong (the study site), dwelling density reaches over 1250 units per hectare, which is in stark contrast to European cities where inner city areas rarely exceed 125 residential units per hectare ([www.plan4sustainabletravel.org](http://www.plan4sustainabletravel.org)). Asian metropolises present unique characteristics typical of ultra-dense environments that can impact on walking and other forms of physical activity. These include air and noise pollution, crowdedness, a complex public transport network, man-made obstacles (e.g., on-road and foot-path parking), extensive indoor areas for walking, slippery/wet pavements (especially during the Monsoon season), and unique types of destinations (e.g., diverse types of open-air and indoor food outlets). Additionally, specific cities have their own built and natural idiosyncrasies, which in the case of Hong Kong include the presence of beaches, steep terrain, outdoor escalators, stairways and pedestrian overpasses.

The main objectives of this paper were to develop and evaluate the Environment in Asia Scan Tool—Hong Kong version (EAST-HK), an audit tool for the measurement of neighbourhood walkability in Hong Kong and similar ultra-dense East Asian metropolises. In doing so, we ensured that the audit tool captured walking-related environmental attributes shared by most urban environments across the globe (Brownson et al., 2009; Pikora et al., 2003), features that are characteristic of East Asian ultra-dense cities (e.g., crowdedness and pollution; Cerin et al., 2010), and elements that are particularly pertinent to Hong Kong (e.g., hilliness; Cerin et al., 2010). Therefore, we aimed to create an instrument tailored to Hong Kong containing core items relevant to other East Asian and global urban locations. Secondary aims of this study were to examine whether environmental assessments of ultra-dense urban environments are as reliable as those conducted in lower-density areas (Europe, Australia and North America), and to establish the minimal percentage of street segments that needs to be audited within a neighbourhood to obtain sufficiently reliable estimates in ultra-dense environments. It was hypothesised that inter- and intra-rater reliability of audit items used in previous studies would be lower in Hong Kong than in the original locations. This is because observation accuracy might be impaired by the increased human and vehicular traffic and high prevalence of high-rise mixed use buildings typical of ultra-dense urban environments. Given that the urban environment in Hong Kong is often very dense and, thus, destination-wise not as homogeneous as that of typical North American cities, we hypothesised that more than 25% of randomly selected street samples per neighbourhood would need to be audited to sufficiently accurately assess various aspects of neighbourhood walkability (McMillan et al., 2010).

## 2. Methods

### 2.1. Study area and context

Hong Kong covers approximately 1104 km<sup>2</sup> of land with a reported population of 6,985,200 and a total of 2,271,900 domestic households in mid-2008 (HKSAR Census and Statistics Department, 2008). For the purpose of this evaluation study, the area assessed using the EAST-HK consisted of eight urban and suburban locations of Hong Kong. Each location was represented by a 400 m radial crow-fly buffer from the centre point of a residential block, corresponding to the commonly adopted definition of 'immediately proximal neighbourhood' (McMillan et al., 2010). These residential blocks were randomly selected from a pool of 32 Tertiary Planning Units (TPUs; small spatial units used for urban planning purposes) representing four strata varying in socio-economic status (SES) and walkability. The 32 TPUs selected were used to recruit 500 adult participants for a study examining the associations of the built environment with physical activity. To select the 32 TPUs, all TPUs in Hong Kong ( $n=197$ ) were ranked and divided into deciles based on a normalised walkability index consisting of the sum of z-scores on dwelling density and intersection density (Leslie et al., 2007). Dwelling density was defined as the ratio of dwelling units to the sum of residential land area in a TPU. Intersection density was operationalized as the number of true intersections divided by a TPU total area. After identifying all TPUs with high walkability (7th to 10th deciles) and low walkability (1st to 4th deciles), they were ranked according to their SES based on 2006 Census data on median monthly household income. TPUs falling into the upper and lower SES quartiles were preliminarily selected to represent four categories of TPUs: high walkable/high SES, high walkable/low SES, low walkable/high SES and low walkable/low SES. Thirty two TPUs, eight per category, were included in the final list taking into account the average age of residents and ensuring that high- and low-walkable TPUs were matched for SES. Table 1 reports descriptive statistics of the eight TPUs selected for this validation study.

### 2.2. Development of the EAST-HK

The EAST-HK was developed to measure aspects of the neighbourhood environment that can potentially impact on walking behaviour. A multi-disciplinary panel of experts from the fields of public health, urban planning, physical activity and geography reviewed a list of items describing features of the neighbourhood environment included in relevant and extensively validated audit tools and questionnaires. The audit tools reviewed were SPACES (Pikora et al., 2002), the Analytic and Checklist Audit Tool (Brownson et al., 2004) and the Irvine-Minnesota Inventory (Boarnet et al., 2006; Day et al., 2006). The questionnaires examined were the Chinese versions of the Neighbourhood Environment Walkability Scale (NEWS; Cerin et al., 2007, 2010). The panel of experts had the task to select items from the above instruments and, if needed, generate new items that would capture the four main built-environment multidimensional themes of functionality, safety, aesthetics and destinations included in the framework proposed by Pikora et al. (2003). The reasons for inclusion of items of the NEWS in the selection list were two twofold. Firstly, the Chinese version of the NEWS was developed to assess aspects of the built environment that are relevant to Asian ultra-dense urban environments, with special focus on Hong Kong (Cerin et al., 2010). Secondly, we aimed to construct an audit tool that would provide a close match to the instrument used to gauge the perceived neighbourhood environment, facilitating a future evaluation of the correspondence

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