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Neighborhood Deprivation and Unmet Health Care Needs: A Multilevel Analysis of Older Individuals in South Korea

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ABSTRACT

Objectives: In this study the relationship between neighborhood deprivation and the unmet health care needs of elderly individuals (≥ 65 years) was examined. Some previous studies suggested that neighborhood characteristics affect access to health care, yet research on the unmet needs of older individuals is limited.

Methods: Multilevel logistic regression analysis was used to assess the relationship of neighborhood-level factors with unmet health care needs due to costs, adjusting for individual-level factors, in individuals ≥ 65 years in the 2017 Korean Community Health Survey (*n* = 63,388).

Results: There were 2.6% of elderly individuals who experienced unmet health care needs due to costs. Following adjustment for individual and neighborhood characteristics, the neighborhood deprivation in urban areas was found to have an inverse association with unmet needs (odds ratio = 0.50; 95% confidence interval = 0.24-1.06) for the most deprived quartile versus the least deprived quartile). However, in rural areas neighborhood deprivation was not a significant variable. Among the individual-level variables, household income was one of the strongest correlates with unmet needs in both urban and rural areas.

Conclusion: The present findings suggest that targeted policy interventions reflecting both neighborhood and individual characteristics, should be implemented to reduce the unmet health care needs of elderly individuals.

Introduction

Health equity is a major goal that many governments pursue through public health care policies. To identify inequity, utilization-based measures (which compare the differences in health care utilization by socioeconomic status) have been widely used. However, this conventional method of measuring inequity is limited in that health care utilization may occur independently of the need for health care. In this limitation, unmet health care needs have been used as a complementary indicator to measure inequity [1,2]. The definition of an unmet health care need appears to vary among scholars. Nevertheless, the most widely accepted definition is "when a person has a condition or disability that can be prevented, alleviated, or cured with the use of the appropriate health care services" [2,3]. Unmet health care needs have been used as an important indicator to evaluate the accessibility to health care services under the public health care system of a country. Failure to

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receive timely medical attention due to socioeconomic reasons, can exacerbate disease severity, and risk complications in patient conditions [4-6].

Although South Korea (hereafter Korea) has a national health insurance system in place, it is not feasible for the health care needs of individuals to be met. It has been reported that in 2015 the coverage ratio of the national health insurance was low (63.4%) and had high deductible rates [7]. Therefore, it is highly likely that the vulnerable elderly population will not be able to meet their health care needs which are further compounded by increasing disability and physical illness that is associated with aging [5,6]. Due to a reduction in their income after retirement, or deterioration in their ability to work, the elderly population are unlikely to have sufficient financial capital to pay for their health care needs [7-9]. It was reported that elderly individuals experienced unmet health care needs more frequently than other ages due to the gap between their health care needs and financial capacity [8-10]. A study in Spain reported that if an elderly person with 2 or more chronic conditions experienced an unmet health care needs, their risk of mortality within 5 years was 1.8 times higher as compared with that of controls [5].

Recently, several studies on the unmet health care needs of elderly individuals have been published in Korea [7-9,11,12]. This may be due to an increased social awareness towards elderly individuals as this population size is increasing in Korea. Currently the proportion of elderly (≥ 65 years) in the population of Korea is14.3%, and by 2026 this is expected to reach 21.4%, making Korea a super aged society [13]. Most previous studies have investigated whether individual characteristics influence the occurrence of unmet health care needs in elderly individuals. Several potential risk factors, including being female, low education, low income, low social support, poor subjective health, and depression, have been identified [6-9,11,12,14,15]. However, to date, only a few studies have included neighborhood characteristics as variables that may affect the unmet health care needs of elderly individuals [6,14,15]. Furthermore, these studies limited neighborhood characteristics to variables such as community size [14], number of general practitioners [6] or social capital, including trust and reciprocity [15]. Therefore, those studies do not reflect the overall socioeconomic characteristics of neighborhoods.

Neighborhood deprivation, as an indicator of the level of material and social deprivation of neighborhoods, could be an important risk factor for the unmet health care needs of elderly individuals. Older individuals stay longer in their houses and communities compared with the general adult population, especially after retirement, or due to the limited scope of activity (caused by the deterioration of physical function). Therefore, they have been reported to be more sensitive to their respective neighborhood environment [16]. In particular, previous studies indicated that, although the elderly and low income population had poor health conditions in general (thus requiring more medical services), their health care needs were unmet in many cases due to poor access to health care [4,9,12,17]. Accordingly, it can be assumed that elderly individuals in regions with serious neighborhood deprivation, increasingly experience inequalities in health care accessibility [17,18]. The association between neighborhood deprivation and unmet health care needs has been investigated in the general adult population [1,19-21] but not in the elderly population.

This study was the first to examine the association between neighborhood characteristics, including deprivation, and unmet health care needs in a nationally representative sample of community-dwelling older individuals in South Korea.

Materials and Methods

1. Data sources

The data for this study were extracted from the Korean Community Health Survey (KCHS) conducted by the Korea Centers for Disease Control and Prevention from August to October 2017. The KCHS is a nationwide survey conducted in 254 districts every year since 2008, selecting sampling points through probability proportion-to-size systematic sampling. At the selected sampling points, an average of 5 households were selected through systematic sampling, and, in principle, all of the household members aged 19 years or older were surveyed, resulting in approximately 900 participants in each district. Trained assessors collected information on health status, use of health care, and health behaviors from the participants, through computerized assisted personal interviews by using computerized explanatory tools [22]. The design of the KCHS has previously been described in detail [23]. The KCHS was designated as state-approved statistics (Approval no.: 117075) in 2008. In 2017, the KCHS surveyed 228,381 people, of which 63,388 elderly (≥ 65 years) people who had unmet health care needs due to costs, were assessed in this study.

2. Definition of variables

2.1. Dependent variables

Studies on unmet health care needs have largely been divided into 2 categories depending on the cause of such needs, either costs or various other factors. Investigation of unmet health care needs attributable to other factors can highlight the medical accessibility issues comprehensively. However, such an approach has limitations in identifying socio-economic issues, because such deviations are mostly attributable to individual characteristics [10]. On the contrary, affordability

of health care costs is an unmet health care need that clearly shows deviations resulting from neighborhood characteristics [21]. Therefore, it is possible to identify helpful policy implications by understanding the accessibility issue focusing on unmet health care needs due to costs. Previously, Lee et al [21] classified the unmet health care needs experienced by the general adult population by cause, and validated its association with neighborhood variables, in which only neighborhood variables (urbanization) affected unmet health care needs due to costs. Thus, the present study focused on unmet health care needs due to costs.

The respondents who answered "Yes" to "In the last year, have you been unable to go to the clinic or the hospital (excluding the dental clinic) when you needed to?" and the reason given was "for financial reasons" were defined as those who experienced unmet health care needs due to costs.

2.2. Independent variables

The major explanatory variable in this study was neighborhood deprivation, which was assessed using the deprivation index. This is a marker of neighborhood socioeconomic characteristics that is conceptualized as a multidimensional phenomenon reflecting a contextual picture of a lack of material resources and social interaction. Previous studies concerning the association between the deprivation index and health outcomes confirmed that the former has a gradient effect on the latter. For instance, residents of a community with the lowest deprivation index enjoyed better health outcomes than their counterparts residing in a community with the 2nd lowest deprivation index [24]. While England has produced and promulgated the Index of Multiple Deprivation as an official national deprivation index annually since 2000, researchers in Korea have been using the Townsend or Castairs indexes, modifying them to fit the Korean context [25-27]. Currently, Korea does not have an official deprivation index. Therefore, the present study utilized the Composite Deprivation Index, devised by Kim et al [27], which is a composite indicator using 10% of the sample survey from the 2015 census, along with district-level data. The index comprises the following 9 domains: the proportion of households living below the minimum housing standard, individuals without a high school diploma, individuals older than 65 years, heads-of-household that have elementary occupations, households living alone, households with female heads-of-household, households without a car, households not living in an apartment, and the proportion of individuals who are divorced or widowed. Details of the Composite Deprivation Index are described elsewhere [21]. The deprivation score was categorized into quartiles (Dep 1 = least deprived, Dep 4 = most deprived).

Along with neighborhood deprivation, this study included

urbanization and health care supply as neighborhood-level variables that could influence unmet health care needs. For urbanization, a variable that indicated whether individuals live in a rural or urban area was included. This is a general proxy for the geographic density of health care providers and facilities [19]. Finally, to measure the health care supply at the neighborhood-level, the number of physicians per 1,000 residents in 2017 and the number of hospital beds per 1,000 residents in 2017 was selected [1,6,20,21]. All neighborhood-level variables were measured by district. The district unit was administratively defined by the government and had a relatively large and heterogeneous population. A district was defined as the smallest unit with administrative autonomy in Korea, and it is the smallest unit from which population census data and national statistics bureau data can be obtained [28].

To distinguish the individual compositional effect from the neighborhood contextual effect, it was necessary to control for individual-level characteristics predicted to be associated with unmet health care needs. Therefore, the individual explanatory variables examined in this study included age, gender, educational attainment, current cohabitation with spouse, employment status, monthly household income, the number of self-reported medical comorbidities (including hypertension, diabetes, dyslipidemia, arthritis and cataract), depressive symptoms, self-reported health status, and current smoking status.

3. Statistical analysis

Individual access to health care is thought to be influenced by factors at 2 levels, those linked to the individual and those reflecting the neighborhood in which the individuals live [19]. Considering the present sample of 63,388 individuals (Level 1) nested within 254 districts (Level 2), to examine the independent association of neighborhood factors with self-reported unmet health care needs, a multilevel logistic regression analysis was conducted [29]. The null hypothesis that the variance of the intercept in the unmet health care needs model is 0 (H0:τ00 = 0) was evaluated to determine the appropriateness of multilevel analysis. The null hypothesis was rejected, confirming that multilevel analysis was appropriate.

The sample for the community health survey was extracted using a complex sample design. Thus, adjusted weights (which were provided by the KCHS), were included in the 2-level designs to account for the design effect [29,30]. In the KCHS, weights were classified into household- and individual-weight for analysis. The household weight reflected the household sampling rate, which considered the sampling process of the sample design, the eligible household rate for the survey, and the household ratio by housing type. The individual weight reflected the individual response rate to the household weight.

The adjusted weights, which were used for the multilevel analysis, were calculated as individual weights adjusted to fit the population by gender and age within each survey area [22,23]. A 2-level random intercept model was fitted to the null model. Firstly, Model 1 was constructed with only deprivation. Model 2 added the contextual-level variables, including urbanization and health care supply into Model 1, followed by the 3rd model with individual and contextual variables (Model 3). Finally, additional analyses were conducted using data stratified by degree of urbanization (urban versus rural). All of the contextual and individual variables were simultaneously included in the models. The analysis was conducted separately for urban and rural areas because urbanization may act as an effect modifier in the relationship between neighborhood deprivation and unmet health care needs [31].

Multilevel analysis was performed in HLM version 7.0 (Scientific Software International, Inc., Lincolnwood, Illinois), while all other analyses were performed using SAS 9.4 (SAS Institute Inc., Cary, NC, USA).

Results

1. Descriptive statistics of the study sample

Table 1 shows the general characteristics of the 63,388 elderly individuals included in the survey and their experience of unmet health care needs. As for the general characteristics of participants, participants ≤ 74 years (54.3%) outnumbered those ≥ 75 years, and there were more females (57.7%) than males. While 63.8% of them were cohabiting with their

Table 1. Sample characteristics and prevalence of unmet health care needs due to costs.

	Unmet health care needs due to costs among the elderly (N = 63,388)						
	Yes		No		Total		p*
	N	%	N	%	N	%	
Individual level							
Unmet health care needs	6,060	8.9	61,767	91.1	67,827	100.0	
Unmet health care needs due to costs	1,621	2.6	61,767	97.4	63,388	100.0	
Age (y)							< 0.0001
65-74	757	2.2	33,636	97.8	34,393	54.3	
≥ 75	864	3.0	28,131	97.0	28,995	45.7	
Gender							< 0.0001
Male	485	1.8	26,300	98.2	26,785	42.3	
Female	1,136	3.1	35,467	96.9	36,603	57.7	
Educational attainment							< 0.0001
University or higher	28	0.7	3,926	99.3	3,954	6.2	
High school	105	1.1	9,091	98.9	9,196	14.5	
Middle school	148	1.6	9,004	98.4	9,152	14.5	
Elementary school or less	1,339	3.3	39,667	96.7	41,006	64.8	
Cohabitation with spouse							< 0.0001
Currently cohabiting	726	1.8	39,686	98.2	40,412	63.8	
Divorced	84	7.4	1,055	92.6	1,139	1.8	
Widowed	760	3.6	20,077	96.4	20,837	32.9	
Separated	35	5.1	657	94.9	692	1.1	
Never married	15	5.6	252	94.4	267	0.4	
Employment status							< 0.0001
Wage worker	212	2.7	7,550	97.3	7,762	12.3	
Employer/self-employed	169	1.3	12,831	98.7	13,000	20.6	
Unpaid family worker	44	1.1	3,920	98.9	3,964	6.3	
Student	0	0.0	4	100.0	4	0.0	
House worker	552	3.2	16,952	96.8	17,504	27.7	
Unemployed	637	3.0	20,364	97.0	21,001	33.2	

Table 1. (Continued).

	Unmet health care needs due to costs among the elderly ($N = 63,388$)						p^*
	Yes		No		Total		
	N	%	N	%	N	%	
Monthly household income (*104 KRW)							< 0.0001
> 400	39	0.8	4,963	99.2	5,002	7.9	
300-399	35	0.9	3,958	99.1	3,993	6.3	
200-299	83	1.1	7,690	98.9	7,773	12.4	
100-199	235	1.6	14,370	98.4	14,605	23.2	
< 100	1,226	3.9	30,328	96.1	31,554	50.1	
No. of medical comorbidities							< 0.0001
0	209	1.8	11,411	98.2	11,620	18.3	
1	405	2.3	17,443	97.7	17,848	28.2	
2+	1,006	3.0	32,913	97.0	33,919	53.5	
Depressive Symptoms							< 0.0001
No	1,230	2.1	58,124	97.9	59,354	93.7	
Yes	390	9.7	3,612	90.3	4,002	6.3	
Self-reported health							< 0.0001
Very good/Good	93	0.7	12,358	99.3	12,451	19.6	
Moderate	323	1.4	22,730	98.6	23,053	36.4	
Bad/Very bad	1,205	4.3	26,674	95.7	27,879	44.0	
Currently smoker							0 0.0134
No	1,448	2.5	56,272	97.5	57,720	91.1	
Yes	173	3.1	5,495	96.9	5,668	8.9	
Neighborhood level							
Neighborhood deprivation							< 0.0001
1st quartile (least deprived)	288	3.0	9,284	97.0	9,572	15.1	
2nd quartile	389	3.2	11,957	96.8	12,346	19.5	
3rd quartile	412	2.5	16,341	97.5	16,753	26.4	
4th quartile (most deprived)	532	2.2	24,185	97.8	24,717	39.0	
Urbanization							< 0.0001
Urban	1,004	3.0	32,985	97.0	33,989	53.6	
Rural	617	2.1	28,782	97.9	29,399	46.4	

* p value by Chi-square test.
Data were missing for some respondents in the following characteristics: educational attainment, 80; cohabitation with spouse, 41; employment status, 153; monthly income, 461; number of medical comorbidities, 1; depressive symptoms, 32; self-reported health, 5.

spouse, 32.9% were widowed. The majority of the elderly had either completed their education up to elementary school or below (64.8%), and 50.1% had a monthly household income < 1,000,000 KRW (≈ US $1,000 in 2017). As for employment status, 33.2% were unemployed, while 27.7%, 20.6%, and 12.3% were house workers, employers or self-employed, and wage workers, respectively. Furthermore, 53.5% of the participants had been diagnosed with comorbid diseases by a physician in the past year, and 44.0% reported that their subjective health status was bad or very bad. While 53.6% resided in urban areas, 46.4% lived in rural areas, and most of the elderly lived in regions belonging to the 4th (39.0%) or 3rd (26.4%) quartile of neighborhood deprivation.

In the present sample, 8.9% of the participants experienced unmet health care needs, and 2.6% experienced unmet health care needs due to costs. When examined based on participant characteristics, the elderly population aged 75 years or older, females, those without a spouse, house workers, and those with depressive symptoms or other diseases had a higher tendency to have experienced unmet health care needs due to

costs. Further, low levels of educational attainment, household income, and self-reported health were directly proportional to the higher experience of unmet health care needs due to costs. As for neighborhood characteristics, those residing in urban areas and in communities falling in the 1st or 2nd quartile of neighborhood deprivation had a higher tendency to have experienced unmet health care needs due to costs.

2. Results of the multilevel analyses

Table 2 presents the findings of the multilevel analyses for the models on unmet health care needs due to costs. In Model 1, where only the deprivation index was entered, it was statistically significant in the 2nd and 4th quartiles. Those elderly living in the 2nd quartile region were 35% more likely to experience unmet health care needs than those living in the 1st (the least deprived) quartile [odds ratio (OR) = 1.35; 95% confidence interval (CI) = 1.03–1.76]. In Model 2, where all neighborhood-level variables were considered, the association between the deprivation index and unmet health care needs remained statistically significant, and the magnitudes of OR changed very little. However, in Model 3, where all individual-level variables were considered, the neighborhood deprivation index was in a marginal inverse relationship. Compared with the elderly living in the 1st quartile (least deprived) region, those living in the 3rd were 27% less likely to experience

unmet health care needs (OR=0.73; 95% CI=0.52–1.03) while those living in the 4th (most deprived) were 31% less likely to (OR=0.69; 95% CI=0.45–1.05).

Among the neighborhood-level variables, while the deprivation index had marginal statistical significance, urbanization had a strong significant association with unmet health care needs. Compared with the elderly living in urban areas, those who live in rural neighborhoods were 41% less likely to experience unmet health care needs (OR = 0.59; 95% CI = 0.45–0.78). All individual-level variables, except age, gender, and number of medical comorbidities, had a statistically significant association with unmet health care needs. Household income had the highest OR value, such that those with a monthly income less than 1,000,000 KRW were 5.46 times more likely to experience unmet health care needs as compared with those who had a monthly income more than 4,000,000 KRW (95% CI = 3.58–8.33). Moreover, the likelihood of experiencing unmet health care needs increased in those with a lower level of self-reported health, depressive symptoms, a lower level of educational attainment, those living alone, and smokers. Regarding employment status, wage workers had a higher tendency to experience unmet health care needs than unpaid family workers, house workers, the self-employed, and the unemployed did. However, age, gender and number of medical comorbidities of the participants showed

Table 2. Multilevel analysis results of unmet health care needs due to costs among the elderly.

	Model 1		Model 2		Model 3	
	OR	95% CI	OR	95% CI	OR	95% CI
Individual level						
Age (y)						
65-74					1.00	(reference)
≥ 75					0.98	(0.83, 1.16)
Gender						
Male					1.00	(reference)
Female					1.04	(0.85, 1.27)
Educational attainment						
University or higher					1.00	(reference)
High school					1.07	(0.66, 1.76)
Middle school					1.44	(0.94, 2.21)*
Elementary school or less					2.52	(1.66, 3.84)***
Cohabitation with spouse						
Currently cohabiting					1.00	(reference)
Divorced					1.98	(1.43, 2.74)***
Widowed					1.31	(1.10, 1.56)**
Separated					1.93	(1.08, 3.45)**
Never married					2.25	(1.28, 3.95)**

Table 2. (Continued).

	Model 1		Model 2		Model 3	
	OR	95% CI	OR	95% CI	OR	95% CI
Employment status						
Wage worker					1.00	(reference)
Employer/self-employed					0.65	(0.49, 0.88)**
Unpaid family worker					0.47	(0.30, 0.73)***
House worker					0.64	(0.51, 0.80)***
Unemployed					0.75	(0.59, 0.96)**
Monthly household income (*10⁴ KRW)						
> 400					1.00	(reference)
300-399					1.69	(0.98, 2.92)*
200-299					1.87	(1.21, 2.90)**
100-199					3.09	(2.02, 4.73)***
< 100					5.46	(3.58, 8.33)***
No. of medical comorbidities						
0					1.00	(reference)
1					0.97	(0.79, 1.19)
2+					1.00	(0.83, 1.22)
Depressive Symptoms						
No					1.00	(reference)
Yes					2.98	(2.50, 3.56)***
Self-reported health						
Very good / Good					1.00	(reference)
Moderate					1.65	(1.28, 2.13)***
Bad / Very bad					3.67	(2.81, 4.79)***
Currently smoking						
No					1.00	(reference)
Yes					1.50	(1.21, 1.85)***
Neighborhood level						
Neighborhood deprivation						
1ˢᵗ quartile (least deprived)	1.00	(reference)	1.00	(reference)	1.00	(reference)
2ⁿᵈ quartile	1.35	(1.03, 1.76)**	1.33	(1.01, 1.76)**	1.18	(0.89, 1.56)
3ʳᵈ quartile	0.86	(0.64, 1.16)	0.90	(0.65, 1.26)	0.73	(0.52, 1.03)*
4ᵗʰ quartile (most deprived)	0.73	(0.54, 0.98)**	0.90	(0.58, 1.41)	0.69	(0.45, 1.05)*
Urbanization						
Urban			1.00	(reference)	1.00	(reference)
Rural			0.68	(0.53, 0.87)**	0.59	(0.45, 0.78)***
No. of physicians per 1,000 residents (continuous)						
			0.96	(0.93, 1.00)*	1.02	(0.98, 1.06)
No. of hospital beds per 1,000 residents (continuous)						
			1.01	(0.99, 1.03)	0.99	(0.97, 1.01)

Model 1: only neighborhood deprivation variable was entered in the model.
Model 2: neighborhood level variables were simultaneously entered in the model.
Model 3: all variables were simultaneously entered in the model.
*$p < 0.1$, **$p < 0.05$, ***$p < 0.001$.

no significant association with unmet health care needs.

Table 3 presents the findings for the multilevel analyses on the experience of unmet health care needs due to costs for both urban and rural areas. For urban areas, the deprivation index exhibited borderline significance when the neighborhood- and individual-level variables were controlled. In the 4th quartile, which was the most deprived region, the likelihood of experiencing unmet health care needs decreased by 50% as compared with the 1st quartile with the lowest deprivation (OR = 0.50, 95% CI = 0.24–1.06). Except for age, gender and number of medical comorbidities of the participants, all individual-level variables were significant predictors of unmet health care needs. Household income had the highest OR value, and it was significant in all sections. Those in the lowest monthly household income group (< 1,000,000 KRW) were 5.53 times more likely to experience unmet health care needs than those in the highest monthly household income group [≥ 4,000,000 KRW (95% CI = 3.57–8.57)]. In addition, low subjective health

status and depression were strongly associated with an increased rate of unmet health care needs, with ORs of 3.71 (95% CI = 2.78–4.95) and 2.93 (95% CI = 2.42–3.54), respectively.

In rural areas, the neighborhood deprivation index was not significant in the unmet health care needs model. Among the individual-level variables, gender, cohabitation with spouse, employment status, household income, depressive symptoms and self-reported health showed significant associations with unmet health care needs. The variable with the greatest OR was cohabitation with a spouse. When compared with older adults cohabiting with a spouse, the probability of experiencing unmet health care needs was 6.34 times higher in separated older adults (95% CI = 3.60-11.16) and 2.95 times higher in divorced older adults (95% CI = 1.57-5.57). In addition, depression and a monthly household income below 1,000,000 KRW were both strongly associated with an increased rate of unmet health care needs, ORs were 3.71 (95% CI = 2.89–4.75) and 3.58 (95% CI = 1.34–9.56), respectively.

Table 3. Multilevel analysis results of unmet health care needs due to costs by urbanization.

		Urban		Rural	
		OR	95% CI	OR	95% CI
Individual level					
Age (y)					
	65-74	1.00	(reference)	1.00	(reference)
	≥ 75	0.98	(0.82, 1.18)	0.97	(0.79, 1.20)
Gender					
	Male	1.00	(reference)	1.00	(reference)
	Female	1.01	(0.81, 1.26)	1.39	(1.04, 1.88)**
Educational attainment					
	University or higher	1.00	(reference)	1.00	(reference)
	High school	1.06	(0.64, 1.76)	1.67	(0.43, 6.51)
	Middle school	1.44	(0.93, 2.24)*	1.54	(0.40, 5.87)
	Elementary school or less	2.51	(1.64, 3.86)***	3.18	(0.89, 11.37)*
Cohabitation with spouse					
	Currently cohabiting	1.00	(reference)	1.00	(reference)
	Divorced	1.95	(1.39, 2.75)***	2.95	(1.57, 5.57)***
	Widowed	1.33	(1.10, 1.62)**	1.14	(0.90, 1.44)
	Separated	1.66	(0.85, 3.26)	6.34	(3.60, 11.16)***
	Never married	2.35	(1.33, 4.16)**	n/a†	
Employment status					
	Wage worker	1.00	(reference)	1.00	(reference)
	Employer/self-employed	0.68	(0.48, 0.96)**	0.67	(0.46, 0.96)*
	Unpaid family worker	0.54	(0.30, 0.97)**	0.39	(0.23, 0.65)**
	House worker	0.63	(0.49, 0.80)***	0.77	(0.54, 1.08)
	Unemployed	0.74	(0.57, 0.96)**	0.94	(0.66, 1.33)

Table 3. (Continued).

		Urban		Rural	
		OR	95% CI	OR	95% CI
Monthly household income (*10^4 KRW)					
	> 400	1.00	(reference)	1.00	(reference)
	300-399	1.75	(1.00, 3.07)*	0.53	(0.10, 2.80)
	200-299	1.89	(1.20, 2.98)**	1.24	(0.41, 3.76)
	100-199	3.14	(2.02, 4.89)***	1.88	(0.68, 5.21)
	< 100	5.53	(3.57, 8.57)***	3.58	(1.34, 9.56)**
No. of medical comorbidities					
	0	1.00	(reference)	1.00	(reference)
	1	0.99	(0.79, 1.23)	0.88	(0.65, 1.20)
	2+	1.03	(0.83, 1.27)	0.81	(0.61, 1.08)
Depressive Symptoms					
	No	1.00	(reference)	1.00	(reference)
	Yes	2.93	(2.42, 3.54)***	3.71	(2.89, 4.75)***
Self-reported health					
	Very good / Good	1.00	(reference)	1.00	(reference)
	Moderate	1.63	(1.24, 2.15)***	1.89	(1.20, 2.98)**
	Bad / Very bad	3.71	(2.78, 4.95)***	3.39	(2.21, 5.22)***
Currently smoking					
	No	1.00	(reference)	1.00	(reference)
	Yes	1.50	(1.20, 1.89)***	1.34	(0.92, 1.97)
Neighborhood level					
Neighborhood deprivation					
	1st quartile (least deprived)	1.00	(reference)	1.00	(reference)
	2nd quartile	1.17	(0.88, 1.56)	1.13	(0.29, 4.45)
	3rd quartile	0.72	(0.50, 1.03)*	1.12	(0.36, 3.48)
	4th quartile (most deprived)	0.50	(0.24, 1.06)*	1.10	(0.36, 3.34)
No. of physicians per 1,000 residents					
		1.02	(0.98, 1.06)	1.29	(0.94, 1.77)
No. of hospital beds per 1,000 residents					
		0.99	(0.97, 1.01)	0.98	(0.96, 1.00)**

All variables were simultaneously entered in the model.
*$p < 0.1$, **$p < 0.05$, ***$p < 0.001$.
†There were no respondents that experienced unmet needs due to costs among never married older adults in rural area.

Discussion

In the present study, the rate of unmet health care needs among the elderly (≥ 65 years) was 8.9%, and the rate of unmet health care needs due to costs was 2.6%. Considering that the overall rate of unmet health care needs was 10.5%, and that due to costs was 1.5% among the entire adult population [≥ 19 years of age (KCHS, 2017)], the elderly was slightly less likely than the general adult population to experience unmet health care needs overall. However, the elderly were about 2 times more likely to experience unmet health care needs due to costs. Previous studies have reported that unmet health care needs arise mostly due to the time restrictions of those aged 65 or younger, while majority of the elderly individuals aged 65 years or older experienced unmet health care needs due to financial reasons [7,9].

The primary result of the present study was that, even after adjusting for individual compositional characteristics, the contextual characteristics of neighborhood (represented by the deprivation index), were associated with the unmet health care needs experienced by elderly individuals. Older adults who lived in deprived neighborhoods were less likely to experience unmet health care needs due to costs. However, the association between neighborhood deprivation and unmet health care needs varied depending on the degree of urbanization. In urban areas, the deprivation index was associated with unmet health care needs, and the magnitude of its OR was higher than that derived from the analysis conducted without classifying the sample based on urbanization. In contrast, in rural areas, the deprivation index had no significant correlation with unmet health care needs.

To our knowledge, this is the only study to date to have validated the association between the unmet health care needs of elderly individuals and neighborhood deprivation. Therefore, there were no preceding studies to compare with the present findings. However, the present results, which indicated that the elderly living in highly deprived-neighborhoods had less possibilities of experiencing unmet health care needs, were contrary to the findings of previous studies conducted in Western countries, which verified the association between neighborhood deprivation and access to health care in the general adult populations. Previous studies conducted in the US revealed that poverty in the region undermined the access to health care [19,20], and that the experience of unmet health care needs increased proportionately with an increase in the poverty level of the region [1]. There can be several explanations for these differences. Firstly, the inverse association of neighborhood deprivation with unmet health care needs of elderly individuals can be explained with the "relative deprivation model," which focusses on the relationship between deprivation and health, as proposed in previous studies [18,32]. The relative deprivation model explains that a disparity between the socioeconomic status of an individual and that of those living around them, affects their health. According to this model, a poor person residing in an affluent neighborhood experiences higher financial stress as compared with their counterparts residing in a poor neighborhood, and that the former would consider their health as poorer or they would have a poorer health condition [18,28,32]. Considering the relative poverty rate of elderly individuals in Korea is 46.1% [33], almost half of the elderly population in Korea would be poor. Therefore, it can be assumed that, if the overall socioeconomic level of a neighborhood was higher, poor elderly individuals residing in that neighborhood would perceive their health status as poorer as compared with their counterparts living in a neighborhood with a lower socioeconomic level. Accordingly, they would

have more health care needs and would experience more unmet health care needs due to costs.

Secondly, as the KCHS questions on unmet health care needs used in this study consisted of general questions, not specific questions according to the type or severity of disease, it was likely that the respondents replied mainly based on their experience of unmet health care needs concerning mild conditions. For mild health conditions, it is assumed that there should not be a huge variation between regions because rural residents can visit the outpatient clinic at the public health centers established in all 254 districts in Korea. Therefore, while deprivation had a significant positive association with unmet health care needs in the studies conducted in the US, where a lack of health care resources could be expected in highly deprived neighborhoods [19], the present study revealed a lower correlation between them.

Finally, it can be explained that different studies used different measures to assess the neighborhood socioeconomic deprivation. Previous studies used variables that usually explain material deprivation, such as poverty rate, low educational attainment, and proportion of the unemployed [1,19,20]. On the contrary, the present study used a deprivation index, which is a more expanded and integrated index covering both material poverty and social deprivations such as restrictions in social activities, and status of social exclusion. This may explain the differences in the present results as compared with those of previous studies.

In addition to neighborhood deprivation, among the neighborhood-level variables, urbanization was another variable that showed a significant association with unmet health care needs due to costs. The significant association persisted even after adjustment for deprivation level. Moreover, the elderly residents in urban areas showed a higher possibility of experiencing unmet health care needs than did those in rural areas. These results are contrary to those reported by a Chinese study in which elderly residents in rural areas were reported to be 1.48 times more likely to experience unmet health care needs as compared with those living in urban areas [14]. These differences can be understood in the context of Korea's health care system. Heo et al [34] explained several reasons for more experiences of unmet health care needs in the urban areas of Korea, regardless of the concentration of health care resources in urban areas. They claimed that areas, where private hospitals were oversupplied, competitively purchased beds and expensive medical equipment, and induced the demand of uninsured services, leading to higher medical costs. This in turn resulted in more unmet needs in Korea due to a low coverage of the national health insurance and a high level of out-of-pocket payment. The out-of-pocket payment in Korea accounts for a considerable proportion of the entire medical expenditure even for the poor, and it is an involuntary payment

because individuals have no option to decide whether or not to choose those uninsured treatments [35]. From these results, it was speculated that the high out-of-pocket payment brought about the undermining of medical utilization by the poor elderly residents in urban areas, since such payments increase their financial burden for medical expenses.

Another possible explanation is that the gap in social capital (i.e., social networks, interpersonal trust, and reciprocity) between urban and rural areas could affect unmet health care needs. In Korea, it was reported that rural areas had a lower movement rate, higher regional cohesion, and qualitatively deeper and more meaningful interactions among neighbors as compared with urban areas [36]. In this context, it could be interpreted that the high level of social capital in Korean rural areas led to a decrease in unmet health care needs by promoting information sharing regarding health care utilization, and by allowing residents to exchange practical assistance to obtain necessary medical services. Previous studies conducted in the US and Japan identified the effect of social capital in the neighborhood on access to health care, which revealed that social capital contributed to the reinforcement of neighborhood accountability. This in turn affected residents, particularly the vulnerable population in the community, to help each other to access the necessary medical services [15,37]. The present study conducted additional analysis on the experience of unmet medical needs by classifying neighborhood types into rural and urban areas, which revealed that the neighborhood deprivation index was not significant in rural areas. This result may be attributable to the controlling effect of the high social capital established among rural residents on the association between neighborhood deprivation and unmet health care needs.

Among the health care supply variables that were included in the model as neighborhood characteristic variables influencing unmet health care needs, number of doctors and number of beds had few associations with unmet health care needs due to costs, which was consistent with the findings of previous studies [19-21]. In other words, the number of doctors or beds were not significant factors influencing access to health care. Korea has the largest number of doctor consultations per capita and beds per capita, among the Organization for Economic Cooperation and Development member countries as of 2011 [38]. This study demonstrated that a mere numeric increase in local health care resources would not contribute to the reduction of unmet health care needs of elderly residents.

For individual-level factors, the results of this study were similar to those of previous studies on the association between gender, education, marital status, income level, depression history, and self-reported health, and unmet health care needs due to costs [8,9,21]. In particular, household income was one of the strongest predictors of unmet health care

needs due to costs both in urban and rural areas. These results indicated that the elderly with a lower socioeconomic status residing in a neighborhood with a higher socioeconomic level would be more prone to experiencing the double jeopardy of having more unmet health care needs as compared with their counterparts living in a neighborhood with a lower socioeconomic level [32]. Thus, it seems necessary to make policy interventions to provide necessary health care services at an affordable cost.

The present study has some limitations. Firstly, the causal relationship between socioeconomic characteristics of neighborhoods and the unmet health care needs of residents could not be clarified as this study used cross-sectional data. Additionally, since the deprivation index used measured at a certain time point, the cumulative inequality throughout the entire life of an individual or across generations was not analyzed. To investigate the accurate size and direction of the effect, instead of the correlation between the socioeconomic characteristics of neighborhoods, such as neighborhood deprivation and unmet health care needs, life-long deprivation and unmet health care needs should be examined using a time series analysis [2]. Furthermore, although this study used the deprivation index calculated based on the administrative units of district, the analysis results can be distorted if the scope of "neighborhood," which actually affects residents, and the scope of the administrative unit of "district" do not match each other [28]. Considering a previous study [15] where an increase in the neighborhood's influence on the health status of its residents was inversely proportional to the unit of the neighborhood, a single neighborhood needs to be selected, and the deprivation index measured at a lower neighborhood unit in future studies, thereby investigating the association with unmet health care needs.

Despite of the aforementioned limitations, this study is significant in that it was the first to analyze the association between neighborhood characteristics and the unmet health care needs of elderly individuals using national data, and it confirmed contextual effect of neighborhoods even after adjustment of the compositional effects of individuals by applying a multilevel modelling approach.

Conclusion

This study demonstrated the association of neighborhood characteristics with unmet health care needs due to costs among elderly individuals in a Korean setting. It seems that the elderly residing in urban rather than rural areas, were more susceptible to the effect of the neighborhood deprivation level, and the elderly living in the most affluent rather than the most deprived areas showed a higher likelihood of

experiencing unmet health care needs. Moreover, household income level was identified as a strong explanatory variable for unmet health care needs both in urban and rural areas. A lower income level was highly likely to be associated with experiencing unmet health care needs due to costs. The present findings suggest the need to consider target interventions for the low-income elderly individuals residing in neighborhoods with a high socioeconomic level in order to reduce the unmet health care needs of elderly individuals in Korea.

Conflicts of Interest

The authors have no conflicting interests to declare.

Acknowledgments

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