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Original Article

Individual and Neighborhood Environmental Factors Affecting Healthy Eating Among Korean Rural Adults

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Abstract

Background: Although it is recognized that social and environmental factors influence healthy eating behaviors, few studies have investigated the association between environmental factors and healthy eating among rural adults in Korea. We aimed to identify individual and neighborhood environmental factors influencing adherence to fruit and vegetable intake among adults living in rural areas using an ecological approach.

Methods: The study sample comprised 1,582 adults from 38 rural areas from Chungbuk Province, South Korea in 2017 who provided individual- and neighborhood-level data. Neighborhood-level data were obtained by aggregating individual-level responses measured for each residential town resulting in an average value for each neighborhood-level variable for the 38 rural areas. The data were merged and used for a series of multilevel logistic regression analyses.

Results: Among the individual-level factors, age, alcohol drinking, physical activity, self-efficacy for healthy eating, and social support for healthy eating were significantly associated with adherence to fruit and vegetable intake. Among the neighborhood-level factors, social cohesion and perceived neighborhood safety were significantly associated with adherence to fruit and vegetable intake.

Conclusion: Multifaceted intervention strategies to increase consumption of fruits and vegetables should include behavioral modification, social support, and improvement of neighborhood environments.

Keywords: Healthy eating; Fruit and vegetable intake; Neighborhood environment; Multilevel analysis

Introduction

Healthy eating that includes high fruit and vegetable intake is linked to overall health and important to prevent noncommunicable diseases (NCDs) (1). Increasing consumption of fruits and vegetables can decrease the risk of obesity, hypertension, cardiovascular disease, and cancer (1, 2). The WHO (1) suggests consuming more than 400 grams of fruits and vegetables per day to improve overall health and reduce the risk of certain-NCDs. Despite the benefits of high fruit and vegetable intake, an estimated 3.9 million deaths worldwide were attributable to inadequate fruit and vegetable consumption in 2017 (1). The proportion of the Korean adult population meeting the recommended intake of fruits and vegetables has decreased from 40.5% in 2015 to

31.3% in 2019 (3). Hence, it is necessary to identify factors influencing people's eating behaviors to increase consumption of fruits and vegetables essential for prevention and control of chronic diseases.

According to the ecological approach in health behavior research, eating behavior needs to be understood in a broad environmental context as well as individual characteristics (4). Neighborhood environmental factors related to healthy eating patterns include social environments such as social cohesion, neighborhood safety from crime, and perceived food environmental features (5-7). Increased levels of social cohesion and positive perceptions of neighborhood safety provide more opportunities for modeling healthy behaviors in a supportive environment among neighborhood residents (5). Positive perceptions of neighborhood food environments (accessibility, availability, and affordability of healthy foods) were associated with more fruit and vegetable consumption (6, 8)

Unfortunately, meeting recommendations for fruit and vegetable intake depends on where people live; and in Korea, similar to what has been found in previous research (9, 10), residents in rural areas would be less likely to achieve what has been recommended for fruit and vegetable consumption compared to urban residents. Indeed, compared with their urban counterparts, research showed that rural residents had higher rates of preventable chronic diseases including cardiovascular disease, obesity, diabetes, and cancer, and these regional differences in health status are thought to stem from social and environmental differences (11, 12). However, no previous study in Korea has examined the associations between environmental factors and healthy eating behaviors of rural adults using an ecological approach.

Therefore, the aim of this study was to identify individual and environmental factors that affect fruit and vegetable intake among rural adults. A multilevel analysis must be performed to analyze the associations amongst multilevel factors using an ecological approach at the regional level (4, 12). As such, the information on individual and neighborhood environmental factors would have utility for the development of intervention strategies to promote healthy eating behaviors in rural adults.

Materials and Methods

Study design

A cross-sectional design was used in this study. To complete the research objectives, this study was structured with individual-level and neighborhood-level data.

Participants and data collection procedure

The study participants were adults aged 20–65 years who had been living in one of the 38 administrative units (towns or townships) in a Korean rural area for at least one year. "Rural area" was defined as having a population density of less than 1,000 persons per km^2 and was a town or township at the county level in South Korea. The participants were selected using two-stage cluster sampling. In the first stage, 38 groups (towns or townships) were created by selecting 3–5 towns or townships from 11 counties in Chungbuk province, which is predominantly inhabited by rural communities. In the second stage, 40 potential participants were conveniently selected from each of the 38 groups. However, our study samples had the disadvantage that it may not represent the characteristics of the rural population because the sampling was not taken using proportional allocation to the population size of each of the 38 towns or townships.

The sample size for multilevel analysis was calculated using Snijders and Bosker's (13) method. When the number of groups (N = 38), the number of individual units per group (n = 40), and the intraclass correlation coefficient (ϱ = 0.1) were applied, the design effect was 4.7, and the total number of participants needed was 1,520. The number of participants included in the final analysis was 1,582, which met the required sample size. A self-reported questionnaire survey was conducted to collect data on fruit and vegetable intake, individual-level factors, and neighbor-

hood-level factors from July to August 2017.
Ethical approval for the study was obtained from the Institutional Research Ethics Committee (1041107–201706–HR- 001-01) of the first authors' university. All participants provided signed informed consent.

Measurements

Healthy eating

Healthy eating was operationalized as meeting the recommended guidelines for eating fruits and vegetables and was measured by asking participants to self-report on fruit and vegetable intake over the past 7 days. Based on previous studies (8, 9), two questions were asked: one asked about the frequency of eating two servings of vegetable side dishes over the past week (a serving = 1/2 cup cooked or 1 cup raw vegetables), and the other asked about the frequency of eating two servings of unprocessed seasonal fruits over the past week (a serving = 1/2 cup of fruit). Responses to these questions were measured using seven categorical variables and were used to categorize participants into two groups (no = did not meet guidelines, yes = met guidelines) according to whether they met the recommended guidelines of eating 4 or more servings of vegetables and two servings of unprocessed seasonal fruits a day.

Individual-level factors

Individual characteristics included demographic characteristics (gender, age, education, and household income), health-related behaviors (smoking, high-risk drinking, physical activity, stress, and self-rated health), self-efficacy, and social support for healthy eating.
Self-efficacy for healthy eating was measured using an eating self-efficacy scale (14), which was developed to evaluate confidence in controlling unhealthy food intake in various tempting situations. Fifteen items regarding eating habits (5 items), food choices (3 items), surroundings (5 items), and negative emotions (2 items) were included using a 5-point Likert scale (strongly disagree = 1 to strongly agree = 5). In this study, the Cronbach's alpha was .86.
Social support for healthy eating was measured using the Social Support for Healthy Eating Scale (15). The 4-item questionnaire was developed in a previous study to evaluate support from parents and friends for healthy eating (15). The items were rated on a 5-point Likert scale (never = 1 to very often = 5), and higher scores indicate higher levels of social support for healthy eating. In this study, the Cronbach's alpha was .87.

Neighborhood-level factors

Social cohesion was measured using 5-item measure of social cohesion (16). Participants responded to each item on a 5-point Likert scale (strongly disagree = 1 to strongly agree = 5). The responses to the items were summed, and scale scores can range from 5–25. In this study, Cronbach's alpha was .93.
Neighborhood safety was measured using questions that were developed with reference to a previous study on neighborhood safety (17). It consisted of three items: "It is safe to be out alone at night in my neighborhood," "It is safe to be out alone during the day in my neighborhood," and "My neighborhood is safe from crime." Participants responded to each item on a 5-point Likert scale (strongly disagree = 1 to strongly agree = 5). The responses to the items were summed, and scale scores can range from 5–15. In this study, Cronbach's alpha was .82.
Perceived food environment was measured as an individual's perception of how the food environment affects their eating. A 4-item measure was developed based on a previous study (18). The four items assess accessibility to healthy foods (fresh fruits/vegetables, low-fat food products, and quality of vegetables/fruits). Participants responded to each item on a 5-point Likert scale (strongly disagree = 1 to strongly agree = 5), and the responses to the items were summed to create a total score ranging from 4–20. In this study, Cronbach's alpha was .89.

Data analysis

Descriptive statistics were calculated to identify the distributions of the study variables, and chi-

square tests and independent *t*-tests were conducted to assess the associations between individual-level and neighborhood-level factors and healthy eating using IBM SPSS/WIN 23.0 software (IBM Corp., Armonk, NY, USA). Multilevel logistic regression analysis was used to identify the effects of individual-level and neighborhood-level factors on healthy eating using Stata/SE 14.0. Because our data were collected to examine whether rural adults' adherence to fruit and vegetable intake guidelines for healthy eating has a tendency to cluster in the same neighborhoods, a two-level logistic regression model consisting of individual-level and neighborhood-level data was established. The individual factors were first-level variables, and neighborhood environmental characteristics were second-level variables. The dependent variable, healthy eating (adherence to fruit and vegetable intake), was coded into two categories (0 = did not meet guidelines, 1 = met guidelines). All individual values of neighborhood-level variables were substituted with the average value of each residential town area. Dummy variables were created for categorical variables. Initially, a null model (Model 1) without any independent variables was established. The null model was used to determine how the 2 different levels contributed to variations in adherence to fruit and vegetable intake of rural adults. After assessing the significance of the variation at each level, conditional models were estimated in Model 2 and Model 3. In Model 2, adults' individual-level variables were included as predictors in a series of multilevel logistic regression models. Finally, in Model 3, adults' individual- and neighborhood-level variables were included. Three models for these estimation methods are described in the following equation, where P_{ij} is the probability that the *i*th adults' healthy eating in the *j*th town, β_{0j} is the overall constant (intercept), X_{ij} are individual i's characteristics residing in j town or township, and Z_j are neighborhood environmental characteristics of j town or township:

$$\text{Model 1: } P_{ij} = P\,(Y_{ij} = 1 \mid \beta)$$

$$\text{Model 2: } \log\,[P_{ij}/(1\text{-}P_{ij})] = \beta_{0j} + \beta_{1j}X_{ij}$$

$$\text{Model 3: } \log\,[P_{ij}/(1\text{-}P_{ij})] = \gamma_{00} + \gamma_{10}X_{ij} + \gamma_{01}Z_j + U_{0j} + \varepsilon_{ij}$$

For each model, the intraclass correlation coefficient (ICC) was calculated, and the model fit was tested.

Results

The mean age of the participants was 45.4 ± 12.4 years (range: 20–65). Men and women accounted for 41.7% and 58.3%, respectively. More information on the participants is provided in Table 1. Table 2 shows the univariate associations between individual- and neighborhood-level factors and healthy eating. Among the individual-level factors, age, smoking, high-risk drinking, moderate-to-vigorous physical activity, self-rated health, self-efficacy for healthy eating, and social support for healthy eating were significantly associated with adherence to fruit and vegetable intake. In terms of neighborhood-level factors, social cohesion was significantly related to adherence to fruit and vegetable intake.

The results of the multilevel regression analyses predicting adherence to fruit and vegetable intake are presented in Table 3. For the random effects parameters in Model 1, the unadjusted ICC, which represents the percentage of variation in healthy eating attributable to the neighborhood-level factors, was 0.038, a significant finding (χ^2 = 6.23, *P*= .006). Thus, the neighborhood environment accounted for 4.8% of the variation in the likelihood of adherence to fruit and vegetable intake among rural adults in this null model. Model 2, which was restricted to individual-level factors, was significantly better than Model 1 at explaining the likelihood of adults' adherence to fruit and vegetable intake (χ^2 = 7.88, *p* = .003). In Model 3, after adjusting for individual- and neighborhood-level factors, the unexplained neighborhood-level variation was reduced (χ^2 = 2.92, *P* = .044).

Table 1: General Characteristics of Participants

Characteristic	*Category*	*N (%) or Mean ± SD*
Gender	Male	660 (41.7)
	Female	922 (58.3)
Age (yr)		45.4 ± 12.4
Education[a]	Elementary	74 (4.7)
	Middle school	127 (8.1)
	High school	673 (42.8)
	≥ College	698 (44.4)
Household monthly income[a]	< ₩3 million	832 (53.1)
	≥ ₩3 million	735 (46.9)
Smoking[a]	Never	1039 (66.1)
	Former smoker	254 (16.2)
	Current smoker	278 (17.7)
High-risk drinking[a]	No	1201 (76.1)
	Yes	378 (23.9)
Physical activity	No	1020 (64.5)
	Yes	562 (35.5)
Stress[a]	Neither or not	362 (23.0)
	Moderate	770 (49.0)
	Much or very much	440 (28.0)
Self-rated health[a]	Poor	279 (17.8)
	Neither poor nor good	797 (50.7)
	Good	495 (31.5)

[a]N < 1,582 responses due to item non-responses.

Table 2: Associations between healthy eating and individual- and neighborhood-level factors

Factor	*Category*	*Adherence to fruit and vegetable intake*		*χ^2 or t (P-Value)*
		No N (%) or M ± SD	Yes N (%) or M ± SD	
Individual-level factors				
Gender	Male	557 (84.4)	103 (15.6)	2.66
	Female	749 (81.2)	173 (18.8)	(.103)
Age		44.74 (12.5)	48.61 (11.3)	5.07
				(<.001)
Education[a]	Elementary	59 (79.7)	15 (20.3)	2.73
	Middle school	99 (78.0)	28 (22.0)	(.436)
	High school	556 (82.6)	117 (17.4)	
	≥ College	583 (83.5)	115 (16.5)	
Household monthly income[a]	< ₩3 million	690 (82.9)	142 (17.1)	0.28
	≥ ₩3 million	602 (81.9)	133 (18.1)	(.593)
Smoking[a]	Never	843 (81.1)	196 (18.9)	9.30
	Former smoker	207 (81.5)	47 (18.5)	(.010)
	Current smoker	247 (88.8)	31 (11.2)	
High-risk drinking[a]	No	969 (80.7)	232 (19.3)	12.60
	Yes	335 (88.6)	43 (11.4)	(<.001)
Physical activity	No	879 (86.2)	141 (13.8)	26.16
	Yes	427 (76.0)	135 (24.0)	(<.001)
Stress[a]	No	285 (78.7)	77 (21.3)	5.45
	Moderate	641 (83.2)	129 (16.8)	(.066)
	Much	373 (84.8)	67 (15.2)	
Self-rated health[a]	Poor	244 (87.5)	359 (12.5)	8.12
	Neither good nor bad	660 (82.8)	137 (17.2)	(.017)
	Good	393 (79.4)	102 (20.6)	

Self-efficacy for healthy eating	40.55 ±6.1	42.89 ± 6.4	5.52 (<.001)
Social support for healthy eating	11.92 ± 3.2	12.98 ± 3.4	4.73 (<.001)
Neighborhood-level factors			
Social cohesion	16.51 ± 1.5	16.80 ± 1.4	2.96 (.005)
Neighborhood safety	10.13 ± 0.9	10.05 ± 0.9	1.38 (.167)
Perceived food environment	12.68 ± 1.8	12.60 ± 1.8	0.68 (.496)

[a]N < 1,582 responses due to item non-responses.

However, in Model 3, the variance at the neighborhood level was still 0.027, indicating that individual- and neighborhood-level variables were insufficient to explain adults' adherence to fruit and vegetable intake. Among the fixed effects in Model 3, the following were significant: age (odds ratio (OR) = 1.024, 95% confidence interval (CI) [1.01–1.04]), high-risk drinking (OR = 0.588, 95% CI [0.40–0.87]), moderate-to-vigorous physical activity (OR = 1.892, 95% CI [1.41–2.53]), self-efficacy for healthy eating (OR = 1.048, 95% CI [1.02–1.07]), social support for heathy eating (OR = 0.260, 95% CI [1.01–1.10]), social cohesion (OR = 1.231, 95% CI [1.06–1.43]), and neighborhood safety (OR = 0.776, 95% CI [0.63–0.95]).

Table 3: Odds ratios of the multilevel logistic regression model for healthy eating among rural adults

Fixed and random effects	***Model 1***		***Model 2***		***Model 3***	
	OR	95% CI	OR	95% CI	OR	95% CI
Individual-level factors (fixed)						
Gender (ref: male)			0.907	0.59–1.39	0.908	0.59–1.39
Age			1.026	1.01–1.04	1.024	1.01–1.04
Smoking (ref: Never smoker)						
Former smoker			0.856	0.52–1.40	0.869	0.53–1.41
Current smoker			0.594	0.34–1.02	0.597	0.35–1.02
High-risk drinking (ref: No)						
Yes			0.584	0.39–0.86	0.588	0.40–0.87
Physical activity (ref: No)						
Yes			1.836	1.37–2.46	1.892	1.41–2.53
Self-rated health (ref: Poor)						
Neither good nor bad			1.298	0.84–2.00	1.339	0.58–1.16
Good			1.382	0.85–2.22	1.416	0.87–2.28
Stress (ref: No)						
Moderate			0.834	0.59–1.18	0.823	0.58–1.67
Much			0.955	0.62–1.45	0.942	0.62–1.43
Self-efficacy for healthy eating			1.048	1.02–1.07	1.048	1.02–1.07
Social support for healthy eating			1.055	1.01–1.10	1.055	1.01–1.10
Neighborhood-level factors (fixed)						
Social cohesion					1.231	1.06–1.43
Neighborhood safety					0.776	0.63–0.95
Perceived food environment					1.112	0.97–1.27
Neighborhood-level random effects						
β (SE)	0.362 (0.100)		0.415 (0.113)		0.301 (0.116)	
ICC	.038		.050		.027	
Model fit statistics	$\chi2 = 6.23$		$\chi2 = 7.88$		$\chi2 = 2.92$	
Likelihood ratio test	($P = .006$)		($P = .003$)		($P = .044$)	

OR, odds ratio; CI, confidence interval; SE, standard error; ICC, intraclass correlation coefficient

Discussion

This is the first study to use an ecological approach as a way to understand the determinants of healthy eating in Korean rural adults. The results showed that factors at two levels—the individual and the neighborhood environment—were significantly associated with the likelihood of healthy eating among rural adults. At the individual level, age, high-risk drinking, physical activity, self-efficacy for healthy eating, and social support for healthy eating were significant factors. The older the age, the higher the likelihood of meeting the recommended fruit and vegetable intake levels. A previous study found that older age was associated with increased consumption of fiber and of fruits and vegetables (8). This can be interpreted as resulting from an increase in chronic disease risk and paying more attention to diet, which is one of the major healthcare strategies, as people get older. High-risk drinkers had a lower likelihood of adherence to fruit and vegetable intake guidelines, and those who engaged in moderate-to-vigorous physical activity had a higher likelihood of meeting the recommended guidelines. The results are consistent with a previous study in which the frequency of fruit and vegetable intake was associated with being more physically active and not being alcohol-dependent in women (19). This implies that other health-related behaviors should be simultaneously addressed in nutrition interventions to increase fruit and vegetable intake.

Those with high self-efficacy for healthy eating were more likely to adhere to the recommended guidelines for fruit and vegetable intake, which is consistent with previous studies (7, 20). Therefore, strategies to improve beliefs about healthy foods should be considered to enhance the consumption of fruits and vegetables. In our study, social support from parents and friends for healthy eating was positively related to adherence to the recommended intake of fruits and vegetables, which is similar to previous studies (15, 21). Therefore, to promote fruit and vegetable intake, setting-based intervention programs that allow participation with one's family, friends, and colleagues should be implemented, as adults generally spend their day with them in a particular setting (home, workplace, and community).

Among the neighborhood-level factors, social cohesion and neighborhood safety influenced healthy eating. Rural adults were more likely to adhere to fruit and vegetable intake guidelines when they lived in neighborhoods with higher social cohesion, where people trusted and helped their neighbors. This finding is in line with previous studies (12, 20). High social cohesion in a neighborhood is considered to have a positive effect on fruit and vegetable consumption by promoting access to health food services and convenience facilities, and by sharing and providing emotional support to community members or those in one's neighborhood (22). Our findings imply that intervention strategies to promote trust and social cohesion among neighbors may be effective in facilitating healthy food intake in rural areas.

This study also found that rural adults who perceived their neighborhoods as safe from crime were less likely to comply with the guidelines for fruit and vegetable intake. This result is contradictory to previous studies in which the perception of safe surroundings provided opportunities to be active, eat well, and support people in making healthy choices (6). The lack of consistency in the relationship between neighborhood safety and fruit and vegetable consumption may be due to the relatively safe environment in rural areas, where the risk of crime is less than that in urban areas. Future studies should compare urban and rural areas on the relationship between the perception of safety in one's community and fruit/vegetable intake.

Our results showed that the perception of access to healthy foods and the quality of food in one's neighborhood was not associated with fruit and vegetable consumption. This finding is inconsistent with studies that reported suggestive associations between perceived neighborhood food environment and individuals' fruit and vegetable consumption (6, 23). However, none of these perceptions of healthy food selection and food

quality was associated with consumption (24), which is consistent with our findings. One possible reason for this difference may be that our rural settings were towns or township areas in one province with a relatively homogenous food environment. Another possible reason may be that our measure of perceived food environment, which assessed convenient access to fruits and vegetables and low-fat products, and, the quality of fruits and vegetables, did not sufficiently reflect characteristics of the food environment in a Korean rural context. In future studies, well-defined concepts and valid measures of the rural food environment should be applied to make significant progress in this area of inquiry (25), along with selecting diverse rural settings.

Limitations

First, the cross-sectional design hindered the derivation of causal relationships between healthy diet and the individual- and neighborhood-level factors. Second, there is the possibility of recall error in self-reported fruit and vegetable intake, although the reliability and validity of this method has been verified and used to measure fruit and vegetable intake in previous studies. Third, while this study identified individual and neighborhood factors affecting healthy eating, the interaction between direct and indirect influences of these factors was not investigated. Lastly, since the data of this study were collected in 2017, it needs to be careful in applying and interpreting the study results to the current rural situations.

Conclusion

Healthy eating for adults living in a rural community is influenced by multiple levels of diverse factors. At the individual level, older age, no high-risk drinking, moderate-to-vigorous physical activity, and high self-efficacy and social support from parents and friends for healthy eating were associated with increased odds of adherence to fruit and vegetable intake guidelines. At the neighborhood level, high social cohesion and the perception of one's neighborhood as being low in safety was associated with increased odds of adherence to fruit and vegetable intake guidelines. Considering individual factors and creating a neighborhood social environment for healthy food choices appear to be important strategies for facilitating fruit and vegetable intake.

Journalism Ethics considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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Conflicts of Interest

The authors declare no conflicts of interest.

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