


## Article

# Neighbourhood Walkability, Recreational Walking, and Their Associations with Physical Activity and Well-Being in Bangkok, Thailand

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**Abstract:** This study investigates the relationship between neighbourhood walkability, recreational walking, and physical activity and well-being outcomes in Bangkok, Thailand. A cross-sectional survey was conducted with 881 residents from 50 districts in Bangkok. The Neighbourhood Environment Walkability Scale-Abbreviated (NEWS-A) was employed to assess neighbourhood walkability and its association with recreational walking behaviour. The Global Physical Activity Questionnaire (GPAQ) and WHO-5 Well-Being Index were used to explore the links between recreational walking, physical activity, and well-being. The findings reveal that neighbourhood environment characteristics significantly influence recreational walking behaviour, with high-rise and planned neighbourhoods showing higher odds of recreational walking compared to unplanned neighbourhoods. Additionally, recreational walking was positively associated with both achieving sufficient physical activity and better well-being scores. These findings suggest that neighbourhood-level interventions aimed at promoting recreational walking could be effective strategies for encouraging physical activity and enhancing well-being in urban residents. The study recommends that targeted, neighbourhood-level interventions focused on creating supportive walking environments may be more effective in promoting health outcomes compared to broader city-wide urban design strategies. Our results also provide evidence-based support for shifting from tourism-centric to neighbourhood-focused walking infrastructure development in Bangkok.

**Keywords:** recreational walking; neighbourhood walkability; physical activity; subjective well-being; landscape architecture; urban health; Bangkok; public health



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## 1. Introduction

Recreational walking has long been recognized as an effective, low-impact way to stay active and maintain both physical health and well-being. On the physical health side, it consistently helps individuals meet recommended physical activity levels, supporting cardiovascular function, managing body weight, and reducing the likelihood of chronic disease [1]. Studies have also shown that regularly walking for enjoyment or relaxation can improve subjective well-being and quality of life, including positive mood, vitality, and general life satisfaction [2]. This dual benefit makes recreational walking particularly appealing as a comprehensive urban health strategy since it requires minimal equipment and can be adapted to a range of urban settings [3]. Taken together, these outcomes highlight how a simple, accessible habit like regular recreational walking can profoundly

benefit overall health and well-being. The importance of recreational walking became even more evident during the COVID-19 pandemic, as lockdowns and social distancing measures led to increased reliance on local outdoor activities for maintaining both physical health and well-being [4,5].

Extensive research in Western countries has established that neighbourhood environment characteristics play a crucial role in promoting recreational walking. Studies have consistently shown that neighbourhood walkability, including factors such as pedestrian infrastructure, street connectivity, and access to green spaces, significantly influences walking behaviour [6,7]. Moreover, well-designed neighbourhood environments that support recreational walking have been linked to increased physical activity levels and improved well-being outcomes among urban residents [8,9]. The growing body of evidence has led many cities to prioritize neighbourhood-level interventions for promoting walking as a public health strategy to boost physical activity and well-being.

However, research specific to Southeast Asia reveals that tropical climate conditions necessitate different environmental approaches to encourage walking. In Singapore, research has demonstrated that shaded pathways, tree-lined streets, and covered walkways significantly encourage walking by enhancing thermal comfort and mitigating the adverse effects of urban heat islands [10,11]. A study in Colombo, Sri Lanka, found that areas with more shade had higher pedestrian activity, suggesting that shade makes walking more appealing and potentially alters distance perception [12]. Similarly, another study documented that elevated walkways can lower the physiological equivalent temperature (PET) by up to 17 °C, substantially improving pedestrian comfort in tropical conditions [13]. These tropical climate studies reveal that while the general principles of walkability established in Western research remain relevant, thermal comfort emerges as a fundamental prerequisite for encouraging recreational walking in Southeast Asian settings. Unlike temperate regions where seasonal variation might prioritize sun exposure during cooler months, tropical urban environments require year-round heat mitigation strategies to maintain walkable neighbourhoods. The intensity and persistence of these tropical conditions make specific environmental mitigations, such as the provision of adequate shade and weather-resistant pathways, exceptionally critical prerequisites for supporting walking activity in many Asian cities, including Bangkok [10,11].

The relationship between neighbourhood environments and recreational walking becomes more complex in cities like Bangkok. Previous studies identify four primary reasons that make walking in Bangkok particularly challenging. First, the city's tropical climate poses significant challenges, such as extreme heat and seasonal rainfall. While thermal comfort is a universal factor influencing outdoor activity, the intensity and persistence of these tropical conditions make specific environmental mitigations, such as the provision of adequate shade and weather-resistant pathways, exceptionally critical prerequisites for supporting walking activity in Bangkok [14]. Second, its diverse urban fabric, characterised by mixed-use development, unplanned settlements, and high-rise apartments, alongside planned housing projects in the outskirts, creates fragmented walking networks that often lack connectivity [15]. Third, informal street markets and motorised traffic frequently dominate pedestrian spaces, further complicating efforts to establish walkable neighbourhoods [16]. Fourth, the prevailing culture and social norms favouring car usage make walking less desirable, as cars are often viewed as symbols of status and convenience in Bangkok. This preference is reinforced by cultural norms and historical planning policies that prioritised road expansion and motorized mobility over active transport [17]. These factors contribute to an environment where walking is perceived as impractical or unsafe, particularly for non-recreational purposes. As a result, recreational walking in Bangkok is primarily restricted to designated urban green spaces, such as public parks, or confined

to controlled environments with green open spaces, including universities, schools, and residential complexes like apartments, condominiums, and gated housing estates [18,19].

In addition to these physical and cultural barriers, there is a large policy gap and an incomplete understanding of how Bangkok's distinct urban settings and climate affect recreational walking. Although extensive evidence from North America and Europe demonstrates how walkability features shape walking, it remains unclear to what extent these findings apply to Bangkok's context. Equally important is showing local policymakers that walking near home can improve residents' health by increasing physical activity, supporting a healthier lifestyle and improving subjective well-being and quality of life. Addressing these dual policy and knowledge gaps is essential since the Bangkok Metropolitan Administration (BMA) has thus far prioritised tourist areas for pedestrian upgrades, often overlooking residential neighbourhoods that could greatly benefit from improved walking infrastructure.

This study addresses these challenges by exploring the relationships among neighbourhood environments, recreational walking, physical activity, and well-being outcomes in Bangkok. Specifically, it seeks to answer the following research questions: (1) How do neighbourhood environmental characteristics shape recreational walking? (2) To what extent is recreational walking linked to achieving sufficient physical activity levels and improved well-being among Bangkok residents? We argue that neighbourhood-level environmental characteristics are significantly associated with recreational walking, contributing to both physical and well-being, even under the demanding climatic and urban conditions prevalent in Bangkok.

This research offers two notable contributions. First, it builds on existing theories of recreational walking by examining how walkability concepts apply to the challenges posed by Bangkok's environment. These lessons could be relevant to other rapidly growing cities in tropical regions. Second, our findings provide policymakers, especially the BMA, with practical evidence to shift planning priorities away from tourist districts towards local neighbourhoods. These insights can help guide policy interventions aimed at creating more walkable neighbourhoods that support both physical activity and well-being, contributing to the broader goal of building more resilient and health-promoting urban environments.

## 2. Materials and Methods

### 2.1. Study Area

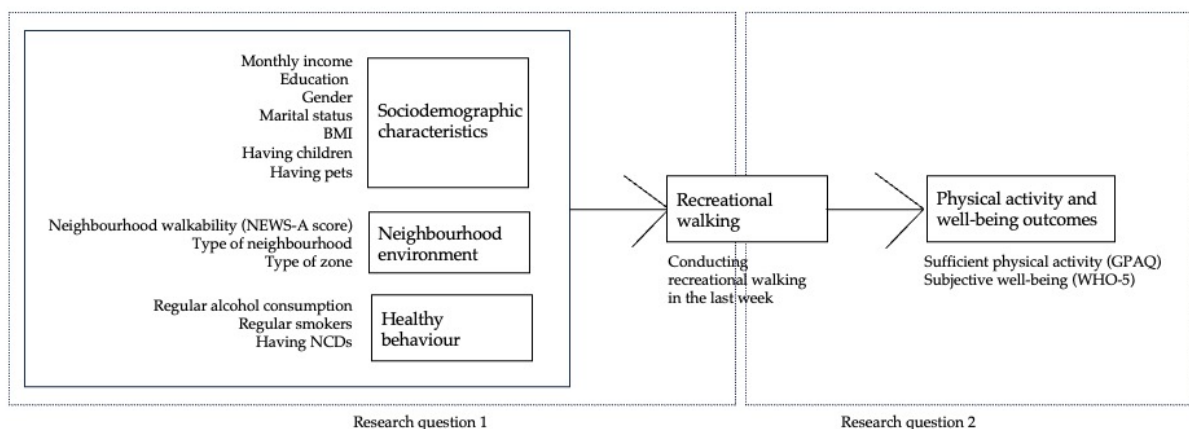
Bangkok has undergone rapid urbanisation with high population densities, particularly in its inner districts. City-wide population density is estimated at around 5300 people per square kilometre, with some central districts such as Din Daeng and Huai Khwang exceeding 9000 people/km<sup>2</sup> [20]. Despite this density, green space provision remains critically low. The most recent report by the BMA indicates that Bangkok provides approximately 6.9 m<sup>2</sup> of public green space per capita, with vast disparities across districts. In several unplanned inner-city areas, green spaces are either absent or extremely limited, often fragmented and poorly maintained [14,20]. While no single global benchmark defines sufficiency, comparative studies show that Bangkok lags behind cities such as Singapore (66 m<sup>2</sup> per capita) and Seoul (41 m<sup>2</sup> per capita), both of which have made concerted efforts to integrate accessible green infrastructure into dense urban fabrics [21]. This limited access to public green spaces—particularly in low-income and informally developed areas—constrains opportunities for residents to engage in recreational activities or obtain the health benefits associated with regular outdoor physical activity.

## 2.2. Study Design

This cross-sectional study investigated the variables associated with recreational walking and its relationship with physical activity levels and well-being among residents of Bangkok using a self-reported survey questionnaire. This self-reported survey approach is preferable in this context compared to purely objective environmental audits or observational methods because it enables a more robust exploration of individuals' subjective experiences and perceptions. While objective measures such as GIS or audit-based walkability tools are valuable for assessing built environment features, they often fail to capture how residents interpret or emotionally respond to their neighbourhood surroundings—factors which are particularly relevant to well-being and perceived walkability [22,23]. By directly engaging participants through interviews, this method allows us to examine not just the physical characteristics of the environment but how they are internalised and acted upon in daily life [14,19].

Moreover, while the NEWS-A and GPAQ instruments are widely used and validated, their selection in this study was not based solely on precedent. We deliberately adopted these tools because our research objectives required comparative and statistically testable assessments of walkability and its relationship to health outcomes across diverse neighbourhoods in a large metropolitan area. The standardized structure enabled efficient data collection across 50 districts and supported a robust quantitative analysis of patterns at the city scale. However, we acknowledge that such instruments may not fully capture local spatial nuances, perceptual subtleties, or lived experiences of the urban environment. Although visual or qualitative methods—such as walk-along interviews, photovoice, or participatory mapping—would provide valuable insights into how walkability is experienced subjectively, these were not feasible within the scope of this cross-sectional, large-sample study. This methodological advantage has been noted in studies examining the psychosocial dimensions of urban design and health in Bangkok [14,19].

The study is based on two main arguments supported by existing literature: first, that the neighbourhood environment influences recreational walking [23,24], and second, that engaging in recreational walking is associated with having sufficient physical activity and better well-being [25–27]. Figure 1 summarises the framework for the study.



**Figure 1.** Conceptual framework of the study.

This study employed a quota sampling approach for data collection. We divided the city based on its 50 administrative districts to ensure that we captured different types of neighbourhoods in each district. The study obtained a list of registered households and their addresses from the Bangkok Metropolitan Administration (BMA) and randomly selected 18 respondents for each district (900 respondents in total) to capture a broad spectrum of the city's demographics, socioeconomic statuses, and neighbourhood types that

influence walking behaviours. This strategy ensures that the sample reflects varied urban conditions, enhancing the study's relevance and accuracy in assessing walking behaviours and neighbourhood walkability. This approach, supported by previous research [28,29], helps in minimising potential biases by distributing the sample evenly and systematically across the city, thereby enhancing the reliability and generalizability of the findings.

We recruited ten trained surveyors to conduct face-to-face interviews with each respondent. The surveyors were master's students from the Faculty of Architecture, Kasetsart University, with backgrounds in landscape architecture, architecture, and urban planning. We conducted a three-day training session and a pre-survey to ensure that all the surveyors thoroughly understood the questionnaire. The survey was conducted between 1 December 2022 and 31 January 2023. Respondents received a souvenir valued at 30 THB (approximately 1 USD) upon the completion of the interview. Following data cleaning procedures, 881 responses were deemed suitable for analysis.

The study was approved by the Institutional Review Board of Silpakorn University in Thailand, adhering to the ethical guidelines of the Declaration of Helsinki. The questionnaire consisted of four main sections: socioeconomic characteristics, physical activity and other healthy behaviours, neighbourhood environment characteristics, and walking behaviours and practices. The reliability of the questionnaire items was assessed using Cronbach's alpha, with values ranging from 0.78 to 0.91, indicating good internal consistency.

### 2.3. Variables and Measurements

Recreational walking in this study was defined as walking for enjoyment, relaxation, or physical activity without a specific destination near one's home and was measured using a binary question (yes/no) regarding engagement in the past week, following established definitions in walking behaviour research [14,19].

To examine the neighbourhood environment, three proxy variables were selected based on their validated use in prior studies. The first variable, the Neighbourhood Environment Walkability Scale-Abbreviated (NEWS-A), was selected for its proven reliability in evaluating walkability across various cultural contexts [30,31]. The NEWS-A assesses six subscales—land use mix-access and mix-diversity, street connectivity, walking facilities, aesthetics, safety from traffic, and safety from crime—using a 5-point Likert scale, with higher scores indicating better walkability. For this study, the NEWS-A scores were categorized into "high walkability" and "low walkability" groups. Although the NEWS-A instrument originates from studies in Western urban contexts, it provides a robust yet flexible structure for walkability assessment. In our study, NEWS-A served as a comparative framework, which we localized to Bangkok's specific spatial and cultural characteristics through tailored item translation and contextual references (e.g., adapting references to temples and alleyways). Importantly, our aim was not to apply NEWS-A uncritically but rather to use it as a starting point to examine how walkability features manifest in Bangkok's distinct urban forms—particularly in neighbourhoods shaped by rapid growth, informal development, and tropical climate constraints [14]. We made minimal adaptations to NEWS-A, focusing on rephrasing items to ensure accurate and culturally appropriate translation without altering the underlying constructs or measurement objectives. Specifically, we translated items from English to Thai—adjusting their wording for local comprehensibility—while also contextualizing references such as "church" to "church/temple" and "North American street blocks" to "streets and alleys". These modifications preserved the scale's original domain structure, as evidenced by the strong internal consistency of our adapted NEWS-A (Cronbach's  $\alpha = 0.83$ ), confirming its reliability and validity for assessing Bangkok's neighbourhood walkability. Such adaptations are common in cross-cultural research and did not adversely affect the instrument's psychometric properties [32].

The second variable was neighbourhood type. The BMA categorizes neighbourhoods into three distinct types [14,33]. The first type is unplanned neighbourhoods, which are formed organically without formal planning. These areas feature mixed land use in dense regions, including informal settlements, and are mostly located in the inner urban areas of Bangkok. The second type is high-rise neighbourhoods, primarily located in both inner and outer Bangkok, catering to middle and upper-income residents. These neighbourhoods offer modern amenities and vertical living, significantly altering the city's skyline, and include vertical government housing. The third type is planned neighbourhoods, typically residential areas, often gated, aiming to provide a higher quality of life with controlled environments. Previous studies have demonstrated that these different neighbourhood types significantly influence walking behaviour through varying levels of infrastructure quality and accessibility [34]. Table 1 summarises the three different neighbourhood characteristics in Bangkok.

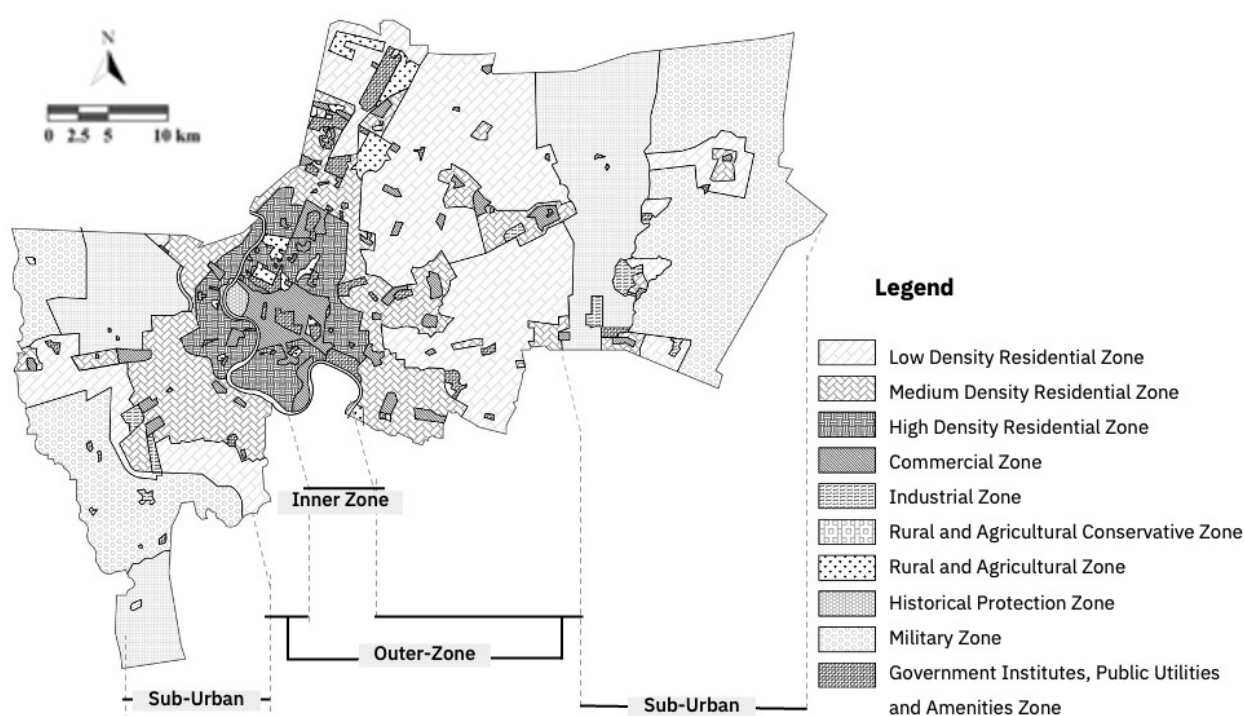
**Table 1.** Summary of characteristics of Bangkok neighbourhoods based on Bangkok Metropolitan Administration Classification (with author interpretation) [33].

	Unplanned Neighbourhoods	High-Rise Neighbourhoods	Planned Neighbourhoods
Typical Location	Inner urban areas	Inner and outer urban areas	Outer urban areas and sub-urban areas
Street Layout and Connectivity	Irregular, narrow streets, low connectivity	Controlled-access, enclosed complexes, moderate connectivity	Organised street networks, high connectivity within the neighbourhood
Pedestrian Infrastructure	Limited, fragmented, often obstructed by informal markets and vehicles; usually better when near tourism areas or central business districts	Good pedestrian infrastructure within complexes, limited external connectivity	Good pedestrian pathways, safe, landscaped streets, traffic-calming measures within the neighbourhood
Green Spaces and Recreation	Limited or absent dedicated recreational green spaces within walking distance	Small parks or gardens, fitness centres within complexes	Small parks, gardens, playgrounds, recreation areas integrated into neighbourhoods
Land Use and Density	High-density, mixed-use, informal settlements	High-density vertical residential developments	Moderate-density, primarily residential, gated communities

The third variable was the type of zone of the respondents, categorized into inner Bangkok, outer Bangkok, and the urban fringe, based on the Bangkok Masterplan [14,28]. This variable captures the impact of city-wide zoning policies and the distribution of public infrastructure and amenities. The BMA reported that inner zones, where economic activities are concentrated, generally have better walking infrastructure and amenities compared to outer zones and the urban fringe [18,35]. Figure 2 summarises zones and land use in Bangkok and provides a visual overview of the diverse urban landscapes included in our study, illustrating how residential areas, commercial districts, and green spaces are distributed across these zones.

Physical activity was measured using the Global Physical Activity Questionnaire (GPAQ), chosen for its international validation and reliability across diverse populations [36]. Responses were categorized following WHO guidelines into sufficient physical activity ( $\geq 150$  min/week) or insufficient physical activity ( $< 150$  min/week) [37]. The well-being variable was assessed using the 5-item World Health Organization Well-Being Index (WHO-5), a validated self-reported tool designed to measure subjective well-being over a two-week period [38]. The index was selected because it measured subjective psychological well-being, including positive mood, vitality, and general life satisfaction, rather than clinical mental health outcomes. The WHO-5 is widely recognized as an effective

questionnaire for evaluating psychological well-being and has been frequently employed in studies examining walkability and built environment contexts, supporting its suitability for this analysis [14,30,39–41]. The index consists of five positively phrased items, each rated on a 5-point Likert scale, where 1 represents “none of the time”, and 5 represents “all of the time”. The raw scores range from 5 to 25, but they are typically transformed by multiplying by 4 to yield a score between 0 and 100. A score below 50 indicates low well-being and may warrant further exploration for potential symptoms of depression but does not directly imply the presence of clinical mental health disorders [42,43]. The health behaviour variables were selected by established associations in the literature. Previous studies have demonstrated that the presence of non-communicable diseases (NCDs) significantly affects walking behaviour, physical activity, and well-being [44]. Smoking habits and alcohol consumption were included based on their documented relationships with physical activity and well-being patterns [45]. Body mass index was included due to its inverse relationship with walking distance and frequency [46].



**Figure 2.** Bangkok zones and land use. Redrawn from Bangkok Metropolitan Administration Comprehensive Bangkok City Plan, 2013 [20].

Sociodemographic and household composition variables were selected based on their established influence on recreational walking patterns. Previous studies have demonstrated that individual characteristics significantly shape walking behaviour and physical activity engagement [47]. Higher educational attainment has been positively associated with recreational walking, meeting physical activity guidelines and better well-being, while lower socioeconomic status shows negative associations. Gender differences play a crucial role, with women generally reporting lower engagement in recreational walking compared to men, a disparity that tends to increase with age [48]. Household composition factors, including the presence of children and dog ownership, were also considered, as they influence walking patterns differently. Dog ownership has been associated with increased frequency and duration of recreational walking [49] while having children can either facilitate or constrain recreational walking depending on family circumstances [50].

#### 2.4. Data Analysis

For data analysis, we employed three multivariable logistic regression models to examine the complex relationships among recreational walking, environmental factors, and health outcomes. We selected binomial logistic regression because our primary outcomes—physical activity and well-being—are most meaningful and actionable when presented in dichotomous form. The WHO-recommended thresholds for sufficient physical activity ( $\geq 150$  min per week) and acceptable subjective well-being (WHO-5 score  $\geq 50$ ) provide clearly defined public health benchmarks. Using continuous measures for these variables could obscure clinically meaningful thresholds. Additionally, many critical, independent variables (e.g., NEWS-A scores, BMI, NCDs, smoking, alcohol consumption) also have established clinical and practical thresholds, justifying their binary categorization and facilitating clearer interpretation and practical relevance. This method is also widely understood by public health officials, ensuring the findings are interpretable, actionable, and directly applicable to policymaking. Additionally, binary logistic regression offers robustness, flexibility in handling dichotomous outcomes, and ease of communicating results, making it more suitable for confirmatory studies using validated measurement tools like NEWS-A, GPAQ, and WHO-5.

The first model investigated the associations between recreational walking and neighbourhood environment variables, including NEWS-A walkability scores, neighbourhood type, and zone location. The second model examined the relationship between recreational walking and physical activity levels, specifically focusing on whether engagement in recreational walking was associated with achieving sufficient physical activity ( $\geq 150$  min/week). The third model analysed the relationship between recreational walking and well-being using the WHO-5 Well-Being Index scores. All models were adjusted for potential confounding factors. Each model produced odds ratios (ORs) with 95% confidence intervals (CI), with statistical significance set at  $p < 0.005$ .

To evaluate how well each logistic regression model fit our data, we performed an omnibus test for overall model significance. A significant omnibus test ( $p < 0.05$ ) indicated that adding predictors improves model fit beyond what would be expected by chance. We also computed a pseudo- $R^2$  (Nagelkerke's) to provide a rough estimate of each model's explanatory power. We also calculated Variance Inflation Factors (VIFs) to ensure no significant multicollinearity among independent variables. A VIF value exceeding 5 typically signals problematic collinearity. All analyses were conducted using JAMOVI version 2.5.1 [51,52].

### 3. Results

Table 2 summarizes the characteristics of the respondents. The study included a diverse sample of Bangkok residents with varied socioeconomic backgrounds. The majority of respondents (44.8%) reported a monthly income between 10,001 and 30,000 THB (300–1000 USD), while 22.0% earned 30,001–50,000 THB (1000–1600 USD). Educational attainment was relatively high, with 87.9% of participants having at least a high school education and 43.9% holding more than a bachelor's degree. The gender distribution was nearly equal, with 53.2% female participants. Most respondents (76.7%) were living with partners, and 65.6% had children. Regarding health characteristics, the majority of participants (84%) had a BMI of 25 or less. The sample showed generally healthy behaviours, with low rates of regular alcohol consumption (13.3%) and smoking (11.1%). Only 11.2% reported having non-communicable diseases (NCDs).

**Table 2.** Respondents' characteristics.

Category	Variable	Sample Characteristics
Sociodemographic	Monthly income	
	Less than 5000 THB (less than 160 USD)	3.9%
	5000–10,000 THB (160–300 USD)	18.7%
	10,001–30,000 THB (300–1000 USD)	44.8%
	30,001–50,000 THB (1000–1600 USD)	22.0%
	More than 50,000 THB	10.6%
	Education	
	High school or less	12.0%
	High school to bachelor's degree	44.0%
	More than a bachelor's degree	43.9%
	Gender	
	Male	46.8%
	Female	53.2%
	Marital status	
	Single	23.3%
	Living with partner	76.7%
	BMI	
	25 or less	84%
	>25	16%
	Having Children	
Yes	34.4%	
No	65.6%	
Having Pets		
Yes	26.3%	
No	73.7%	
Healthy behaviour	Regular alcohol consumption	
	Yes	13.3%
	No	86.7%
	Regular smokers	
	Yes	11.1%
	No	88.9%
	Having non-communicable diseases (NCDs)	
Yes	11.2%	
No	88.8%	
Neighbourhood environment	NEWS-A score	
	Low	72.3%
	High	27.7%
	Type of Neighbourhood	
Unplanned neighbourhood	58.8%	

**Table 2.** *Cont.*

Category	Variable	Sample Characteristics
	High-rise neighbourhood	16.7%
	Planned Neighbourhood	24.5%
	Type of zone	
	Inner Bangkok	47.2%
	Outer Bangkok	36.1%
	Urban fringe	16.7%
Physical activity	Physical activity level	
	Sufficient physical activity (more than 150 min/week)	78.7%
	Insufficient physical activity (150 min/week or less)	21.3%
Well-being	WHO-5 scores	
	>50	37.2%
	<50	62.8%
Recreational Walking	Conducting recreational walking	
	Yes	42.2%
	No	57.8%

The Neighbourhood Environment Walkability Scale-Abbreviated (NEWS-A) assessment revealed that 72.3% of participants lived in areas with low walkability scores. The majority (58.8%) resided in unplanned neighbourhoods, while 24.5% lived in planned neighbourhoods and 16.7% in high-rise neighbourhoods. Nearly half (47.2%) of the participants lived in Inner Bangkok, with 36.1% in Outer Bangkok and 16.7% in urban fringe areas. A significant proportion (78.7%) of participants reported sufficient physical activity levels (more than 150 min per week). However, only 42.2% engaged in recreational walking in the previous week. Well-being scores, as measured by the WHO-5 index, showed that 62.8% of participants scored below 50.

Table 3 presents the multivariable logistic regression analysis examining the associations between various factors and recreational walking. Multiple factors showed significant associations with recreational walking behaviour. Having children (OR = 1.626, 95% CI: 1.098–2.400) and pets (OR = 10.671, 95% CI: 6.9099–16.479) were strongly associated with an increased likelihood of recreational walking. Built environment characteristics also played a crucial role, with high NEWS-A scores showing a positive association (OR = 2.422, 95% CI: 1.7019–3.446). Compared to unplanned neighbourhoods, both planned neighbourhoods (OR = 1.636, 95% CI: 1.0439–2.563) and high-rise neighbourhoods (OR = 2.951, 95% CI: 1.793–4.857) showed significantly higher odds of recreational walking.

**Table 3.** Associations between recreational walking and neighbourhood environment variables.

Category	Variable	OR	95% CI
Sociodemographic	Monthly income		
	Less than 5000 THB (less than 160 USD)	ref	
	5000–10,000 THB (160–300 USD)	1.286	0.5567–2.972
	10,001–30,000 THB (300–1000 USD)	1.125	0.4718–2.681

Table 3. Cont.

Category	Variable	OR	95% CI
	30,001–50,000 THB (1000–1600 USD)	1.506	0.5629–4.029
	More than 50,000 THB	1.366	0.3659–5.101
	Education		
	High school or less	ref	
	High school to bachelor's degree	1.010	0.7138–1.430
	More than a bachelor's degree	1.108	0.6555–1.872
	Gender		
	Male	ref	
	Female	0.995	0.7214–1.372
	Marital status		
	Single	ref	
	Living with partner	0.988	0.6428–1.520
	BMI		
	25 or less	ref	
	>25	0.727	0.470–1.126
	Having Children		
	No	ref	
	Yes	1.626 *	1.098–2.400
	Having Pets		
	No	ref	
	Yes	10.671 *	6.9099–16.479
Healthy behaviour	Regular alcohol consumption		
	Yes	ref	
	No	1.316	0.8157–2.122
	Regular smokers		
	Yes	ref	
	No	1.174	0.7119–1.938
	Having non-communicable diseases (NCDs)		
Yes	ref		
No	0.801	0.4649–1.379	
Neighbourhood environment	NEWS-A score		
	Low	ref	
	High	2.422 *	1.7019–3.446
	Type of Neighbourhood		
	Unplanned neighbourhood	ref	
	Planned Neighbourhood	1.636 *	1.0439–2.563
	High-rise neighbourhood	2.951 *	1.793–4.857
Type of zone			
Inner Bangkok	ref		

Table 3. Cont.

Category	Variable	OR	95% CI
	Outer Bangkok	0.768	0.503–1.174
	Urban fringe	1.098	0.677–1.781

Note:  $\chi^2 = 236$ ,  $df = 21$ ,  $p < 0.005$ . Nagelkerke  $R^2 = 0.316$ . VIF = 1.03–1.07. \* =  $p < 0.005$ . The dependent variable was “Did you engage in walking for enjoyment, relaxation, or physical activity without a specific destination around home in the last week?”

Table 4 illustrates the results of the multivariable logistic regression analysis focusing on the associations among recreational walking, physical activity, and well-being. Recreational walking showed strong positive associations with both physical activity and well-being outcomes. Participants who engaged in recreational walking were significantly more likely to achieve sufficient physical activity levels (OR = 2.9067, 95% CI: 1.8958–4.4565) and report better well-being (OR = 1.765, 95% CI: 1.270–2.453). Several other factors were significantly associated with physical activity levels. Non-alcohol consumers (OR = 3.0076, 95% CI: 1.8622–4.857), non-smokers (OR = 2.2930, 95% CI: 1.3740–3.827), and those without NCDs (OR = 6.1540, 95% CI: 3.6396–10.405) showed higher odds of achieving sufficient physical activity. High NEWS-A scores (OR = 2.7326, 95% CI: 1.8484–4.040) and residing in planned neighbourhoods (OR = 1.9800, 95% CI: 1.1434–3.429) were also positively associated with physical activity levels. The consistent relationship between recreational walking and improved well-being scores remained significant even after controlling for other sociodemographic and environmental factors, highlighting the potential importance of recreational walking for health promotion in urban settings.

Table 4. Associations between physical activity and well-being and recreational walking.

Category	Variable	Physical Activity		Well-Being	
		OR	95% CI	OR	95% CI
Neighbourhood environment	NEWS-A score				
	Low	ref		ref	
	High	2.7326 *	1.8484–4.040	1.804 *	1.305–2.494
	Type of Neighbourhood				
	Unplanned neighbourhood	ref		ref	
	Planned Neighbourhood	1.9800 *	1.1434–3.429	1.165	0.739–1.838
	High-rise neighbourhood	1.8123 *	1.0192–3.223	0.955	0.624–1.461
	Type of zone				
	Inner Bangkok	ref		ref	
	Outer Bangkok	1.8046	0.1009–2.958	1.103	0.747–1.628
Urban fringe	0.4315	0.2212–0.842	1.052	0.663–1.670	
Recreational walking	Conducting recreational walking				
	No	ref		ref	
	Yes	2.9067 *	1.8958–4.4565	1.765 *	1.270–2.453

Note: For the physical activity model, the dependent variable was the physical activity level based on GPAQ questionnaire and dichotomised into “sufficient physical activity (more than 150 min/week) and insufficient physical activity (150 min/week or less)”.  $\chi^2 = 201$ ,  $df = 22$ ,  $p < 0.005$ , Nagelkerke  $R^2 = 0.316$ , VIF = 1.02–1.12. For the well-being model, the dependent variable was the WHO-5 well-being index score dichotomised into high (>50) and low (<50).  $\chi^2 = 939$ ,  $df = 22$ ,  $p < 0.005$ , Nagelkerke  $R^2 = 0.905$ , VIF = 1.00–1.21. Both models were adjusted for monthly income, education, gender, marital status, BMI, having children, having pets, regular alcohol consumption, regular smoking, and having non-communicable diseases. \* =  $p < 0.005$ .

For each of the three logistic regression models, recreational walking, physical activity, and well-being, the omnibus test was statistically significant ( $p < 0.05$ ), indicating that our predictors collectively improved the model beyond the null model. The pseudo- $R^2$  (Nagelkerke's) values ranged from 0.3 to 0.9 across the three models, indicating moderate explanatory strength. Multicollinearity diagnostics showed that all predictor variables for all three models had VIF values well below 5 (1.03–1.07; 1.02–1.12; 1.00–1.21), confirming no substantial collinearity issues. Taken together, these diagnostics support the robustness and reliability of our regression results.

#### 4. Discussion

This study examined the relationships among neighbourhood environments, recreational walking, and health outcomes in Bangkok, Thailand. Three key findings emerged from our analysis. First, neighbourhood environment variables were significantly associated with recreational walking, with walkability and neighbourhood type emerging as important determinants. Second, engaging in recreational walking was positively associated with achieving sufficient physical activity levels. Third, recreational walking showed a significant positive relationship with well-being, as measured by WHO-5 scores.

Our first finding on the significant relationship between neighbourhood environments and recreational walking aligns with existing studies from Western contexts but also highlights critical distinctions unique to Bangkok. The robust association observed between NEWS-A walkability scores and recreational walking indicated that living in walkable neighbourhoods can effectively encourage recreational walking across different urban contexts [53,54]. Although the NEWS-A scoring provided quantifiable metrics for walkability, our spatial typology allowed for a richer understanding of how walkability operates differently across Bangkok's diverse neighbourhoods. For instance, in unplanned inner-city areas, walkability is constrained by fragmented alley networks and sidewalk encroachment. In contrast, planned communities in suburban areas may score higher on pedestrian infrastructure but remain isolated from key destinations. These contrasting spatial configurations suggest that walkability in Bangkok is highly contingent on urban morphology, infrastructure quality, and informal land use patterns. Hence, the direct applicability of NEWS-A to Bangkok requires further consideration due to the city's distinctive cultural and environmental characteristics. Although NEWS-A is a validated tool widely used in various settings, it assesses overall neighbourhood walkability without explicitly distinguishing between features supporting recreational versus utilitarian walking (e.g., commuting or daily errands). This distinction becomes particularly relevant in Bangkok's unique urban landscape, characterized by car-centric infrastructure. Consequently, while our findings confirmed a significant statistical relationship between neighbourhood walkability and recreational walking, this may not apply equally to utilitarian walking patterns. Specifically, Bangkok's urban environment features obstacles such as poorly maintained sidewalks, fragmented pedestrian pathways between commercial destinations, and dominance by informal street vendors and motorized traffic, all of which significantly impede practical, destination-oriented walking.

Additionally, in Bangkok, socio-cultural norms, including preferences for shaded pathways due to the tropical climate, prevalence of informal markets, and strong reliance on motorised transportation, likely shape residents' perceptions of walkability. The city's high-density urban form and mixed land-use patterns, often juxtaposing unplanned developments with modern infrastructure, may further lead to different interpretations of walkability compared to Western cities. Despite these contextual challenges, the strong relationship between neighbourhood walkability and recreational walking persisted, underscoring the robustness of the walkability–walking link across diverse urban environments.

This supports the case for investing in neighbourhood-level walking infrastructure while emphasizing the need for context-specific urban design solutions tailored to Bangkok's unique conditions. Nevertheless, the distinct significance of neighbourhood environment characteristics predominantly affecting recreational rather than utilitarian walking suggests that the NEWS-A tool, although validated internationally, may require further refinement to capture the nuanced dynamics of recreational versus utilitarian walking specific to Bangkok's urban context.

The higher likelihood of recreational walking in high-rise and planned neighbourhoods, compared to unplanned neighbourhoods, underscores the importance of well-designed environments in promoting walking behaviour in Bangkok. These neighbourhoods often feature better access to green spaces, connected walking paths, and recreational facilities within development complexes, creating an environment conducive to recreational walking [25,55]. Their compact and controlled nature fosters a sense of safety and community, which is particularly beneficial for encouraging walking among older adults and women [56–58]. We recognise that the BMA's neighbourhood classification—unplanned, planned, and high-rise—represents a relatively broad-brush typology and does not fully reflect the spatial or design complexity relevant to walkability. However, it provided a practical and policy-relevant framework for sampling and stratifying neighbourhood conditions at scale across Bangkok. Importantly, our findings revealed statistically significant differences in recreational walking across these categories, suggesting their utility as proxies for infrastructure quality and development form. Still, we acknowledge that more granular spatial typologies—incorporating urban form, street connectivity, land use fragmentation, or access to public space—could enhance future research. Such approaches could deepen the explanatory power of walkability studies in rapidly urbanising cities like Bangkok.

Interestingly, the lack of significance for the zoning variable suggests that mixed-use environments at the city level are less influential in recreational walking in Bangkok. This contrasts with findings from the United States and Europe, where mixed-use neighbourhoods are typically associated with higher walking rates [25]. Such differences highlight the cultural and contextual specificity of the relationship between neighbourhood design and walking behaviour. In Bangkok, the quality of design and the presence of controlled environments seem to play a more crucial role in encouraging recreational walking [59].

Interestingly, our study found that socioeconomic variables did not show significant associations with recreational walking, contrasting with findings from Western studies, where socioeconomic status often emerges as a significant predictor [60]. This suggests that in Bangkok's context, neighbourhood-level characteristics may exert a stronger influence on recreational walking than individual socioeconomic factors. However, household composition factors, particularly dog ownership, showed significant associations with recreational walking participation, consistent with previous research [61]. Several explanations may account for this individual socioeconomic contrast. First, although our sample included participants across various income brackets, the relatively homogenous distribution of income within our sample, with most respondents concentrated in middle-income categories, may have diluted the detectable differences in walking behaviour across income groups. Second, Bangkok's urban development patterns are spatially fragmented, with communities of varying socioeconomic status—low, middle, and high income—dispersed throughout the city rather than clustered in specific zones. This spatial mixing means that high- and low-income households may share similar access—or lack thereof—to walking infrastructure, weakening the typical associations found between income and recreational walking observed in more socioeconomically segregated cities. Third, cultural and contextual factors might play a mediating role. In Bangkok, social norms surrounding car ownership and the uses of public space (e.g., walking in public parks, temples, shopping malls, markets, or

university campuses) cut across income groups and might reduce socioeconomic gradients in walking behaviour. Fourth, public recreational spaces are not necessarily distributed along economic lines. Parks and semi-public walking spaces are scattered in ways that may not privilege affluent neighbourhoods. Finally, our sampling strategy, which included residents from all 50 districts of Bangkok, ensured greater geographic and social diversity than studies focused on selected neighbourhoods, possibly capturing broader patterns that dilute socioeconomic effects. This finding highlighted the importance of contextualising walking behaviour research and cautions against directly transferring Western-derived assumptions about socioeconomic influences to Southeast Asian urban settings.

Our second finding revealed the positive relationship between recreational walking and achieving sufficient physical activity levels. This finding underscores the unique urban mobility patterns in Bangkok. Unlike cities where utilitarian walking is prevalent, walking in Bangkok is primarily recreational rather than transport-oriented. This trend is largely influenced by urban characteristics that hinder walking, including poorly maintained pedestrian infrastructure, limited connectivity between destinations, and a car-centric urban design that prioritises vehicular transportation [62]. Studies indicate that only 16.3% of Bangkok residents participate in transportation-related physical activity, suggesting a preference for walking as a leisure activity over walking for transport [63]. The strong association between recreational walking and physical activity levels highlights the importance of creating supportive neighbourhood environments for recreational walking, as it is the most accessible and culturally relevant form of walking-based physical activity for Bangkok residents.

Our third finding identified a significant positive relationship between recreational walking and well-being, as assessed by the WHO-5 Well-Being Index. These findings align with previous research highlighting the benefits of recreational walking, such as reduced anxiety and depression, improved mood, and enhanced psychological well-being [64,65]. Similarly, our results are consistent with studies from other Asian cities, which have reported stronger links between recreational walking and well-being when walking takes place in well-designed neighbourhood environments [34,35,65]. This finding reiterates the importance of walking environment quality and emphasizes the need for neighbourhood-level interventions to create supportive spaces for walking. The dual benefits of recreational walking—enhancing both physical activity levels and well-being—highlight its potential as an effective health promotion strategy, especially in urban settings where other opportunities for physical activity may be limited.

However, this study has several limitations that should be considered. As a cross-sectional study, it cannot establish causal relationships between neighbourhood environments, recreational walking, and health outcomes. This limitation underscores the importance of exercising caution in interpreting causal inferences and highlights the need for longitudinal studies to explore temporal relationships and causal pathways. Additionally, this study employed a relatively modest sample size of 881 respondents, constrained by the practical resources available for PhD research. Future studies with greater resources could benefit from larger samples to potentially capture additional nuances in walking behaviour across Bangkok's diverse urban landscape.

While our binary measure offered practical clarity for large-scale analysis, we acknowledge that it oversimplifies walking patterns. This finding highlights the need for more nuanced measurement approaches—such as capturing frequency, duration, and context of walking—which would deepen future research and enhance our interpretation of the associations already observed. Future studies should adopt nuanced measurement approaches to provide a more comprehensive understanding of walking patterns. Moreover, this study utilised the WHO-5 Well-Being Index, which captures subjective psychological well-being

rather than clinical mental health. Future studies might consider incorporating clinical mental health measures for a more comprehensive understanding of mental health outcomes. We also acknowledged that dichotomizing variables while enhancing interpretability and policy relevance, might result in the loss of detailed information and potential variability. Future studies could explore continuous or ordinal measures to capture more subtle gradations in physical activity and well-being, provided clinically meaningful thresholds are maintained.

Additionally, while the NEWS-A items features, such as mixed land use and street connectivity that theoretically benefit both walking types, Bangkok's high density and mixed-use developments often create congestion and sensory overload that might discourage utilitarian walking while still supporting recreational walking in controlled environments like parks or planned neighbourhoods. This distinction is crucial for urban planners, as interventions aimed at increasing recreational walking (such as improving park quality) may differ substantially from those needed to support utilitarian walking (such as enhancing pedestrian connectivity between transit stops and commercial areas). Our current findings already suggest that recreational and utilitarian walking are influenced by different environmental features in Bangkok. To build on this insight, future research should consider using specialized tools—such as micro-scale street audits or activity-specific walkability indices—to more precisely capture these differences, given Bangkok's distinct urban morphology, cultural practices, and climate conditions.

It is also important to acknowledge, however, that our cross-sectional study design presents inherent limitations in establishing causality between neighbourhood walkability and recreational walking. The significant association between NEWS-A walkability scores and recreational walking could also be influenced by residential self-selection, where individuals with pre-existing preferences for walking may choose to live in neighbourhoods that better support this activity. This self-selection effect makes it difficult to determine whether walkable environments encourage recreational walking or whether residents who enjoy walking simply select more walkable neighbourhoods. The relationship between neighbourhood design and walking behaviour is likely bidirectional, with environmental characteristics and individual preferences mutually reinforcing each other over time. These complex relationships cannot be fully disentangled without longitudinal data that track changes in behaviour following neighbourhood relocation or environmental modifications. Future research should employ longitudinal designs that follow residents before and after they move between neighbourhoods with varying walkability characteristics or quasi-experimental approaches that evaluate behavioural changes following neighbourhood-level interventions. Such methodological approaches would strengthen causal inferences regarding the impact of Bangkok's unique neighbourhood environments on walking behaviours.

We acknowledge that relying on the Bangkok Metropolitan Administration's three-part neighbourhood classification presents limitations in fully capturing the spatial nuances relevant to walkability. While these categories—unplanned, high-rise, and planned neighbourhoods—are useful in distinguishing broad differences in infrastructure and form, they do not comprehensively account for micro-scale design features such as block size, connectivity, or shade coverage. Nonetheless, our findings indicate that these categories still reveal meaningful differences in recreational walking behaviour, particularly in relation to controlled access, internal pathways, and proximity to green space. Given the scale of this study and the absence of a standardized urban morphology classification system for Bangkok, this framework offered a pragmatic and policy-relevant way to stratify urban environments. Future research should expand upon this approach by integrating spatial analysis methods and finer-grained urban design metrics to develop typologies more directly tied to walkability outcomes.

Another limitation of this study was that we did not empirically examine the impact of Bangkok's tropical climate on recreational walking despite identifying it as a potential barrier in our introduction. Bangkok experiences high temperature and humidity levels, and a distinct monsoon season with heavy rainfall. These climatic conditions likely influence walking patterns significantly, potentially creating seasonal variations in recreational walking behaviour that our cross-sectional design could not capture. For instance, our data collection period (December 2022 to January 2023) coincided with Bangkok's relatively cooler season, which may have yielded different results compared to surveys conducted during the hotter months (March to May) or rainy season (June to October). The associations we found between neighbourhood characteristics and recreational walking may be moderated by seasonal weather patterns, with certain environmental features (such as tree canopy coverage and sheltered pathways) becoming more crucial during extreme weather conditions. Future research should incorporate objective weather data, conduct seasonal comparisons of walking behaviour, and specifically examine how neighbourhood design elements might mitigate the negative impacts of tropical climate on recreational walking. Such studies could employ longitudinal designs with repeated measures across different seasons or incorporate objective environmental measurements such as ambient temperature, humidity levels, and thermal comfort indices to better understand how Bangkok's climate interacts with neighbourhood design to influence walking behaviour.

Furthermore, the study's focus on adults limits its inclusivity. Expanding research to include diverse population groups, such as children, the elderly, and individuals with disabilities, would enhance the generalisability and relevance of findings. Such inclusivity is critical for ensuring universally accessible walking environments. Future research should consider using qualitative or mixed-method approaches to better understand the complex interplay of gender roles, cultural norms, and walking behaviours. Incorporating visual methods, such as photo-elicitation interviews and urban design mapping, would also provide valuable insights into how walkability is perceived and experienced across different spatial and socio-cultural settings, allowing for a deeper exploration of the subjective dimensions of walking.

This study provides an initial understanding of which types of neighbourhoods are associated with greater recreational walking. Building on this, more granular investigations of specific design features—such as shaded pathways, traffic calming, or internal connectivity—could inform targeted urban design strategies suited to Bangkok's context. Detailed insights into these elements can guide the development of targeted urban design guidelines. To strengthen generalisability and provide further insight into climatic and socio-cultural variability in walkable design, future research should incorporate cross-regional comparative studies between tropical cities in Southeast Asia and cities in temperate climates. Such comparisons could help elucidate whether and how thermal comfort interventions vary in effectiveness across climatic zones. Moreover, the economic implications of implementing walking-friendly neighbourhood designs warrant comprehensive exploration, particularly in terms of their cost-effectiveness and potential long-term public health benefits. This includes analysing reductions in healthcare costs associated with increased physical activity and improved well-being. Our findings—linking walkable neighbourhoods with improved health outcomes—suggest that investments in walkability could yield substantial public value. Economic analyses evaluating property values, tourism potential, or business vibrancy would complement our results and provide policymakers with additional justification for prioritising pedestrian infrastructure. These findings could provide policymakers with robust evidence to justify investments in walking-friendly infrastructure and its role in promoting urban health. In addition to

that, conducting comparative studies with other major Asian cities could provide valuable regional insights and inform urban planning strategies to promote walking.

The role of technology, including smartphones and fitness trackers, in influencing walking behaviour was not addressed in this study. This represents an emerging area for research, as technological tools can potentially encourage recreational walking and facilitate data collection. Finally, a deeper examination of social norms and cultural factors unique to Bangkok would provide additional context to the findings, enabling a more nuanced understanding of walking behaviour in this setting.

Despite these limitations, our study makes significant contributions to understanding the role of neighbourhood environments in promoting recreational walking and its associated health benefits in Bangkok. Our findings provide evidence-based support for prioritizing neighbourhood-level interventions in urban planning and public health policies aimed at promoting physical activity and well-being among Bangkok residents. First, the strong association between neighbourhood walkability and recreational walking indicates that the Bangkok Metropolitan Administration should establish context-specific guidelines that adapt NEWS-A criteria for residential projects in Bangkok, moving beyond the current tourism-centric approach that enhances pedestrian infrastructure in tourist areas but neglects residents' daily walking needs. These guidelines should incorporate provisions for covered walkways and pedestrian safety features tailored to Bangkok's tropical climate. Second, our finding that different neighbourhood types show varying associations with recreational walking supports customized design interventions for existing neighbourhoods, especially those with low walkability. This includes creating green space networks within residential areas, particularly in high-density zones; implementing traffic-calming measures to prioritize pedestrian safety; and enhancing connectivity between existing green spaces through well-maintained, shaded pathways to mitigate the effects of the tropical climate. Third, the significant link between recreational walking and both physical activity and well-being justifies specific policy mechanisms such as developer incentives for creating walking spaces, repurposing underutilized urban land into community parks and recreational hubs, and establishing neighbourhood-level grants for community-initiated walking infrastructure. These targeted interventions, adapted to Bangkok's specific urban context, can significantly contribute to creating walkable, health-promoting neighbourhoods that support residents' physical activity and well-being.

While our findings support significant associations between neighbourhood environment, recreational walking, and health outcomes, we acknowledge that the environmental characteristics used—primarily NEWS-A subscales and a typology of neighbourhoods derived from BMA categories—may not fully capture the spatial richness or morphological detail often needed to understand walkability in depth. These proxies were selected to balance empirical tractability with conceptual relevance across a large urban sample and have precedent in urban health literature. Nevertheless, we recognise that more spatially grounded, design-sensitive, and context-specific environmental indicators would enhance explanatory power and relevance. Future research should incorporate methods such as streetscape audits, GIS-based morphometric analysis, or participatory spatial techniques to complement and deepen the insights from standardized survey-based walkability tools. Our aim here was to establish statistically testable patterns across a diverse population and to lay a foundation for more refined walkability frameworks tailored to tropical megacities like Bangkok.

## 5. Conclusions

This study examined the relationships between neighbourhood environments, recreational walking, physical activity, and well-being in Bangkok, Thailand. Our findings

highlight three key points. First, neighbourhood environment characteristics, particularly walkability scores and neighbourhood type, significantly influence recreational walking behaviour. High-rise and planned neighbourhoods showed higher odds of recreational walking compared to unplanned neighbourhoods, suggesting that specific urban forms and design features can effectively promote walking behaviour. Second, engagement in recreational walking was positively associated with achieving sufficient physical activity levels, underscoring its potential as a public health strategy. Third, recreational walking showed significant positive associations with well-being, demonstrating its broader health benefits beyond physical activity.

Our findings provide evidence-based recommendations for urban planners and policymakers in Bangkok and similar urban contexts. The success of high-rise and planned neighbourhoods in fostering recreational walking suggests that targeted, neighbourhood-level interventions are more effective than broad city-wide strategies. Such interventions should prioritise the creation of green space networks in residential areas, particularly in high-density zones, alongside the development of additional shaded pathways to enhance accessibility and mitigate the tropical climate's impact. Improving connectivity between green spaces through safe and well-maintained walkways is essential. Policymakers should also repurpose underutilised urban spaces into recreational hubs and community parks, addressing the specific needs of local residents. The strong associations among recreational walking, physical activity, and well-being further strengthen the case for investing in neighbourhood walkability.

While these findings reflect Bangkok's unique climatic and cultural conditions—particularly the role of unplanned neighbourhoods and extreme heat—several conclusions may be transferable to other rapidly urbanising, high-density cities in tropical regions. The emphasis on pedestrian infrastructure, shaded walkways, and localised green space networks is likely relevant beyond Thailand, offering a potentially generalisable framework for urban health interventions. However, the extent of application in different contexts may depend on variations in land-use patterns, socio-cultural norms, and urban governance structures. Recognising which elements are broadly applicable and which are specific to Bangkok ensures that decision-makers can adapt strategies appropriately to diverse environments.

The study's findings advance both theoretical and practical understanding. Theoretically, it deepens knowledge of how neighbourhood characteristics shape walking behaviour under tropical climatic conditions, highlighting the significance of cultural and environmental factors unique to Bangkok while underscoring potential parallels with other global contexts. Practically, it provides robust evidence to support neighbourhood-focused urban planning. To extend the contributions of this study, further research should adopt longitudinal designs, incorporate objective activity measures, and engage more diverse populations. These directions would help validate and deepen the statistical relationships we have already established across Bangkok's urban environments. Examining specific neighbourhood design features in Bangkok's context—such as connectivity, safety elements, and unplanned versus planned infrastructures—would aid in developing more finely tuned urban design guidelines. Additionally, research on seasonal variations in walking behaviour and their interaction with neighbourhood characteristics could inform climate-adaptive urban strategies. Finally, expanding the scope to include diverse groups, such as children, the elderly, and individuals with disabilities, is essential for creating inclusive walking environments that benefit all residents.

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