

Influence of health equity-based Healthy City infrastructure on walking practice

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Objectives: This study examined the associations between individual and regional factors, with a focus on Healthy City infrastructure, particularly the inclusion of health equity principles in Healthy City ordinances, and the walking practice of local residents in South Korea. **Methods:** Using cross-sectional data from the 2023 Community Health Survey and municipal-level statistics, a two-level multilevel logistic regression model was applied to analyze the data on 222,165 adults residing within 228 local government jurisdictions. **Results:** Walking practice was significantly associated with demographic and health behavioral factors at the individual level. At the regional level, public transportation usage and inclusion of health equity in Healthy City ordinances were positively associated with walking practice. **Conclusion:** Health equity-oriented Healthy City infrastructure—such as ordinances embedding equity principles—was positively associated with residents' walking practice and may serve as an indirect indicator of equity-focused urban health governance. However, more refined measures are needed to further elucidate the role of Healthy City infrastructure in promoting healthy behaviors.

Key words: Healthy City, health equity, walking practice, multilevel analysis

I. Introduction

Walking is the most fundamental and natural form of physical activity, constituting an aerobic exercise that can be readily incorporated into daily life without the need for specialized skills or equipment (Morris & Hardman, 1997). Walking confers a number of health benefits, including strengthening of the cardiovascular system, obesity prevention, and reduction of stress (I. M. Lee & Buchner, 2008). As a result, walking is often considered a pivotal health promotion strategy in the domain of public health. According to the seminal work of Lalonde (1974), the concept of health is influenced by a multitude of factors, including biological, environmental, medical, and lifestyle elements. Of these, lifestyle factors play a particularly salient role.

Walking is an integral component of daily activities and is influenced by an individual's immediate environment. Well-designed pedestrian environments, including sidewalk width, street landscaping, and parks or green spaces, serve as key factors in encouraging residents to walk (Ewing & Handy, 2009; Renalds et al., 2010). Meanwhile, walking is influenced not only by individual lifestyle habits but also by community and policy factors. The Socio-Ecological Model (SEM) (McLeroy et al., 1988) posits that health behaviors are determined by a multitude of factors, including the individual, interpersonal relationships, organizations, communities, and public policy. From this perspective, public policy factors, such as relevant laws or ordinances, may function as structural mechanisms that guide the health behaviors of individuals (Fleury & Lee, 2006;

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Glanz et al., 2008).

The World Health Organization (WHO)'s Healthy City initiative is predicated on the principle of "Health in All Policies (HiAP)," a multi-layered approach that emphasizes policy elements. This highlights the fact that health is given paramount value in policy-making processes within cities, with the objective of promoting health equity (Ritsatakis et al., 2000). Since the establishment of the Korea Healthy Cities Partnership in 2006, the government of South Korea has promoted health-focused initiatives based on ordinances established in individual cities (Kang & Baek, 2023). These ordinances establish the legal basis for the Healthy City initiatives of local governments, set principles for allocating resources, and provide the foundations for determining the direction and priorities of these policy projects (J. Park, 2017). According to the Ministry of Health and Welfare's 2024 "Guidelines for the Utilization of Healthy City Indicators," the Healthy City ordinance is a core element in establishing a Healthy City infrastructure. Ordinances provide the institutional foundation for securing stable policy resources, such as organization, personnel, and budget (Kang et al., 2021) and serve as the basis for determining the values pursued by the region and the priorities of its projects. Furthermore, they emphasize the importance of clearly defining equitable planning and operational principles for local government initiatives, with the aim of reflecting policy directions that prioritize vulnerable groups across all urban infrastructures.

The inclusion of "health equity" in the Healthy City ordinances may serve as a foundational institutional standard, thereby establishing policy directives and resource allocation priorities. This development transcends the mere declarative nature of the original message. In general, urban infrastructure improvements tend to focus on areas with relatively well-established foundations. This focus is influenced

by financial conditions and administrative efficiency. However, this focus can, in fact, exacerbate inequality. Nevertheless, equity provisions have been shown to function as institutional mechanisms that prioritize vulnerable regions in resource allocation and contribute to the prevention of polarization (Smith et al., 2017). In this context, the HiAP principles of the WHO Healthy City prioritize health equity in urban areas, and the "Guidelines for the Utilization of Healthy City Indicators" from Ministry of Health and Welfare also delineate the enactment of ordinances and equitable project planning as a fundamental component of a Healthy City.

Consequently, equity-based ordinances and policies can function as institutional benchmarks, thereby influencing resource allocation priorities to prioritize socially vulnerable areas (Heo et al., 2017), which aligns with the socio-ecological perspective that policy factors can influence individual health.

This policy orientation prioritizes public infrastructure investment in vulnerable areas (Davies et al., 2019; Rigolon & Collins, 2023), thereby facilitating improvements to the pedestrian environment, such as sidewalk repairs and enhanced park accessibility, in these vulnerable neighborhoods.

Therefore, it sets forth a policy direction to expand opportunities for health behaviors among vulnerable groups previously excluded from physical activity due to infrastructure gaps and to help mitigate regional disparities in walking practice.

However, previous studies addressing existing Healthy City infrastructure have primarily focused on the physical environment, such as local parks, transportation, and buildings (B. Kim & Hyun, 2021; J. H. Lee, 2016; J. M. Kim et al., 2015; K.-H. Lee, 2012). In contrast, studies analyzing diverse urban environments, including policy elements, such as Healthy City ordinances (Kang & Baek, 2023), have been relatively scarce. Therefore, there is a meaningful

need for research that analyzes the influence of health equity provisions within Healthy City ordinances on local residents' health behaviors, such as walking practice.

However, the equity provisions in the ordinances used in this study should be interpreted not as indicators that directly measure the outcomes of policy implementation, but rather as indicators that indirectly measure the policy orientation of the local government by assessing whether equity is institutionally specified within the Healthy City policy. Accordingly, this study aims to examine the influence of individual and regional factors on residents' walking practice through a multilevel analysis, focusing on the presence of explicit health equity provisions within ordinances. This work is intended to provide evidence for the effective implementation of Healthy City policies and ultimately contribute to enhancing health equity in the community.

residents, utilizing hierarchically structured data. Consequently, when conducting simple regression analysis without controlling for these factors, statistical errors may occur, such as the underestimation of standard errors. Moreover, multilevel analysis helps prevent ecological fallacies or errors of aggregation that may stem from hierarchical data structures. To this end, multilevel analysis was used to separate and analyze factors at the individual level (Level 1) and the regional level (Level 2) hierarchically.

According to the SEM (McLeroy et al., 1988), the influencing factors on the dependent variable, namely individual walking behavior, were categorized into individual and regional variables. Individual variables (Level 1) comprised demographic characteristics and health behaviors, while regional variables (Level 2) were defined across three detailed domains: socioeconomic characteristics, environmental characteristics, and Healthy City policy characteristics [Figure 1].

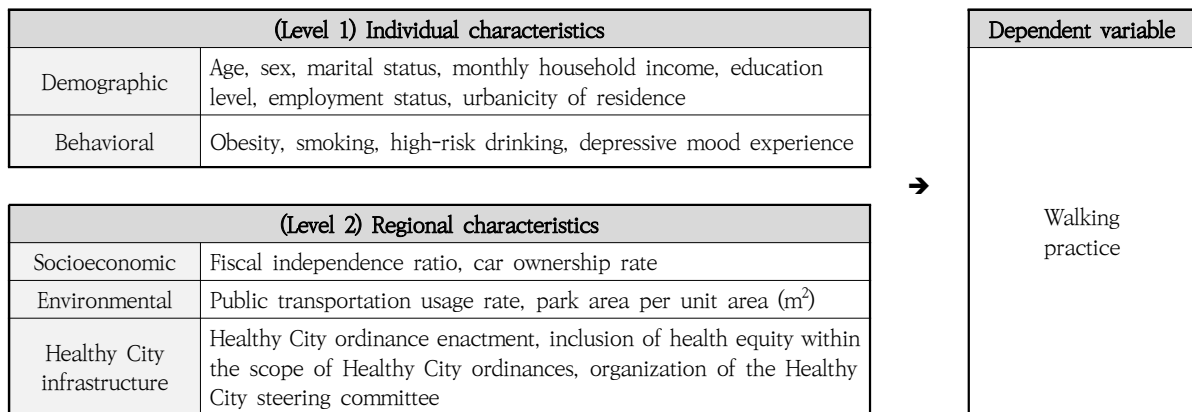
II. Methods

1. Study design

This study was designed as a multilevel analysis to examine the influence of Healthy City policy infrastructure on walking practice among local

2. Subjects

This study utilized raw data from the 2023 Korea Community Health Survey, an annual survey approved by the Korea Statistical Information Service (KOSIS), administered by the Korea Disease Control and Prevention Agency and public health centers



[Figure 1] Analysis model of the study

〈Table 1〉 Regional variables list

Variables	Description	Data sources
(Level 2) Regional characteristics		
Socioeconomic		
Fiscal independence ratio	Fiscal independence ratio (post-revenue classification reform)	KOSIS (2023)
Car ownership rate	Number of registered cars per capita	Car registration status report (2023)
Environmental		
Public transportation usage rate	Number of public transportation users /registered population×100	STCIS (2023)
Park area per unit area	Park area (m ²) / jurisdictional area (m ²) × 100	Statistical yearbook (2023)
Healthy City infrastructure		
Healthy City ordinance enactment	Yes or no	ELIS (2023)
Inclusion of health equity within the scope of Healthy City ordinances	Yes or no	
Organization of the Healthy City steering committee	None, operation of other committee, operation of Healthy City committee	

Notes. KOSIS=Korea Statistical Information Service; STCIS=Smart Transit Card Information System; ELIS=Enhanced Local laws and regulations Information System

nationwide. Data for the survey was collected using the computer-assisted personal interviewing method. The sample analyzed in this study comprised 222,165 individuals selected from a pool of 231,752 adults nationwide aged 19 or older. This sample was obtained after excluding 9,587 participants who had missing values or did not respond. The regional data were collected using the 228 cities, counties, and districts nationwide as the unit, utilizing each city, county, and district's statistical yearbooks, KOSIS, and the Enhanced Local Laws and Regulations Information System (ELIS) 〈Table 1〉.

3. Variables

1) Dependent variable: Walking practice

Walking practice was measured as the dependent variable by determining whether participants had walked for at least 30 minutes on five or more days during the past week. Following the Korea Disease Control and Prevention Agency's definition of walking

practice rate, this was measured as a binary variable.

2) Individual variables

Based on health determinants (Lalonde, 1974) and the SEM (McLeroy et al., 1988), individual variables were categorized into demographic characteristics and health behaviors. Demographic variables, such as age, gender, income, and education level, are key factors that explain differences in physical activity levels and health behaviors. Health behaviors, such as smoking, obesity, and alcohol consumption, are also related. The choice of variables was made based on prior research (B. Kim & Hyun, 2021; J. H. Lee, 2016; J. M. Kim et al., 2015; K.-H. Lee, 2012).

The individual demographic characteristics included age, sex, marital status, monthly household income, education level, employment status, and urbanicity of residence.

Sex was categorized as male or female, while age was divided into six categories: 19-29, 30-39, 40-49, 50-59, 60-69, and 70 and older.

Marital status was categorized into three groups: (i) spouse, (ii) divorce, bereavement, or separation, (iii) and single.

Monthly household income was categorized as follows: (i) less than KRW 2 million, (ii) KRW 2 million or more, but less than KRW 4 million, (iii) KRW 4 million or more, but less than KRW 6 million, and (iv) KRW 6 million or more.

Education level was categorized into five groups: (i) no schooling, (ii) elementary school, (iii) middle school, (iv) high school, and (v) college degree or higher.

Employment status was measured by engagement in economic activity.

Urbanicity of residence was categorized into: (i) rural areas, (ii) Small and medium-sized cities, and (iii) large cities, including autonomous districts in Seoul and metropolitan cities, as well as cities with populations exceeding 500,000.

Obesity was defined as a body mass index of $25\text{kg}/\text{m}^2$ or higher. Smoking was defined as having smoked at least five packs (100 cigarettes) in one's lifetime and currently being a smoker (smoking daily or occasionally). High-risk drinking was defined as consuming seven or more drinks for men and five or more drinks for women in a single drinking session at least twice a week during the past year (Shon & Yi, 2023). Depressive mood experience was measured as experiencing sadness or despair severe enough to interfere with daily life for two or more consecutive weeks during the past year.

3) Regional variables

Regional characteristics were measured by categorizing them into socioeconomic and environmental characteristics, and Healthy City infrastructure, as presented in <Table 1>. This was based on the premise proposed in the SEM (McLeroy et al., 1988) that individual health behaviors are influenced by multidimensional factors, such as local

financial conditions, transportation and park infrastructure, and policies. In addition, variables were set by referring to prior research (B. Kim & Hyun, 2021; J. H. Lee, 2016; J. M. Kim et al., 2015; Kang & Baek, 2023).

Socioeconomic characteristics included fiscal independence ratio and car ownership rate. The fiscal independence ratio was defined as the proportion of a local government's own revenue. The fiscal independence ratio indicator followed the revised classification standards provided by the KOSIS in 2023.

The car ownership rate was calculated by dividing the number of registered cars in the region by the resident population and multiplying by 100. The 2023 Vehicle Registration Status Report was used as the data source.

Environmental characteristics included public transportation usage rate and park area per unit area. The public transportation usage rate was calculated in 2023 by dividing the number of public transportation trips by the registered population, then multiplying by 100, utilizing the Smart Transit Card Information System (STCIS) big data. The park area per unit area was measured by dividing the total park area (m^2) of the region by its administrative area (m^2) and multiplying by 100, based on the 2023 city, county, and district statistical yearbook.

Local government Healthy City ordinances were utilized to facilitate the measurement and analysis of the Healthy City infrastructure, with data collected as of 2023 through ELIS.

Variables were measured by whether a Healthy City ordinance was enacted, whether health equity was incorporated into the scope of the ordinance, and the organization of the Healthy City steering committee. The establishment of a Healthy City ordinance was categorized as "Yes" where the ordinance was enacted as of 2023 and "No" where it was not enacted or enacted in 2024.

The inclusion of health equity within the scope of Healthy City ordinances was categorized into a dichotomous group: those where “equity” was mentioned within the scope and those where it was not mentioned or where no ordinance existed.

The organization of the Healthy City steering committee was categorized into three types: (i) cases where no ordinance or committee provisions existed, (ii) cases where another committee, such as the Healthy Living Practice Council, serving the duties, and (iii) cases where a separate steering committee was established to operate the Healthy City initiative.

Meanwhile, the incorporation of health equity into the scope of Healthy City ordinances can be viewed as an indirect indicator that equity has been adopted as a value within the Healthy City policy rather than as a variable measuring the extent to which the local government promotes equity-based improvements to the walking environment or programs.

4. Analysis methods

As the data collected in this study exhibited a hierarchical structure at both the individual and regional levels, and the dependent variable, whether walking practice occurs, is a binary variable, multilevel logistic regression analysis was performed.

The analysis was conducted in stages to distinguish between the null baseline model (Model 1), which was

used for baseline model verification, and three other models, including one that incorporated only individual variables (Model 2), one that incorporated only regional variables (Model 3), and one that incorporated both individual and regional variables (Model 4).

The model fit was compared and verified using -2 Log Likelihood (-2LL), Akaike Information Criterion (AIC), and Bayesian Information Criterion (BIC). Additionally, to identify the dispersion of walking practice rates across regions and confirm the suitability of applying multilevel analysis, the Intraclass Correlation Coefficient (ICC) was calculated and presented in a random-intercept model. All statistical analyses were performed using the Statistical Analysis System (SAS) (version 9.4).

III. Results

1. Participant characteristics

The demographic and health behavioral characteristics of the subjects are shown in <Table 2>. Of a total of 222,165 people, the age distribution was as follows: 9.1% were aged 19-29, 10.3% were aged 30-39, 14.5% were aged 40-49, 18.3% were aged 50-59, 22.5% were aged 60-69, and 25.3% were aged 70 or older. In terms of sex, males accounted for

<Table 2> Distribution of characteristics

N=222,165

Variables		N (%) or Mean±SD
(Level 1) Individual characteristics		
Demographic characteristics		
Age	19-29	20,182 (9.1)
	30-39	22,893 (10.3)
	40-49	32,165 (14.5)
	50-59	40,761 (18.3)
	60-69	49,995 (22.5)
	≥ 70	56,169 (25.3)
Sex	Male	101,087 (45.5)
	Female	121,078 (54.5)

Variables		<i>N (%)</i> or <i>Mean±SD</i>
Marital status	Spouse	140,719 (63.3)
	Divorce, bereavement, separation	45,577 (20.5)
Monthly household income	Single	35,869 (16.2)
	0-2 million won	61,412 (27.6)
	2-4 million won	61,754 (27.8)
	4-6 million won	50,191 (22.6)
Education level	≥ 6 million won	48,808 (22.0)
	No education	10,843 (4.9)
	Elementary school	35,058 (15.8)
	Middle school	24,496 (11.0)
	High school	64,258 (28.9)
Employment status	College degree or higher	87,510 (39.4)
	Unemployed	80,985 (36.5)
	Employed	141,180 (63.5)
Urbanicity of residence	Rural areas	71,998 (32.4)
	Small and medium-sized cities	52,421 (23.6)
	Large cities	97,746 (44.0)
Behavioral characteristics		
Obesity	No	154,213 (69.4)
	Yes	67,952 (30.6)
Smoking	No	185,727 (83.6)
	Yes	36,438 (16.4)
High-risk drinking	No	199,402 (89.8)
	Yes	22,763 (10.2)
Depressive mood experience	No	205,162 (92.3)
	Yes	17,003 (7.7)
(Level 2) Regional characteristics		
Socioeconomic		
Fiscal independence ratio (%)		21.89±13.09
Car ownership rate (%)		0.51±0.11
Environmental		
Public transportation usage rate (%)		47.37±50.93
Park area per unit area (m ²)		0.03±0.04
Healthy City infrastructure		
Healthy City ordinance enactment	No	119,651 (53.9)
	Yes	102,514 (46.1)
Inclusion of health equity within the scope of Healthy City ordinances	No	217,145 (97.7)
	Yes	5,020 (2.3)
Organization of the Healthy City steering committee	No	155,416 (70.0)
	Operation of other committee	4,396 (2.0)
	Operation of Healthy City committee	62,353 (28.0)

Note. *SD*=Standard Deviation

45.5%, while females accounted for 54.5%. For marital status, 63.3% were living with a spouse, 20.5% were divorced, bereaved, or separated, and 16.2% were single. As for monthly household income, 27.6% earned less than KRW 2 million, 27.8% earned KRW 2 million or more, but less than KRW 4 million, 22.6%

earned KRW 4 million or more, but less than KRW 6 million, and 22.0% earned KRW 6 million or more, showing a similar distribution. Among the education levels, 4.9% had no education, 15.8% had an elementary school education, 11.0% had a middle school education, 28.9% had a high school education,

and 39.4% had a college education or higher. Those with employment accounted for 63.5%, exceeding those without employment at 36.5%. The urbanicity of residence was classified into large cities (44.0%), small and medium-sized cities (23.6%), and rural areas (32.4%).

Regarding health behavior characteristics, 30.6% of the population was obese compared with 69.4% that was not. Smokers accounted for 16.4%, while non-smokers accounted for 83.6%. High-risk drinking was reported by 10.2% of respondents, while depressive mood experience was reported by 7.7%.

2. Regional characteristics

Among the characteristics of the 228 cities and counties where the subjects resided, the average fiscal independence ratio was 21.89%, and the average car ownership rate was 0.51%. The average public transportation usage rate was 47.37%, less than half. The average park area per unit area was 0.03 m².

Regarding the policy infrastructure characteristics of the Healthy City initiatives, 53.9% of regions lacked ordinances, constituting a majority. The majority of areas (97.7%) lacked health equity within the scope of Healthy City ordinances. In terms of the organization of Healthy City steering committees, 70.0% of regions had no committee, 2.0% had other committees serving the duties, and 28.0% had separately organized Healthy City steering committees.

3. The influence of regional characteristics on walking practice

A multilevel logistic regression analysis was conducted to examine the influence of regional characteristics on walking practice among local residents. Starting with Model 1, the baseline model for identifying regional differences in walking practice, individual variables were added in Model 2, regional variables in Model 3, and finally, both individual and regional variables were included in Model 4. The analysis results are shown in <Table 3>.

<Table 3> Results of multilevel regression analysis

Variables		Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)	Model 4 OR (95% CI)
Intercept		0.885(0.834-0.938)***	0.474(0.431-0.523)***	0.893(0.840-0.950)***	0.569(0.507-0.640)***
(Level 1) Individual characteristics					
Demographic characteristics					
Age	19-29		1.032(0.979-1.087)		1.033(0.980-1.088)
(ref. ≥ 70)	30-39		0.834(0.798-0.872)***		0.835(0.799-0.872)***
	40-49		0.809(0.778-0.841)***		0.809(0.778-0.841)***
	50-59		0.894(0.864-0.926)***		0.895(0.864-0.927)***
	60-69		1.114(1.082-1.146)***		1.114(1.083-1.146)***
Sex (ref. Male)	Female		0.893(0.875-0.911)***		0.893(0.875-0.911)***
Marital status (ref. Single)	Spouse		0.941(0.910-0.974)***		0.942(0.911-0.974)***
	Divorce, bereavement, separation		0.867(0.833-0.902)***		0.867(0.834-0.902)***
Monthly household income (ref. 0-2 million won)	2-4 million won		1.075(1.047-1.103)***		1.074(1.047-1.103)***
	4-6 million won		1.043(1.013-1.075)**		1.043(1.012-1.074)**
	≥ 6 million won		1.007(0.975-1.039)		1.006(0.974-1.038)

Variables		Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)	Model 4 OR (95% CI)
Education level (ref. No education)	Elementary school		1.372(1.308-1.440)***		1.372(1.308-1.440)***
	Middle school		1.650(1.566-1.738)***		1.649(1.565-1.737)***
	High school		1.744(1.657-1.836)***		1.743(1.655-1.835)***
	College degree or higher		1.807(1.712-1.907)***		1.804(1.709-1.903)***
Employment status (ref. Unemployed)	Employed		1.146(1.123-1.169)***		1.147(1.124-1.170)***
Urbanicity of residence (ref. Rural areas)	Small and medium-sized cities		1.126(0.996-1.274)		0.991(0.873-1.125)
	Large cities		1.716(1.536-1.916)***		1.160(0.992-1.357)
Behavioral characteristics					
Obesity (ref. No)	Yes		0.935(0.917-0.953)***		0.935(0.917-0.953)***
Smoking (ref. No)	Yes		0.900(0.877-0.923)***		0.900(0.877-0.924)***
High-risk drinking (ref. No)	Yes		0.997(0.968-1.027)		0.997(0.968-1.027)
Depressive mood experience (ref. No)	Yes		0.799(0.773-0.826)***		0.799(0.773-0.826)***
(Level 2) Regional characteristics					
Socioeconomic					
Fiscal independence ratio				1.006(1.002-1.010)**	1.004(1.000-1.009)
Car ownership rate				0.441(0.246-0.792)**	0.555(0.296-1.041)
Environmental					
Public transportation usage rate				1.003(1.002-1.004)***	1.002(1.001-1.004)**
Park area per unit area				2.808(0.681-11.580)	2.394(0.577-9.926)
Healthy City infrastructure					
Healthy City ordinance enactment (ref. No)	Yes			1.010(0.882-1.156)	1.010(0.882-1.158)
Inclusion of health equity within the scope of Healthy City ordinances (ref. No)	Yes			1.489(1.129-1.965)**	1.541(1.166-2.037)**
Organization of the Healthy City steering committee (ref. None)	Operation of other committee			1.050(0.769-1.432)	1.097(0.803-1.499)
	Operation of Healthy City committee			1.013(0.881-1.164)	1.010(0.878-1.161)
Model fit statistics					
-2LL		298474.1	295773.8	298328.7	295721.3
AIC		298478.1	295821.8	298348.7	295785.3
BIC		298484.9	295904.1	298383.0	295895.0
ICC		0.057	0.038	0.030	0.029

Notes. OR=Odds Ratio; 95% CI=Confidence Interval; ref=reference; -2LL=-2 Log Likelihood; AIC=Akaike Information Criterion; BIC=Bayesian Information Criterion; ICC=Intraclass Correlation Coefficient
* $p < .05$, ** $p < .01$, *** $p < .001$

The ICC value for Model 1 was 0.057, confirming that inter-regional differences in walking practice were significant. Model 4 showed the lowest values across all model fit indices (-2LL, AIC, and BIC) and was thus judged to be the most suitable final model.

An analysis of individual characteristics revealed that, compared to individuals aged 70 or older, those aged 30-39 ($OR=0.835$, $p<.001$), 40-49 ($OR=0.809$, $p<.001$), and 50-59 ($OR=0.895$, $p<.001$) were less likely to walk. Compared to males, females were significantly less likely to engage in walking ($OR=0.893$, $p<.001$). Compared to unmarried individuals (single), those who were living with a spouse ($OR=0.942$, $p<.001$) and those who were divorced, bereaved, or separated ($OR=0.867$, $p<.001$) were less likely to walk. Compared to monthly household incomes below KRW 2 million, the likelihood of walking practice was significantly higher among those earning KRW 2 million or more, but less than KRW 4 million ($OR=1.074$, $p<.001$) and KRW 4 million or more, but less than KRW 6 million ($OR=1.043$, $p=.006$). Compared to those with no education, the likelihood of walking practice increased with increasing education level: elementary school ($OR=1.372$, $p<.001$), middle school ($OR=1.649$, $p<.001$), high school ($OR=1.743$, $p<.001$), and college degree or higher ($OR=1.804$, $p<.001$). Employment status showed that having a job significantly increased the likelihood of walking practice compared to being unemployed ($OR=1.147$, $p<.001$).

In terms of health behavior characteristics, the likelihood of walking was significantly lower among obese individuals compared to non-obese individuals ($OR=0.935$, $p<.001$), among smokers compared to non-smokers ($OR=0.900$, $p<.001$), and among those experiencing depressive mood compared to those not experiencing depressive mood ($OR=0.799$, $p<.001$).

At the regional level, a higher public transportation usage rate was significantly associated with a higher likelihood of walking practice ($OR=1.002$, $p=.001$). The

presence of a Healthy City policy infrastructure significantly increased the likelihood of walking practice compared to its absence within the scope of the Healthy City ordinances ($OR=1.541$, $p=.002$).

IV. Discussion

This study sought to determine the influence of Healthy City policy infrastructure on the walking practice of local residents. This study used raw data from the 2023 Korea Community Health Survey, as well as data from other relevant institutions. The study covered 222,165 individuals across 228 cities, counties, and districts nationwide.

The ICC value of the baseline model was 0.057, confirming a significant difference in walking practice between regions. Among the models with variables added stepwise, Model 4, the final model, was found to be the most appropriate. Among individual variables, most demographic and health behavior characteristics, including age, sex, monthly household income, education level, employment status, obesity, smoking, and experience of depressive mood, were found to have a significant impact on walking practice. Among regional variables, the public transportation usage rate and the presence of health equity within the scope of Healthy City ordinances were found to have a significant impact.

This finding partially supported previous studies (B. Kim & Hyun, 2021; J. H. Lee, 2016; J. M. Kim et al., 2015; K.-H. Lee, 2012) that reported an association between personal characteristics, such as age, sex, monthly household income, and educational level, and health behaviors or health status. The findings of this study, indicating that the public transportation usage rate at the local level significantly influences walking behavior, are in support of prior studies (Ewing & Handy, 2009; Renalds et al., 2010) in which

well-developed pedestrian infrastructure was found to enhance walking. This suggests that walking is associated not only with individual characteristics but also with the physical environment of the area.

The significant impact of the inclusion of health equity within the scope of Healthy City ordinances identified in this study can be interpreted not as the ordinance itself directly changing residents' walking practice, but rather as an indication that the region institutionally recognizes the importance of health equity and considers it in its policies. In essence, regions with ordinances explicitly targeting health equity are likely to have a policy orientation that prioritizes vulnerable groups in the creation of pedestrian environments, the allocation of park and green space resources, and the operation of local public health programs. However, the health equity indicators in this study are indirect measures based on ordinance wording, which does not allow for verification of how policies have been implemented in practice. Despite this, it can be considered to align with the socio-ecological perspective, which posits that individuals and the diverse physical, social, and policy environments surrounding them influence personal health (McLeroy et al., 1988; Son et al., 2018).

Moreover, apart from the research analysis, an additional set of publicly available data from local governments was reviewed, encompassing health equity provisions within ordinances. This review revealed several similarities.

First, efforts were made to establish a policy infrastructure foundation, such as the inclusion of strategies and implementation plans that enhance equity in the health environment creation sector when formulating local governments' Regional Healthcare Plans or establishing governance plans for realizing Healthy City.

Secondly, in comparison to other cities and counties, the local government implemented activities

to enhance accessibility and expand resident participation, such as increasing the frequency of walking programs and hosting walking events tailored to vulnerable groups.

Third, interventions were also implemented to improve the pedestrian environment for vulnerable groups. Walkability improvement activities were implemented, encompassing the provision of assistive devices for the elderly, the maintenance of traffic safety pedestrian signal systems, the expansion of pedestrian pathways, and the maintenance of barrier-free walking paths.

However, it is imperative to recognize that these cases are unique to specific local governments. Consequently, when interpreting these outcomes, it is essential to exercise caution and refrain from assuming that they are based on the presence of equity clauses.

This strategic approach suggests that health equity values can foster an environment conducive to promoting walking practice when they are concretely reflected in actual budget allocations and project implementation processes, rather than merely remaining as policy declarations. In other words, infrastructure such as Healthy City ordinances can function as a key mechanism to establish health equity as an official standard in urban policy, leading to consistent legal and administrative infrastructure, governance, and implementation systems capable of realizing this goal (Kang et al., 2020; K. K. Kim et al., 2016).

Furthermore, the integration of environmental factors that significantly influence walking practice contributes to enhancing the potential for walking among all residents within the community, particularly vulnerable groups. This suggests that the value of health equity within the Healthy City ordinances is not merely an abstract goal but rather holds the potential to contribute to public health improvement by

addressing structural issues that cause health inequalities through concrete resource allocation and project planning and by creating a walkable environment in general (Kang et al., 2020; Yoo & Kim, 2017).

Meanwhile, among the regional variables, fiscal independence ratio, car ownership rate, and park area per unit area did not show significant effects in this study. Although the association between park area and physical activity has been consistently reported, the fact that it was not significant in this study may be attributed to the fact that simple area metrics fail to adequately reflect factors that determine actual use, such as accessibility, facility quality, and safety. The fiscal independence ratio also only gave an indication of the region's financial scale, without fully explaining how the budget was actually allocated to initiatives like the Healthy City project or pedestrian environment improvements. The relationship between car ownership rate and walking also varied depending on city scale and structure, making it difficult to identify a consistent trend in nationwide analyses. This finding indicates that specific environmental factors, such as accessibility to walking destinations, play a more significant role in explaining walking behavior than simple aggregate indicators (Anderson et al., 2024; Ewing & Cervero, 2010; K.-H. Lee, 2012; Yon, 2023).

However, the findings of this study also have considerable implications for health education. The incorporation of health equity provisions within Healthy City ordinances underscores their potential to serve as a foundational framework for the promotion of health education and behavior change programs involving direct participation by local residents, transcending mere policy declarations (N.-S. Park, 2022). Future Healthy City policies must extend beyond infrastructure development to incorporate participatory health education strategies that focus on

enhancing citizen capacity. This study underscores the notion that the Healthy City initiative, when implemented with a comprehensive approach that encompasses not only environmental enhancements but also the explicit integration of core values, such as health equity, into its policy framework, is poised to achieve better public health outcomes.

This study is significant because it uses multilevel analysis to identify various factors that influence walking practice and demonstrates, using nationwide data, the importance of substantive aspects of Healthy City ordinances, especially the core value of "health equity." However, it also has several limitations.

First, variable input was limited during the research analysis process. In multilevel analysis, the inclusion of too many individual-level variables may result in insufficient reflection of area-level effects or excessive correlation among variables. Therefore, this study developed a model based on individual-level variables that have been consistently associated with walking practice. Furthermore, due to limitations in utilizing nationwide secondary data, variables such as destination accessibility, road connectivity, and mixed land use could not be included. The omission of these variables could have led to a lack of sufficient reflection of the influence of local environmental factors.

Second, the variables used in the study cannot fully reflect the timing, intensity, or outcomes of policy implementation because they are based on a specific point in time. Furthermore, since this is a cross-sectional study, establishing causality is difficult, necessitating more precise analysis of policy effects through longitudinal studies or comparative analysis between similar regions.

Finally, the concept of health equity is influenced by a multitude of factors, including social structures and resource allocation, rendering it challenging to assess its effectiveness using a singular indicator. The

“inclusion of health equity within the scope of Healthy City ordinances” used in this study should be interpreted as an indirect indicator of policy infrastructure level, demonstrating that the local government has institutionalized equity as an official value within its Healthy City policy, rather than as a direct measure of policy implementation intensity.

It is difficult to view the presence of ordinances as directly leading to improvements in urban infrastructure or the reduction of health disparities. This phenomenon can be attributed to the mediating role of administrative processes, including the establishment of governance systems, budgetary allocation, and interdepartmental cooperation, which serve as crucial factors in the actual implementation of policy. Therefore, rather than backing the interpretation that the explicit mention of the ordinance directly caused these changes, this study’s findings suggest that regions that have declared equity to be a policy value are more likely to have well-established administrative conditions necessary for creating health-friendly environments and supporting health behaviors.

In conclusion, further refinement is required to establish a causal linkage from policy declarations in ordinances to actual infrastructure improvements and changes in health behaviors through longitudinal analysis, including factors such as budget size and project implementation levels.

V. Conclusion

This study identified the role of Healthy City policy infrastructure among the multilevel factors influencing the walking practice of local residents. A nationwide analysis revealed a statistically significant correlation between the inclusion of health equity in Healthy City ordinances and various characteristics at the individual

and regional levels.

These findings can be interpreted as an indirect indicator of Healthy City governance, demonstrating that the health equity clause prioritizes equity-centered health policies in the region and incorporates them into the policy implementation process. In other words, areas with ordinances explicitly stating health equity are likely to have established policy foundations for improving walking environments, such as enhancing pedestrian infrastructure, expanding access to parks and green spaces, and operating walking programs for vulnerable groups.

These findings indicate that the promotion of walking practice requires local governments to explicitly include health equity in ordinances when implementing Healthy City initiatives. Based on this, governance systems must be strengthened to prioritize policies and resource allocation that consider vulnerable groups. This approach not only promotes walking practice among the entire local community but also reduces disparities in walking environments and health behaviors, thereby contributing to improved health equity. Nevertheless, careful interpretation of the results is required considering the various limitations of this study.

This study holds academic and policy significance in that it identifies various factors influencing walking behavior through a multilevel analysis and empirically demonstrates that the content of Healthy City ordinances serves as an indirect indicator reflecting the local Healthy City policy infrastructure. However, several limitations, such as the need for more careful variable setting, qualitative aspects like policy timing and exposure levels, and the constraints of operationalizing equity variables, limit the interpretability of these results. Future research should supplement these findings with more sophisticated indicators to measure equity more precisely and

thoroughly investigate the effectiveness of Healthy City infrastructure.

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