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Community Morphology and Perceptual Evaluation from the Perspective of Density: Evidence from 50 High-Density Communities in Guangzhou, China

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Abstract

Spatial density, as a key indicator of the quality of the urban residential environment, comprises both physical and perceived dimensions. Physical density refers to objective spatial characteristics (e.g., building density and population density), whereas perceived density denotes residents' perceptual evaluations (e.g., perceived crowding, visual openness, and overall environmental quality). Clarifying the relationship between physical and perceived density is therefore critical for advancing livability-oriented urban planning and design. This study examines the relationship through an empirical analysis of 50 representative high-density communities in Guangzhou. Using morphological classification, descriptive statistics, and multiple linear regression, the analysis compares objective density indicators with residents' perceptual evaluations and identifies key environmental factors that shape perceived density. Findings indicate that physical and perceived density are not fully aligned: compact but coherent spatial forms can enhance residents' perceptual evaluations, whereas overcrowded and deteriorating environments intensify negative perceptions. The identified community typologies—for example, urban villages, traditional walk-up estates, and modern high-rise complexes—exhibit distinct perceptual patterns and influencing factors. These results highlight the need for density regulation to move beyond conventional physical indicators and to incorporate perceptual dimensions into planning frameworks. Overall, the study provides theoretical insights and practical guidance for tailored strategies in the renewal and management of high-density communities.

Keywords: spatial density; perceived density; morphological characteristics; high-density communities; Guangzhou

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1. Introduction

Urban settlements emerge from human agglomeration, and large cities evolve through sustained population migration. Globally, the concentration of people in large and megacities has become a defining pattern of urbanization in Global South cities, particularly in Asia. According to United Nations projections, more than 60% of the global population will live in urban areas by 2030 [1], with the number of megacities—those exceeding 10 million inhabitants—expected to reach 43, nearly one-fifth of which will be located in China [2]. As a result, population concentration and rising spatial density have become defining features of China's urban transformation. In addition to demographic dynamics, institutional factors have also profoundly shaped this process. The land finance system enabled local governments to rely heavily on revenues from land transfers, stimulating high-intensity development and incentivizing projects with higher plot ratios [3]. The household registration system further restricted migrants' eligibility for formal housing, pushing many low-income migrants to concentrate in urban villages or informal enclaves [4]. Together, these demographic pressures and institutional arrangements fostered the coexistence of diverse high-density community types in Chinese cities.

Under the dual pressures of land scarcity and increasing spatial demand, high density has become a common urban form in many Chinese cities. This form provides notable benefits, such as facilitating infrastructure provision, fostering economic agglomeration, and improving residents' accessibility to services [5]. Prior research has emphasized the necessity of high-density development from the perspectives of sustainability [6], population pressure [7], economies of scale [8], and the balance between large populations and limited arable land [9]. However, growing concerns point to the negative externalities of excessive density, including environmental pollution, disease transmission, infrastructure deficiencies, and traffic congestion [10–13]. Coordinating high-density construction with high-quality urban development has thus become a pressing challenge [14].

As the fundamental unit of urban space and the primary setting of everyday life, the community plays a critical role in shaping residents' spatial experiences and perceived well-being, while also reflecting the precision of urban governance [15,16]. However, research on high-density communities remains insufficient in several respects. First, most studies have concentrated on macro- or meso-levels (e.g., cities or districts), with limited attention to micro-scale relationships between spatial form, resident perception, and density [17]. In high-density neighborhoods, limited open and recreational spaces constrain residents' daily activities; compact building forms and crowded environments reduce opportunities for spontaneous neighborhood interaction; and persistent spatial pressure may contribute to psychological stress and lower perceived well-being [18,19]. Although these lived experiences are crucial for grasping the perception of density, they have rarely been investigated systematically. Second, physical density is typically measured through rigid indicators such as floor area ratio, building coverage, or green space ratio, which fail to capture subjective experiences (e.g., perceived crowding, spatial pressure, and visual openness). Perceived density, as a softer and more resident-centered concept, still lacks a clear definition, measurement framework, or mechanisms for comparison with physical density [20]. Third, density control in planning practice continues to rely heavily on regulatory tools (e.g., FAR zoning, building height restrictions) designed for new-town development and expansion. These tools offer limited guidance for the spatial restructuring and environmental upgrading of high-density, aging communities, and fail to respond to differences across morphological types [21]. By addressing these gaps, this study combines objective physical indicators with perception-based evaluations, contributing to a more integrated framework that links built form, residents' lived experiences, and the evolving concept of perceived density in high-density communities.

Moreover, in high-density urban environments, perceived density is also a central factor influencing residents' sense of crowding, which may in turn trigger negative evaluations of residential environments [22]. Although planning concepts often emphasize population density indicators, research on the relationship between density and residents' subjective perceptions remains limited [23]. Current approaches to measuring perceived density largely rely on indirect assessments from a physical perspective. For example, some studies determine a fixed observation point within the outdoor space of a residential area and measure the perceived density by calculating the volume of visible space within the human eye's field of vision, while others assess the sense of oppression and perceived density through indicators such as the number of buildings or horizontal spacing between them [24–28]. However, with the prevalence of open block patterns and shared space concepts, residents' daily activities increasingly extend beyond traditional community boundaries. As a result, measurements based solely on internal community elements and building forms fail to accurately reflect residents' true perceptions of the environment. Moreover, different social groups may exhibit systematic differences in density perception, influenced by factors such as socioeconomic status, lifestyle habits, cultural background, and individual expectations [29]. This suggests that perceived density is not a simple extension of physical density, but rather the outcome of multiple interacting factors. Therefore, based on a conceptual distinction between physical density and perceived density, this study employs detailed field surveys and structured questionnaires to collect residents' direct feedback on perceived density, thereby facilitating an in-depth analysis of the relationship between the two and the key factors influencing it.

In response to these gaps, this study takes 50 high-density communities in Guangzhou as case samples. It analyzes both physical and perceived spatial density, identifies key morphological characteristics, and explores the mechanisms shaping perceptual differences. Three core research questions are addressed: (1) What is the essential purpose of spatial density control in urban planning, and how are planning principles reflected in guiding and regulating density? (2) To what extent do residents' perceptions of density align with objective physical measures, and what spatial factors contribute to perceptual differences? (3) What are the typical morphological types of high-density communities in Guangzhou, and how can tailored strategies for spatial optimization be developed in response to these differences?

2. Data and Methods

2.1. Research Sample and Location

This study selects 50 high-density communities in Guangzhou with diverse morphological characteristics as the sample. These communities capture a range of building forms, development periods, and locations to represent the broader spatial evolution of Guangzhou's high-density neighborhoods [30]. The initial selection covered 5900 residential communities built after 1980 in Liwan, Yuexiu, Tianhe, and Haizhu Districts, all of which were listed for sale or rent. Data on each community's name, floor area ratio, construction year, and coordinates were collected from real estate platforms including Beike and Lianjia in August 2024 to ensure data timeliness and accuracy.

A time-series analysis of the average FAR of residential communities constructed over the years (Figure 1) reveals a consistent upward trend. In certain years, the average FAR exceeded 3.5, reflecting the city's ongoing trend toward higher density. Then, stratified sampling was employed considering factors such as geographic location, construction period, morphological traits, and spatial density distribution. This ensured temporal, spatial, and morphological representativeness and diversity in the final selection of 50 communities (Figure 2).

2.2. Data Acquisition and Measurement

The study uses two types of data: physical environment indicators and resident perception indicators. The physical indicators describe actual density and quality and serve as explanatory variables [31,32]. The perception indicators reflect how residents evaluate density and the environment and serve as dependent variables [33]. By comparing these two sets of indicators, the study identifies key spatial elements influencing residents' perception of density. The physical environment data were collected from publicly available sources such as Amap Open Platform and WorldPop. These data were verified and enriched through field surveys and on-site observation. The resident perception data were collected from a survey conducted from July to October 2024 titled "Guangzhou Community Environment and Life Quality Survey." The questionnaire included items on basic demographics and perceived density. After data cleaning and validation, with a valid response rate of 92.7% (Table 1).

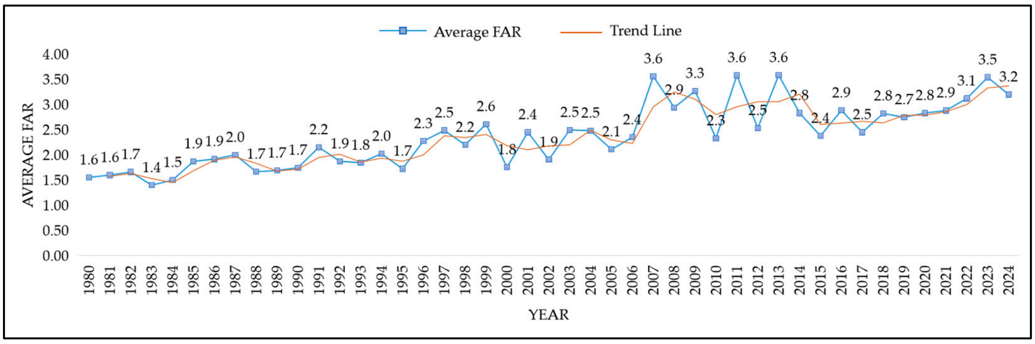


Figure 1. Changes in average floor area ratio (FAR) of Guangzhou residential communities.

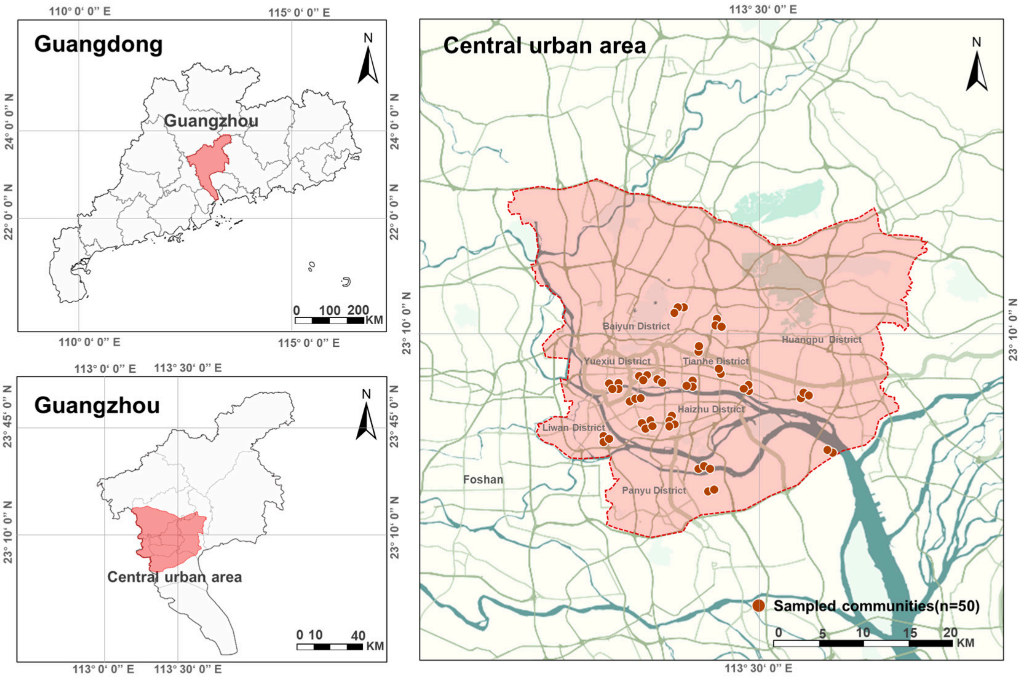


Figure 2. Study area and spatial distribution of sampled communities.

Table 1. Characteristics of survey respondents (N = 1552).

Category	Variable	Sample Size (N)	Proportion (%)
Gender	Male	798	51.42
	Female	754	48.58
Age	<18	91	4.90
	18–30	443	27.51
	30–45	493	30.73
	45–60	292	17.78
	>60	312	19.07
Education	High school or below	395	24.48
	Technical school	238	14.30

Table 1. *Cont.*

Category	Variable	Sample Size (N)	Proportion (%)
Education	Junior college	316	19.33
	Bachelor's degree	475	29.57
	Master's degree or above	207	12.31
Annual Income	<¥10,000 (unemployed)	360	22.23
	¥10,000–¥50,000	205	12.18
	¥50,000–¥100,000	339	20.81
	¥100,000–¥200,000	448	27.84
	>¥200,000	279	16.95
Years of Residence	<1 year	236	14.24
	1–3 years	332	20.36
	3–5 years	366	22.55
	5–10 years	344	21.13
	>10 years	353	21.71
Motor Vehicle Ownership	Yes	967	62.31
	No	585	37.69

Existing studies focused on spatial factors such as land use and functions, transportation and streets, facilities and open space, and layout and spatial form [34–36]. Drawing on this body of work—particularly the "5D" built environment framework (density, diversity, design, destination accessibility, and distance to transit) and related studies on density control indicators (e.g., FAR zoning, greening standards, building height restrictions)—and adapting them to Guangzhou's socio-spatial context, this study selects ten objective indicators that directly reflect development intensity and density: Floor Area Ratio, Green Space Ratio, Building Coverage Ratio, Population Density, Land Area, Main Building Height, Distance to Major Roads, Construction Year, Housing Price Level, and Geographic Location.

Likewise, existing studies incorporated aspects such as community functions, transportation, and open Spaces into the environmental evaluation indicators for residents [37,38]. Based on the concept of density and Guangzhou's local context, this study defines perceived density through eight dimensions: Land Use (concentration of land use and unctions), Layout (comfort of residential layout and sunlight spacing), Transport (convenience of public and pedestrian transport), Open Space (accessibility of open and activity spaces), Facility (aggregation of public and life service facilities), Climate (comfort of climate and air quality), Character (visual appeal of built form and streetscape), and Evaluation (overall satisfaction with perceived residential density) [39–42]. This indicator system highlights the correspondence between physical and perceived dimensions and facilitates the subsequent analysis of their divergence and influencing factors.

In terms of control variables, prior studies typically accounted for individual and socioeconomic attributes. Accordingly, this study collects demographic information including gender, age, education level, annual income, length of residence, and motor vehicle usage (Table 2).

Table 2. Indicator variables, measurement methods, and data sources.

Indicator Variable	Measurement Method	Data Source
	Environmental metrics (independent variables)	
Floor Area Ratio	Gross floor area/total site area	Beike/Lianjia platforms

Table 2. *Cont.*

Indicator Variable	Measurement Method	Data Source
Green Space Ratio	Greening area/total site area	Beike/Lianjia platforms
Building Coverage Ratio	Building footprint area/total site area	AutoNavi (Gaode) platform
Population Density	Permanent residents per km^2	WorldPop database
Land Area	Total community land area (km^2)	AutoNavi (Gaode) platform
Main Building Height	Dominant residential building stories	Field survey and panoramic mapping
Distance to Major Roads	Distance from community to arterial roads (km)	AutoNavi (Gaode) platform
Construction Year	Community completion year	Beike/Lianjia platforms
Housing Price Level	Average selling price (September 2024, CNY)	Beike/Lianjia platforms
Geographic Location	Distance from community to urban core (km)	AutoNavi (Gaode) platform
	Resident-perceived metrics (dependent variables)	
Land Use	Extent to which amenities satisfy daily needs	Questionnaire survey
Layout	Comfort, spacing, and sunlight exposure	Questionnaire survey
Transport	Convenience of walking and access to bus stops	Questionnaire survey
Open Space	Accessibility of parks and squares	Questionnaire survey
Facility	Adequacy of cultural, sports facilities	Questionnaire survey
Climate	Perceived air quality and climate comfort	Questionnaire survey
Character	Quality of surrounding built and urban image	Questionnaire survey
Evaluation	Overall evaluation of perceived density	Questionnaire survey

Notes: Measurement of resident-perceived indicators was based on a standard 5-point Likert scale: 1 = completely disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree.

2.3. Research Methods and Models

To explore how the physical environment relates to perceived density in Guangzhou's high-density neighborhoods, this study uses three main methods: morphological typology classification, descriptive statistical analysis, and multiple linear regression. The morphological classification was developed through on-site surveys and in-depth investigations of 50 high-density communities. It identifies and summarizes distinct spatial layouts and architectural forms, laying the foundation for subsequent analysis of the differences and issues in both physical and perceived aspects across spatial typologies. The descriptive analysis summarizes the average values and standard deviations of each indicator and uses line and comparison charts to show differences across community types, helping to outline the overall spatial pattern of high-density neighborhoods in Guangzhou. The multiple linear regression aims to explore the associations between physical environment variables and perceived density ratings. The data were first normalized using the min-max method, then analyzed with SPSS 27 to build regression models. These models reveal how each physical factor affects perception and help guide strategies for improving high-density environments (Figure 3).

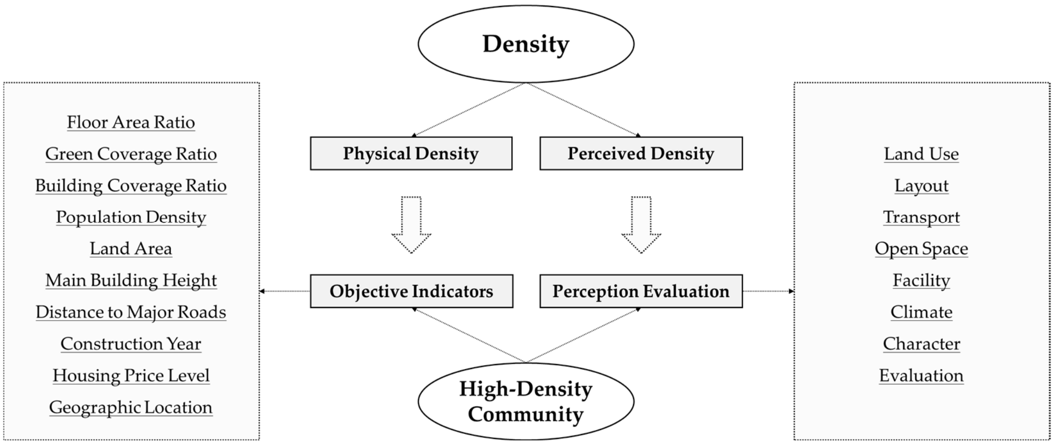


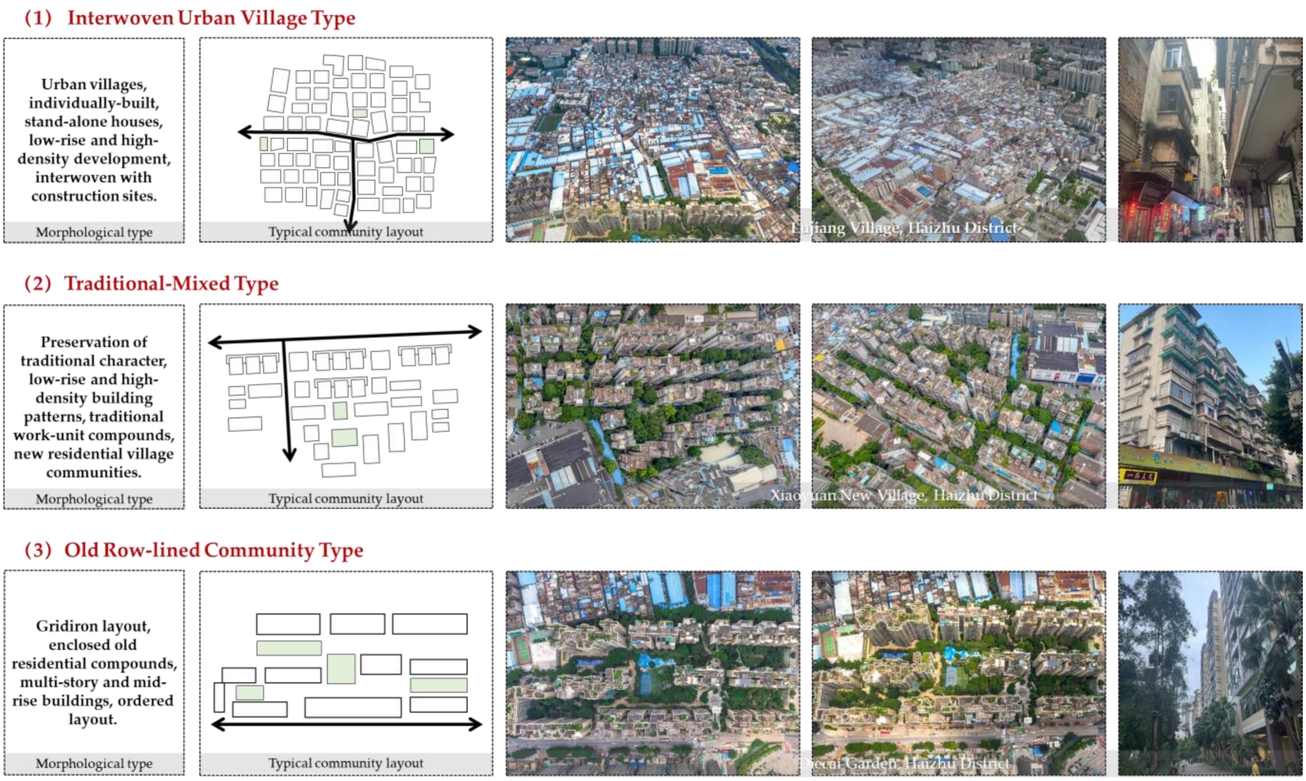
Figure 3. Empirical Research Design.

Arrows represent logical relationships, indicating how density is conceptualized as physical and perceived, operationalized through objective indicators and perception evaluation, and applied to analyze high-density communities.

3. Spatial Characteristics of High-Density Communities

3.1. Morphological Type Induction

Based on field investigations and data collection from 50 high-density communities, this study classifies Guangzhou's high-density neighborhoods into six types (Figure 4). The classification draws on indicators like FAR, building and green space density, height, and layout [43].



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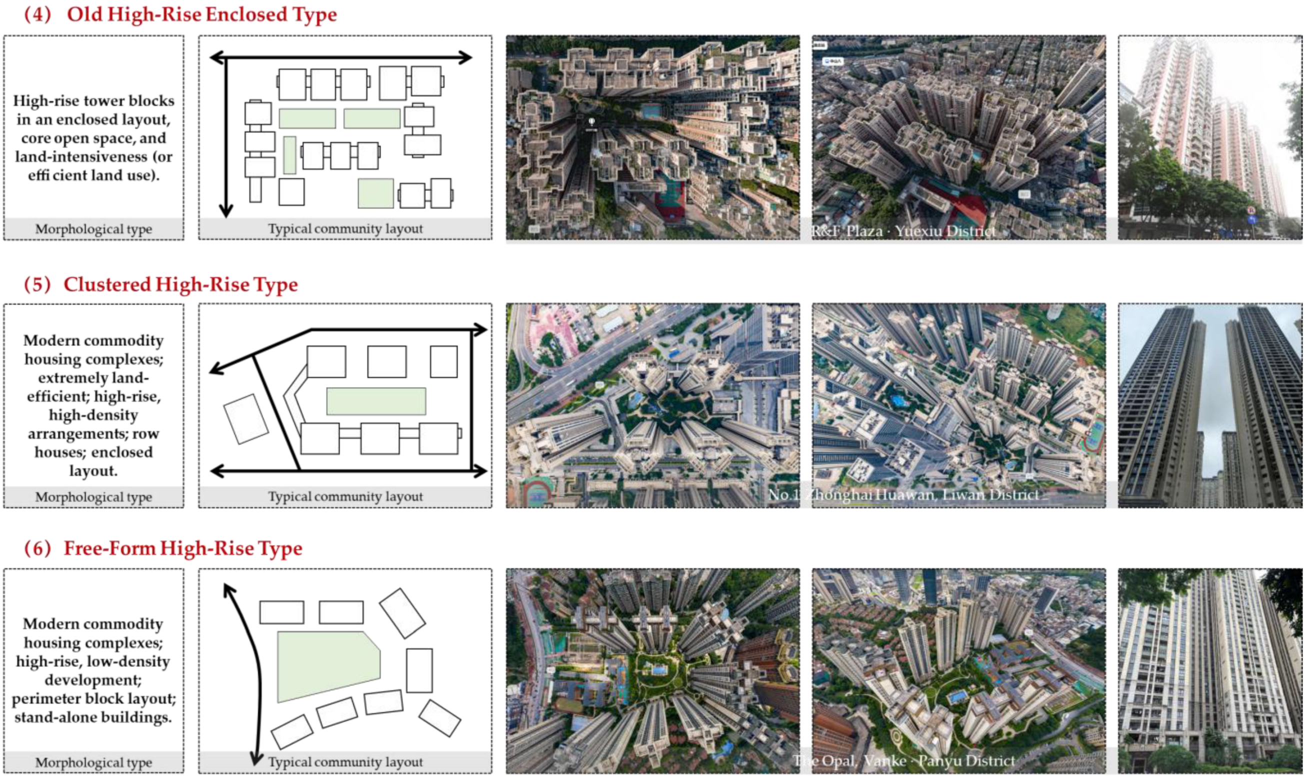


Figure 4. Morphological types of high-density communities in Guangzhou.

(1) Interwoven Urban Village Type: Refers to urban villages that lag behind in urbanization and retain traditional rural spatial forms. These areas exhibit low-rise but high-density characteristics, with irregular layouts interspersed with formal urban land uses. The building stock primarily consists of self-built detached housing, with residents' activities concentrated along the main streets.

(2) Traditional-Mixed Type: These communities preserve elements of historical architectural styles or reflect socio-cultural patterns from specific historical periods. They are characterized by low-rise, high-density forms, including state-owned housing blocks from the planned economy era and informal post-reform residential enclaves. These areas are spatially interwoven with surrounding urban blocks and reflect a transitional morphology between traditional and modern urban forms.

(3) Old Row-lined Community Type: Characterized by orderly, linear arrangements of mid-rise residential blocks within enclosed compounds. These communities exhibit consistent building height and density, with open spaces distributed between aligned buildings.

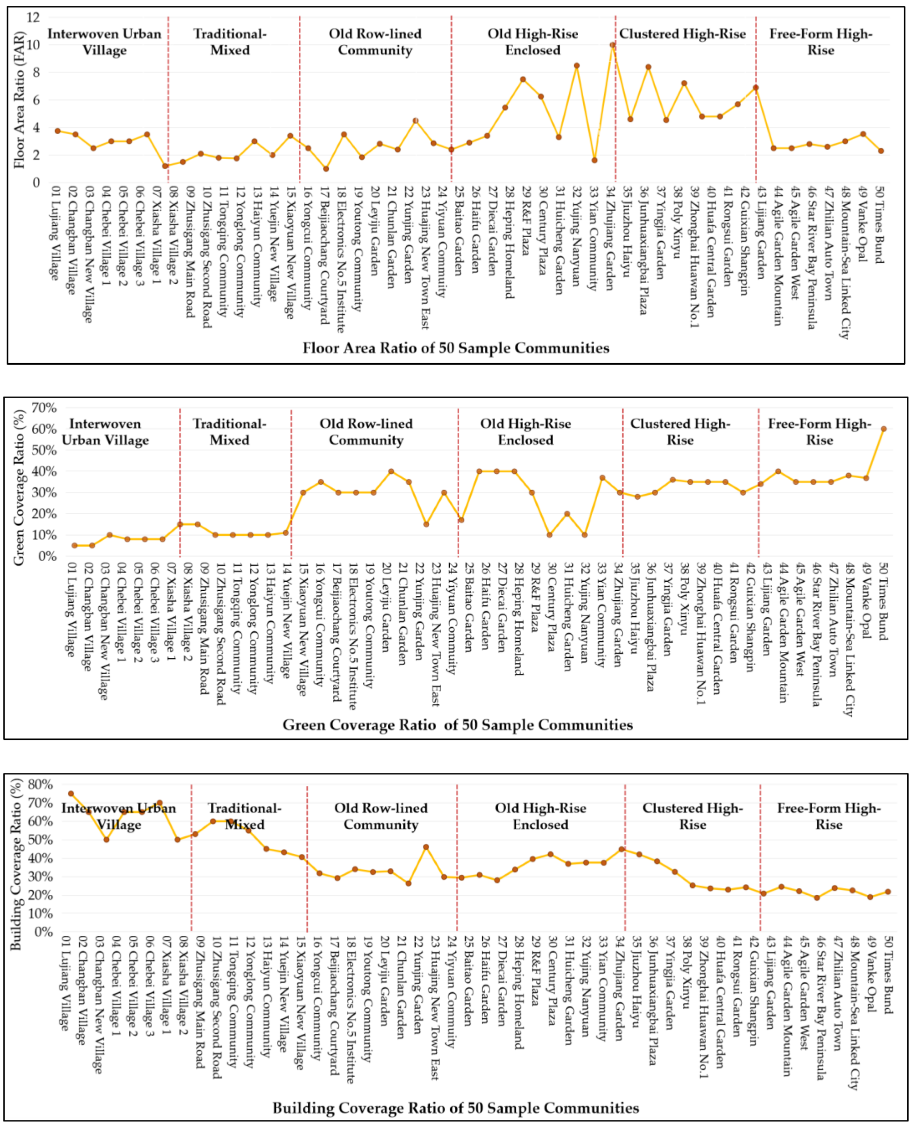
(4) Old High-Rise Enclosed Type: Typically composed of high-rise towers arranged in a semi-regular enclosed pattern, these communities exhibit compact land use and centralized residential clustering. Towers are grouped around a central open space, though internal organization remains irregular.

(5) Clustered High-Rise Type: Found in inner-city or land-constrained areas, these modern residential communities feature concentrated clusters of high-rise towers and extremely high floor area ratios. The layout is highly intensive and space-efficient.

(6) Free-Form High-Rise Type: Represents modern developments where high-rise towers are distributed more loosely, with relatively low building coverage despite their height. Layouts vary and may include perimeter or freestanding forms, often designed to maximize ventilation, views, or sunlight access.

3.2. Spatial Characteristics Analysis

The average FAR is 3.85 across the sample. Urban villages, traditional neighborhoods, old row-lined communities, and modern high-rises tend to fall within a narrower FAR range of 2–4, while enclosed high-rise and clustered tower developments exhibit higher and more variable FAR values. The average greening ratio is 26%, ranging from a high of 60% in high-rise communities to a low of 5–10% in urban villages. Significant variation exists in greening ratios across morphological types. The average building coverage ratio is 38.33%, ranging from 18.5% in high-rise communities to 60–70% in urban villages. Additionally, high-density communities exhibit marked variation in other attributes such as population density, land area, building height, proximity to major roads, construction year, housing prices, and geographic location. For example, traditional and enclosed high-rise communities often have higher population densities and are located in central urban districts, constrained by their historical development and physical form. In contrast, free-form high-rise communities are typically situated in peripheral or newly developed zones, with greater emphasis on green space and spatial experience. In summary, by classifying 50 high-density communities and analyzing key indicators (Figure 5), the study reveals their spatial differences. These results offer a solid basis for exploring how the environment shapes resident perceptions and for tailoring planning strategies to each community type.



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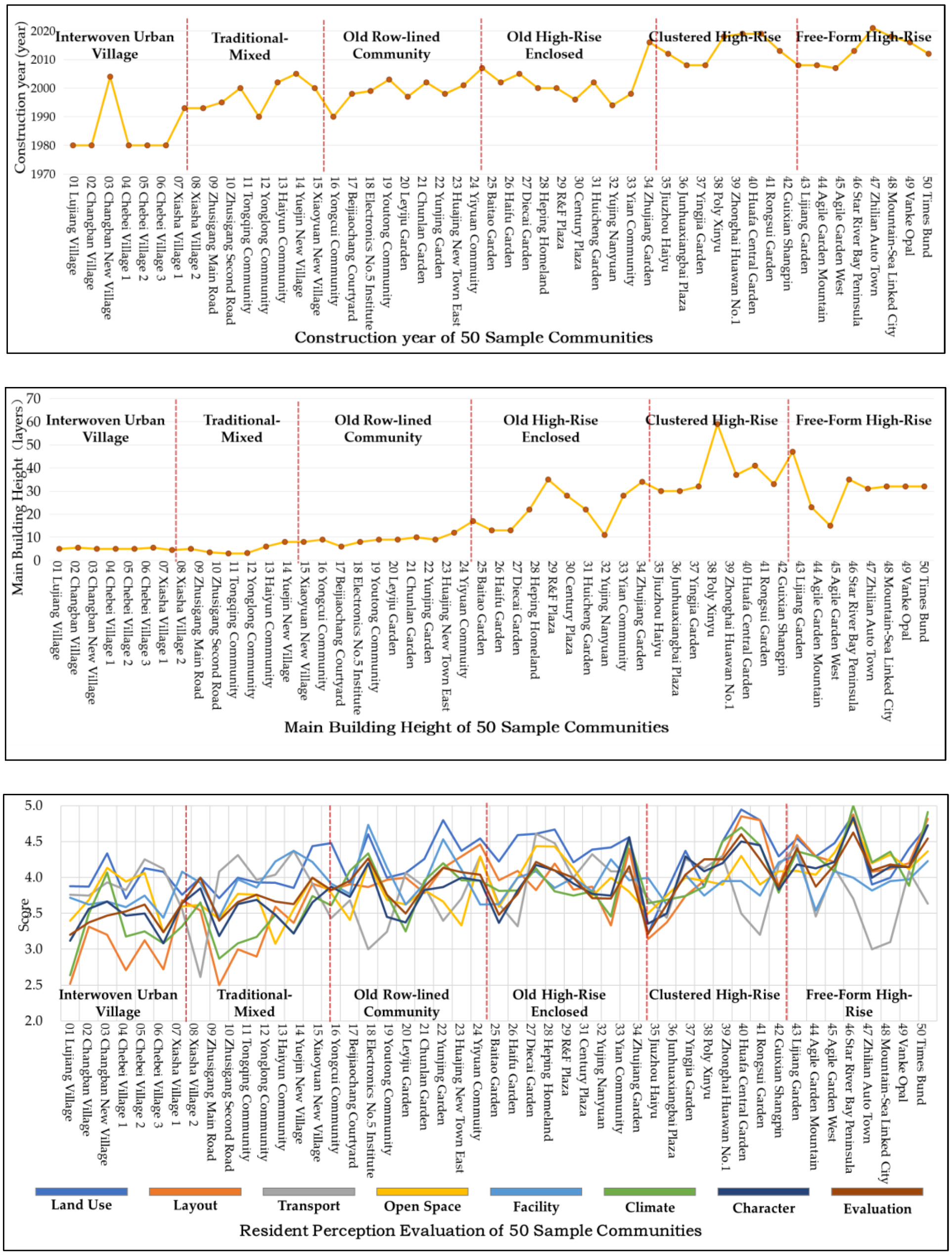

Figure 5. Statistical analysis of environmental indicators and residents' perception evaluation.

4. Resident Perception and Correlation Analysis

In high-density urban areas, resident subjective perceptions do not always align with the objective presentation of physical density. Perceived density reflects an individual's psychological construction of the spatial environment, shaped by the environment, social background, and personal characteristics. Drawing on field observations and survey data from 50 representative high-density communities in Guangzhou, this study employs multiple linear regression models to systematically examine the strength and direction of the effects of various physical environment factors on perceived density. It further explores heterogeneity across different perceptual dimensions to elucidate the underlying mechanisms through which the built environment influences subjective density perceptions.

4.1. Factors Affecting Perceived Density

In the multiple linear regression model examining the relationship between physical environment indicators and overall perceived density, all independent variables passed the multicollinearity check (VIF < 10). The adjusted R^2 was 0.609, and the model was statistically significant ($F = 8.179$, $p < 0.001$), showing it fits the data well (Table 3). Of the ten explanatory variables, six exerted statistically significant effects ($p < 0.05$).

Table 3. Regression results of environmental indicators and residents' overall perception evaluation.

Variable	β	SE	Std. β	t-Value	p-Value	VIF
Floor Area Ratio	−0.432	0.165	−0.395	−2.62	0.013	2.674
Green Space Ratio	−0.137	0.206	−0.129	−0.664	0.511	4.473
Building Site Coverage	−0.462	0.223	−0.489	−2.075	0.045 *	6.531
Population Density	0.059	0.115	0.061	0.516	0.609	1.627
Land Area	−0.166	0.139	−0.163	−1.196	0.239	2.187
Main Building Height	0.481	0.199	0.48	2.417	0.021 *	4.638
Distance to Major Roads	−0.026	0.155	−0.019	−0.168	0.867	1.555
Construction Year	−0.4	0.182	−0.429	−2.197	0.035 *	4.489
Housing Price Level	0.656	0.236	0.574	2.786	0.008 **	4.993
Geographic Location	0.573	0.259	0.458	2.21	0.034 *	5.052

Notes: Standardized coefficients are reported. Robust SEs in parentheses. ** $p < 0.01$, * $p < 0.05$. Model metrics: $F = 8.179$, Adj. $R^2 = 0.609$, DW = 1.891, N = 50.

Housing price exhibited a strong positive association with perceived density, reflecting the alignment between environmental quality and market value. At the physical level, higher housing prices are usually accompanied by superior building quality, enhanced green and open spaces, and more complete service facilities, all of which mitigate the sense of spatial crowding in dense environments. At the social level, expensive housing often corresponds to a more homogeneous and higher socioeconomic resident group, which fosters order, reduces conflicts, and enhances the perceived livability of high-density communities. Beyond these tangible aspects, housing prices also serve as a symbolic marker of exclusivity and spatial scarcity, such psychosocial satisfaction can offset discomfort typically associated with density and lead to higher overall evaluations.

Building height and distance from the city center were also positively associated with perceived density. Newer high-rise projects in outer-city areas generally provide better facilities, environmental quality, and spatial order, which enhance comfort and reduce the psychological pressure of density. Tall residential towers are often equipped with elevators, sound insulation, and modern building materials, which alleviate the discomfort that traditionally accompanies compactness. In addition, suburban high-rise developments usually benefit from larger plots, clearer community boundaries, and better integration of supporting amenities, thereby improving residents' satisfaction with dense living. By contrast, building density, FAR, and year of construction were negatively associated with perceived density. When floor area ratio and site coverage are excessively high, the sense of enclosure increases and natural ventilation and sunlight exposure are compromised, which directly generates feelings of crowding and spatial stress. Similarly, older housing stocks with limited maintenance exacerbate these negative experiences, as deteriorating infrastructure and poor environmental quality reinforce perceptions of congestion and decline. These findings suggest that density itself is not inherently detrimental; rather, its perceptual impact depends on whether spatial compactness is accompanied by high-quality design and renewal. Meanwhile, greening, population density, land size, and distance to major roads did not show significant effects.

4.2. Differences in Environmental Factors

To further unpack the relationship, perceived density was disaggregated into seven component dimensions, and separate regression models were estimated for each (Table 4). The results reveal clear differences in how physical environment factors translate into perceptual outcomes. Models for Layout, Climate, and Character achieved the best fits (adjusted R^2 values of 0.784, 0.715, and 0.535), suggesting that these dimensions are most directly and consistently shaped by measurable physical attributes. The analysis shows that layout is linked to tangible spatial order, sunlight exposure, and spacing between buildings; climate reflects immediate bodily experiences of ventilation, temperature, and thermal comfort; and character relates to visual impressions of streetscape and architectural form. These factors are directly perceived by residents and thus yield strong statistical associations.

Table 4. Regression results of environmental indicators and perceived density dimensions.

Modeling Metrics	Land Use	Layout	Transport	Open Space	Facility	Climate	Character
Statistical Significance (p)	0.024 *	<0.001 ***	0.156	0.005 **	0.241	<0.001 ***	<0.001 ***
R^2	0.404	0.831	0.304	0.473	0.273	0.777	0.636
Adj. R^2	0.239	0.784	0.11	0.327	0.071	0.715	0.535
F	2.442	17.677	1.57	3.231	1.353	12.525	6.291
DW	2.199	2.121	2.059	1.996	1.957	2.013	2.081

Notes: Statistical significance levels: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$.

By contrast, Land Use and Open Space dimensions demonstrated moderate explanatory power, with more context-specific and group-dependent effects. For instance, functional mix or park accessibility may be highly valued by families with children or physically active groups, but less relevant for others. Transport and Facility dimensions were not statistically significant, suggesting that their perception depends more on individual habits and social stratification.

4.3. Analysis of the Influence Mechanism

Based on the morphological classification, descriptive statistical analysis, and multiple regression results, the study reveals three underlying mechanisms shaping residents' perceptions of density. First, the morphological visibility mechanism. Elements such as floor area ratio, site coverage, building height, and spatial configuration are visually perceivable, directly influencing residents' sense of enclosure, crowding, and spatial order. This reflects a "physical–visual–perceptual" pathway, where compactness or openness in the built form translates into immediate perceptual responses. Second, the structural adaptability mechanism. Factors such as open space provision, functional mix, and community character exert indirect influences by improving spatial usability and environmental satisfaction. Although not direct indicators of density intensity, these features determine whether high-density living is experienced as oppressive or supportive of daily activities. Third, the experiential heterogeneity mechanism. Dimensions such as transportation convenience and public facilities are filtered through personal behaviors, social stratification, and lifestyle differences. For example, service accessibility may be valued differently by elderly residents, families with children, or young professionals, producing varied density perceptions under similar physical conditions.

Overall, perceived density emerges as a multidimensional construct, shaped not only by statistical correlations with physical indicators but also by complex and heterogeneous interactions between individuals, communities, and their environments.

5. Discussion

5.1. Divergence Between Physical and Perceived Density

This study highlights the divergence between physical density indicators and residents' perceptions of density. While objective measures such as FAR, building coverage, and population density offer standardized ways to assess compactness, residents' subjective evaluations are more strongly shaped by experiential qualities such as spatial order, openness, aesthetics, and social conditions. The results confirm that density itself is not inherently detrimental. Rather, it is the organization of dense environments (e.g., orderly layouts, adequate facilities, and favorable climatic or visual conditions) that determines whether compactness is experienced as crowding or as livable intensity. This reinforces the idea, widely discussed in environmental psychology, that perceived density represents a cognitive and affective construction, not a linear extension of physical measures.

5.2. Mechanisms Shaping Perception and Contextual Differences

Building on the regression models and typological analysis, three distinct pathways can be identified to explain how physical environments translate into density perceptions.

First, the morphological visibility pathway emphasizes how form-based elements (e.g., height, spacing, and coverage) act as immediately visible cues. These factors directly influence judgments of enclosure, openness, and sunlight, thereby shaping residents' overall satisfaction. This pathway is especially salient in explaining why high-rise projects with sufficient spacing may be evaluated more positively than compact low-rise enclaves with the same FAR.

Second, the structural adaptability pathway captures how organizational features such as open spaces, greenery, and functional mix shape perception indirectly. These elements may not reduce density in absolute terms, but they alter residents' daily activities and service experiences, thereby moderating the psychological impact of compactness. For example, parks and recreational spaces allow residents to reinterpret density as vibrancy rather than congestion, aligning with prior findings that social and environmental affordances mediate the stress of crowding.

Third, the experiential heterogeneity pathway reveals that perceptions of density are filtered through individual behaviors, expectations, and socioeconomic status. For transport and facility dimensions, the lack of significant statistical effects suggests that their evaluation depends less on physical provision and more on personal usage. Residents with higher resources may downplay density-related inconvenience, while low-income households or elderly groups may experience the same built form as oppressive [44].

5.3. Implications for Theory, Practice, and Future Research

The findings extend beyond the technical measurement of density, offering insights into urban theory and practice [45,46]. At the theoretical level, the study demonstrates that density must be understood as a multi-layered construct, shaped simultaneously by morphological visibility, structural adaptability, and experiential heterogeneity. This integrated framework bridges planning metrics with resident-centered evaluations, contributing to density debates in both urban studies and environmental psychology.

At the practical level, the results call for differentiated renewal strategies. Typological differences across Guangzhou's high-density communities imply that one-size-fits-all approaches are ineffective. For example, urban villages require investments in infrastructure and open space to mitigate stress, while modern high-rise clusters should focus on enhancing functional clusters and neighborhood cohesion to meet rising expectations. Housing prices, meanwhile, emerge not only as a market outcome but also as a psychosocial mechanism that mediates satisfaction, underscoring the importance of integrating socioeconomic considerations into density governance.

Finally, this study acknowledges several limitations. The analysis is based on cross-sectional data from Guangzhou, and subjective perceptions were measured primarily through survey responses, which may not capture temporal dynamics. Future research should extend the framework through longitudinal designs, cross-city comparisons, and the integration of behavioral big data (e.g., mobility records or social media activity) to better trace how perceptions evolve over time and across different urban contexts.

6. Conclusions

This study investigated the relationship between the physical environment and residents' perceived density in 50 high-density communities in Guangzhou by integrating morphological classification, descriptive statistics, and multiple regression analysis. Several key conclusions can be drawn.

First, the study confirms that reliance on single physical indicators is inadequate for capturing the lived experience of density. Regulatory metrics such as floor area ratio (FAR) and building coverage provide baseline measures but fail to reflect how residents evaluate density in daily life. Instead, factors such as layout clarity, climatic comfort, and architectural character emerged as critical determinants of perception.

Second, the study demonstrates that physical and perceived density do not always align. Dense communities with well-ordered spatial organization, sufficient open space, and appealing visual form can be positively evaluated, while environments with similar FAR but poorer quality are perceived as oppressive. Housing price, building height, and location further mediate this divergence, revealing the interplay between material environments and social expectations.

Third, the study highlights that perceived density is a multidimensional construct shaped by diverse mechanisms. The findings identified three key pathways: morphological visibility (direct perception of spatial form), structural adaptability (indirect influence through environmental quality and functional organization), and experiential heterogeneity (variation by social group and lifestyle). These mechanisms explain why density perception varies not only across morphological types but also among different resident groups.

Fourth, typological differences underscore the need for tailored governance strategies. Urban villages and traditional communities should prioritize infrastructure upgrades and open space improvements; older estates and enclosed high-rises require interventions to alleviate overcrowding and service shortages; while clustered towers and modern high-rises demand policies that strengthen neighborhood cohesion and expand functional clusters.

Overall, the study advances both theory and practice by conceptualizing density as an integrated outcome of morphological visibility, structural adaptability, and experiential heterogeneity. It emphasizes that managing high-density environments requires moving beyond static physical metrics to incorporate residents' perceptual experiences. Future research should extend these findings through longitudinal designs, comparative studies across different urban contexts, and the use of big data to capture temporal and behavioral dynamics in density perception.

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References

1. Habitat UN. *International Guidelines on Urban and Territorial Planning*; United Nations Human Settlements Programme: Nairobi, Kenya, 2015.
2. UN Department of Economic and Social Affairs (UN DESA). 2018 Revision of World Urbanization Prospects [EB/OL]. Available online: https://www.un.org/development/desa/pd/news/world-urbanization-prospects-2018 (accessed on 1 September 2018).
3. Zhang, M.; Tan, S.; Zhang, Y.; He, J.; Ni, Q. Does land transfer promote the development of new-type urbanization? New evidence from urban agglomerations in the middle reaches of the Yangtze River. *Ecol. Indic.* **2022**, *136*, 108705. [CrossRef]
4. Chen, M.; Liu, W.; Lu, D.; Chen, H.; Ye, C. Progress of China's new-type urbanization construction since 2014: A preliminary assessment. *Cities* **2018**, *78*, 180–193. [CrossRef]
5. Yao, M.; Yao, B.; Cenci, J.; Liao, C.; Zhang, J. Visualisation of High-Density City Research Evolution, Trends, and Outlook in the 21st Century. *Land* **2023**, *12*, 485. [CrossRef]
6. Pan, G.C. High-density development in Hong Kong. *City Plan. Rev.* **1996**, *6*, 11–12.
7. Li, Q.; Zhang, H.H. Urban layout and high-density population society in China. *Strategy Manag.* **2004**, *3*, 84–92.
8. Wu, E.R.; Sun, L.B. High density and environmental sustainability in Hong Kong: A personal vision of the future. *World Archit.* **2007**, *10*, 127–128.
9. Li, H.P.; Liu, Z. Spatiotemporal evolution of urban density and analysis of high-density development in China: From 1981 to 2014. *Urban Dev. Stud.* **2019**, *26*, 46–54.
10. Zheng, Y.; Yang, J.Y. Rethinking and exploring design methods for high-density cities from a "pan-health" perspective. *Urban Dev. Stud.* **2022**, *29*, 23–32+2.
11. Wang, Z.H.; Zhang, C.Y. A review of the relationship between high-density built environments and public health. *South Archit.* **2023**, *6*, 21–31.
12. Galle, O.R.; Gove, W.R.; McPherson, J.M. Population density and pathology: What are the relations for man? Evidence from one city suggests that high population density may be linked to "pathological" behavior. *Science* **1972**, *176*, 23–30. [CrossRef]
13. Gove, W.R.; Hughes, M.; Galle, O.R. Overcrowding in the home: An empirical investigation of its possible pathological consequences. *Am. Sociol. Rev.* **1979**, *44*, 59–80. [CrossRef]
14. Koohsari, M.J.; Yasunaga, A.; Veitch, J.; Kaczynski, A.T.; Oka, K. The density paradox: Density, walking, and psychological stress in overcrowded public spaces. *Cities Health* **2024**, 1–4. [CrossRef]
15. Yuan, Y.; Chen, Y.J.; Liu, Y.; Ding, K. Neighborhood effects of greening environments in Guangzhou communities on residents' self-rated health. *Acta Geogr. Sin.* **2021**, *76*, 1965–1975.
16. Boyko, C.T.; Cooper, R. Clarifying and Re-conceptualising Density. *Prog. Plan.* **2011**, *76*, 1–61. [CrossRef]
17. Wu, Y.H.; Liu, Y. Research progress on urban morphology in compact high-density environments: Origin, categories and strategies. *New Archit.* **2023**, *5*, 139–145.
18. Ding, D.; Sallis, J.F.; Kerr, J.; Lee, S.; Rosenberg, D. Neighborhood environment and physical activity among adults: A mediation analysis. *Int. J. Behav. Nutr. Phys. Act.* **2013**, *10*, 57. [CrossRef]
19. Mangrio, E.; Zdravkovic, S. Crowded living and its association with mental ill-health among recently-arrived migrants in Sweden: A quantitative study. *BMC Res. Notes* **2018**, *11*, 609. [CrossRef]
20. Li, Y.C.; Zhong, X.H.; Qi, J.H.; Hu, M.X. Study on spatial growth characteristics and influencing factors of Chinese cities based on building density distribution. *Urban Plan. Int.* **2024**, *39*, 9–19.
21. Tang, Z.L.; Tian, B.J.; Zhang, Y. Basic characteristics and practical cases of density zoning control in urban planning. *Urban Plan. Int.* **2023**, *38*, 8–14.
22. Berthelsen, A.L.; Caspers, B.; Chakarov, N.; Childs, A.K.; Coculla, A.; Dammhahn, M.; Moiron Cacharron, M.; Mühlenhaupt, M.; Müller, C.; Petit, J.; et al. Individual Variation in Perceived Density and Its Impacts on the Realization of Ecological Niches. *EcoEvoRxiv*, 2025, *Preprint*. [CrossRef]
23. Talen, E.; Wileden, L. The Density Puzzle: What Is Known, What Is Disputed, and Where to Go from Here. *J. Plan. Lit.* **2025**, *40*, 283–299. [CrossRef]

24. Asgarzadeh, M.; Lusk, A.; Koga, T.; Nakaya, T.; Hirate, K.; Inoue, S. Measuring oppressiveness of streetscapes. *Landsc. Urban Plan.* **2012**, *107*, 326–335. [CrossRef]
25. Byun, K.; Munakata, J.; Yoshizawa, N.; Sato, Y.; Hwang, T. A discussion on evaluating indicators of the sense of physical oppression and the sense of openness using imaging experiments—A study on the sense of physical oppression and the sense of openness created in urban spaces part 2. *J. Environ. Eng.* **2011**, *76*, 107–113. [CrossRef]
26. Yan, J.-B.; Xie, F. Discussion on the research and application of density atlas. *Urban Dev. Stud.* **2021**, *28*, 33–38.
27. Wang, T.; Huang, Y.-R. Quantitative study on perceived density of residential areas based on continuous spatial scenes. *Time + Archit.* **2023**, *1*, 180–185.
28. Hwang, T.; Yoshizawa, N.; Munakata, J.; Sato, Y. A study on the oppressive feeling caused by the buildings in urban space focused on the physical factors corresponding with oppressive feeling. *J. Environ. Eng. (Trans. AIJ)* **2007**, *72*, 25–30. [CrossRef]
29. Mousavinia, S.F.; Pourdeihimi, S.; Madani, R. Housing Layout, Perceived Density and Social Interactions in Gated Communities: Mediational Role of Territoriality. *Sustain. Cities Soc.* **2019**, *51*, 101699. [CrossRef]
30. Chen, J.; Pellegrini, P.; Wang, H. Comparative Residents' Satisfaction Evaluation for Socially Sustainable Regeneration—The Case of Two High-Density Communities in Suzhou. *Land* **2022**, *11*, 1483. [CrossRef]
31. Patil, M.P.; Romice, O. An Empirically Validated Framework for Investigating the Perception of Density. *Archnet-IJAR Int. J. Archit. Res.* **2025**, *19*, 23–43. [CrossRef]
32. Chen, S.; Yu, B.; Shi, G.; Cai, Y.; Wang, Y.; He, P. Scale-Dependent Relationships Between Urban Morphology and Noise Perception: A Multi-Scale Spatiotemporal Analysis in New York City. *Land* **2025**, *14*, 476. [CrossRef]
33. Kyttä, M.; Broberg, A.; Tzoulas, T.; Snabb, K. Towards contextually sensitive urban densification: Location-based softGIS knowledge revealing perceived residential environmental quality. *Landsc. Urban Plan.* **2013**, *113*, 30–46. [CrossRef]
34. Wang, H.; Zhang, C. Study on the Impact of Built Environment on Neighborhood Interaction Activities: Empirical Evidence from 51 Typical Residential Areas in Guangzhou. *South Archit.* **2023**, 60–68.
35. Liu, Z.R.; Liu, C. The Association between Urban Density and Multiple Health Risks Based on Interpretable Machine Learning: A Study of American Urban Communities. *Cities* **2024**, *153*, 105170. [CrossRef]
36. Foster, S.; Giles-Corti, B.; Bolleter, J.; Turrell, G. Denser Habitats: A Longitudinal Study of the Impacts of Residential Density on Objective and Perceived Neighbourhood Amenity in Brisbane, Australia. *Cities* **2023**, *143*, 104565. [CrossRef]
37. Wu, X.; Xu, L. Perceived Density in the Context of High-Density Urban Development: Connotations, Values, and Key Research Questions. *Urban Plan. Int.* **2024**, *39*, 62–70.
38. Fleming, I.; Baum, A.; Weiss, L. Social Density and Perceived Control as Mediators of Crowding Stress in High-Density Residential Neighborhoods. *J. Personal. Soc. Psychol.* **1987**, *52*, 899–906. [CrossRef]
39. He, D.S.; Miao, J.; Lu, Y.; Song, Y.; Chen, L.; Liu, Y. Urban Greenery Mitigates the Negative Effect of Urban Density on Older Adults' Life Satisfaction: Evidence from Shanghai, China. *Cities* **2022**, *124*, 103607. [CrossRef]
40. Gao, M.L.; Astell-Burt, J.; Knuiman, C.P. Perceived Built Environment and Health-Related Quality of Life in Four Types of Neighborhoods in Xi'an, China. *Health Place* **2016**, *39*, 110–115. [CrossRef] [PubMed]
41. Yang, J.Y.; Shi, B.X.; Shi, Y.; Marvin, S.; Zheng, Y.; Xia, G. Air Pollution Dispersal in High-Density Urban Areas: Research on the Triadic Relation of Wind, Air Pollution, and Urban Form. *Sustain. Cities Soc.* **2020**, *54*, 101941. [CrossRef]
42. Yuan, C.; Ng, E.; Norford, L.K. Improving Air Quality in High-Density Cities by Understanding the Relationship between Air Pollutant Dispersion and Urban Morphologies. *Build. Environ.* **2014**, *71*, 245–258. [CrossRef]
43. Chen, J. Characteristics and Evolution of Residential Areas in Guangzhou Since the Early 20th Century from a Typological Perspective. Master's Thesis, South China University of Technology, Guangzhou, China, 2014.
44. Liu, X.; Yu, Y. Impact and Intervention Path of Built Environment on the Health of Elderly in High-Density Residential Conditions. *Urban Dev. Stud.* **2023**, *30*, 35–42.
45. Dempsey, N.; Brown, C.; Bramley, G. The Key to Sustainable Urban Development in UK Cities? The Influence of Density on Social Sustainability. *Prog. Plan.* **2012**, *77*, 89–141. [CrossRef]
46. Cui, G.; Wang, M.; Fan, Y.; Xue, F.; Chen, H. Assessment of Health-Oriented Layout and Perceived Density in High-Density Public Residential Areas: A Case Study of Shenzhen. *Buildings* **2024**, *14*, 3626. [CrossRef]