The Association Between the Supply of Primary Care Physicians and Population Health Outcomes in Korea

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Background and Objectives: *Several studies reported that primary care improves health outcomes for populations. The objective of this study was to examine the relationship between the supply of primary care physicians and population health outcomes in Korea.* Methods: *Data were extracted from the 2007 report of the Health Insurance Review, the 2005 report from the Korean National Statistical Office, and the 2008 Korean Community Health Survey. The dependent variables were age-adjusted all-cause and disease-specific mortality rates, and independent variables were the supply of primary care physicians, the ratio of primary care physicians to specialists, the number of beds, socioeconomic factors (unemployment rate, local tax, education), population (population size, proportion of the elderly over age 65), and health behaviors (smoking, exercise, using seat belts rates). We used multivariate linear regression as well as ANOVA and* t *tests.* Results: *A higher number of primary care physicians was associated with lower all-cause mortality, cancer mortality, and cardiovascular mortality. However, the ratio of primary care physicians to specialists was not related to all-cause mortality. In addition, the relationship between socioeconomic variables and mortality rates was similar in strength to the relationship between the supply of primary care physicians and mortality rates. Accident mortality, suicide mortality, infection mortality, and perinatal mortality were not related to the supply of primary care physicians.* Conclusions: *The supply of primary care physicians is associated with improved health outcomes, especially in chronic diseases and cancer. However, other variables such as the socioeconomic factors and population factors seem to have a more significant influence on these outcomes.*

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Effectiveness, efficiency, and equity have become important issues in health-system reform and have led to a focus on strengthening primary care.[1] Several studies show that the increased availability of primary care clinicians reduces avoidable mortality or morbidity and minimizes total health care costs.[2-4] In addition, in a county-level study analyzing 11 years (1985–1995) of data from 50 states in the United States, an increased supply of primary care clinicians was associated with lower rates of infant mortality and low birth weight.[5] Other studies, however, suggest better outcomes for specialists caring for patients with a single discrete condition, such as diabetes or acute coronary artery disease.[3,6-9]

A Geographic Information System (GIS)-based study on the distribution of major health manpower in Korea suggests that patients who live in areas with more primary care physicians use more primary care and have more hospital admissions,[10] increasing costs but not necessarily improving care or health outcomes. A further evaluation of health outcomes in Korea—a country with universal health insurance—might provide useful information to countries considering changes in their health care sytems.[11,12]

This study examines the distribution of primary care physicians in 250 administrative districts in Korea and analyzes the relationship between the supply of primary care physicians and population health outcomes. The hypothesis of this study is that patients who live in areas with more primary care providers have better health outcomes.

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Methods

Setting

The Korea National Health Insurance program is a system of universal health care coverage for the country's entire population. In contrast to a strong public sector role in health care financing, health care delivery is mainly organized as a private sector-dominated system in which patients choose their doctors and hospitals. Most physicians in Korea are board-certified specialists and work either in a hospital as an employee or as the owner of a private clinic (with less than 30 beds). Internal medicine physicians, pediatricians, and family physicians are regarded as primary care physicians in Korea. Patients do not need to register with a primary care clinician, and they can see specialists without a referral from a primary care physician. We studied all 250 existing administrative districts in Korea.

Data and Variables

Data were extracted from the 2007 Korean Health Insurance Review,[13] the 2005 Population Census of the Korean National Statistical Office,[14] and the 2008 Community Health Survey.[15] Due to the nature of the universal coverage system, claims data within the Health Insurance Review contain extensive information on medical care provided in Korea.

All dependent and independent variables were measured in terms of administrative districts, which are the unit of analysis in the databases. The dependent variables from the 2005 Population Census of the Korean National Statistical Office were age-adjusted all-cause mortality rates (the number of deaths per 100,000 persons) and other causes of mortality, including cancer, cardiovascular, accident, suicide, infection, and perinatal mortality. The independent variables were the number of primary care physicians per 10,000 persons and the ratio of primary care physicians to other specialists, based on data from the 2007 Korean Health Insurance Review. Internal medicine physicians, pediatricians, and family physicians who provide primary care services were categorized as primary care physicians. Administrative districts were categorized into three groups by the number of primary care physicians per 10,000 persons. We used these tertile groups of primary care physicians as an indicator of supply of primary care.

We adjusted for four categories of covariates in the model: medical care availability, regional socioeconomic variables, population characteristics, and health behavior. Medical care availability was defined as the number of beds per 10,000 persons. For regional socioeconomic variables, unemployment rate, local tax rate, financial autonomy of local governments, marriage rate, and the rate of those completing education beyond high school were used (individually, not as a single composite variable). Local tax data were extracted from the 2006 Regional National Tax Yearbook,[19] and the financial autonomy of local governments were taken from the 2005 Korean National Statistical Office data. Population characteristics included population size, sex ratio, and the number of people over age 65. Health behavior characteristics extracted from the 2008 Community Health Survey[15] were those shown to contribute to preventable mortality and included current smoking status, physical activity level, obesity, perceived stress level, and use of seatbelts. Administrative districts were categorized into high (at or above the median) or low (below the median) for each of these variables.

Data Analysis

Two different approaches were used to examine the relationship between the supply of primary care physicians and population health outcomes. First, we tested the univariate association between health outcomes and the supply of primary care physicians per 10,000 persons and various other independent variables. We used one-way analysis of variance (ANOVA) and *t* tests for these analyses. Next, multivariate linear regression was used, adjusting for other covariates known to be associated with higher mortality such as smoking, exercise, and drinking rate.

In Model 1, independent variables other than the supply of primary care physicians were used as predictors of mortality. Next, the medical care availability that included primary care physicians per 10,000 persons and the ratio of primary care physicians to specialists were added as independent variables (Model 2). In addition, we estimated adjusted means of all-cause mortality, cancer mortality, and cardiovascular mortality for a statistically significant model. All analyses were conducted using STATA Version 10. Statistical significance was defined as a *P* value of less than .05.

Results

Table 1 shows the descriptive statistics for all variables examined in this study. The average age-standardized all-cause mortality rate was 529 per 100,000 persons. The average number of primary care physicians in the lower tertile group in terms of the supply of primary care providers was 5.7 per 10,000 persons and that for the highest tertile group was 9.4. The average of the ratio of primary care physicians to specialists was 0.9 with range of 0.15–11. The median ratio was 0.66, and the modal ratio was 0.66 and 0.72).

Table 2 shows the results of multivariate analyses to test the relationship between the supply of primary care physicians and population health outcomes. In Model 1, in which independent variables other than the supply of primary physicians were used as predictors of mortality, variables that were significant contributors to all-cause mortality included the high number of total hospital beds per 10,000 persons and high smoking

Table 1

Characteristics of Variables by 250 Administrative Districts

	n	*Mean*	*SD*	*Range (Low–High)*
All-cause mortality/100,000 population	250	529.33	63.63	337–682
Cancer mortality/100,000 population	250	130.58	18.13	0.0–175.4
Cardiovascular mortality/100,000 population	250	117.58	19.92	68.4–179
Accident mortality/100,000 population	250	74.41	21.50	24.6–138.8
Suicide mortality/100,000 population	250	27.26	8.15	0–52.7
Perinatal mortality/100,000 population	250	0.11	0.39	0–4.3
Infection mortality/100,000 population	250	10.75	3.82	0–24.6
Number of primary care physician/10,000 population	248	5.67	6.04	1.75–63.65
Lower tertile	83	3.23	0.40	1.75–3.79
Middle tertile	80	4.41	0.34	3.80–5.18
Upper tertile	85	9.25	9.31	5.18–63.65
The ratio of primary care physicians to specialists	224	0.90	1.09	0.15–11.00
<Median	122	0.47	0.13	0.15–0.66
≥ Median	122	1.33	1.42	0.66–11.00
Total bed/10,000 population	221	85.54	77.54	0.97–716.09
<Median	111	37.22	22.50	0.97–69.49
≥ Median	110	134.30	82.76	70.07–716.09
Unemployment rate	246	0.81	0.59	0.00–3.04
<Median	123	0.36	0.22	0.00–0.69
≥ Median	123	1.26	0.48	0.70–3.04
Local tax per person (1,000 won)	222	819.61	846.70	233.76–8,682.70
<Median	111	453.11	89.05	233.76–598.41
≥ Median	111	1,186.12	1,077.64	607.12–8,682.70
Education beyond high school (%)	250	45.61	11.72	67.38–21.47
<Median	125	35.51	7.40	21.47–48.50
≥ Median	125	55.71	3.94	48.50–67.38
Married (%)	250	60.82	4.27	48.15–70.91
<Median	125	57.41	2.85	48.15–60.93
≥ Median	125	64.23	2.24	61.18–70.91
Population size	250	186,592.20	146,370.70	8,329–603,238
<Median	125	64,184.96	34,092.80	8,329–140,805
≥ Median	125	308,999.40	107,937.50	143,568–603,238
Sex ratio	250	98.44	5.28	85–115
<Median	141	95.04	4.00	85–99
≥ Median	109	102.84	2.95	100–115
Over 65 rate (%)	250	14.13	8.26	3.46–33.76
<Median	125	7.42	1.66	3.46–10.85
≥ Median	125	20.83	6.60	10.912–33.76
Smoking rate (%)	249	48.28	5.87	30–60.8
<Median	125	43.78	4.60	30–49.1
≥ Median	124	52.82	2.61	49.2–60.8

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Table 1

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	n	*Mean*	*SD*	*Range (Low–High)*
Heavy drinkers (%)	249	45.79	7.68	22.6–78.6
<Median	125	39.95	4.43	22.6–45.6
≥ Median	124	51.68	5.44	45.7–78.6
Obesity rate(%)	249	21.78	3.19	14.3–34.6
<Median	125	19.39	1.83	14.3–21.7
≥ Median	124	24.34	2.21	21.9–34.6
Exercise rate(%)	249	51.40	13.62	13.1–88.7
<Median	125	40.51	7.50	13.1–50.5
≥ Median	124	62.37	8.69	50.6–88.7
Increased stress level(%)	249	27.55	5.83	9.7–43.3
<Median	125	22.99	4.06	9.7–28.2
≥ Median	124	32.14	3.10	28.3–43.3
Seat belt use(%)	249	85.03	9.43	49.2–98.2
<Median	125	78.38	8.74	49.2–87.7
≥ Median	124	91.95	2.85	87.8–98.2
Hypertension prevalence per 1,000	249	129.21	10.38	81.7–180.8
<Median	125	114.16	11.57	81.7–129
≥ Median	124	144.63	18.79	129.1–180.8
Diabetes prevalence per 1,000	249	47.75	9.30	24.6–84.7
<Median	125	40.36	5.25	24.6–47.9
≥ Median	124	55.19	5.92	48–84.7

rates. Socioeconomic variables (such as high local tax rate per person and high education) and exercise rate were negatively associated with all-cause mortality. The number of total hospital beds per 10,000 persons and higher smoking rates were also associated with higher cardiovascular mortality. Districts with higher socioeconomic levels, exercise, and greater use of seat belts were negatively associated with accident mortality.

Controlling for other covariates in Model 2, in which primary care physicians per 10,000 persons and the ratio of primary care physicians to specialists were added as independent variables, revealed that the increased number of primary care physicians was associated with lower average of all-cause mortality, cancer mortality, and cardiovascular mortality. On the other hand, accident mortality, suicide mortality, infection mortality, and perinatal mortality had no significant relationship with the supply of primary care physicians. In both models, the ratio of primary care physicians to specialists was not related to any cause of mortality.

In terms of the association between independent variables other than the supply of primary care physicians and health outcomes, the results of Model 1 are comparable to Model 2. The coefficient of determination (R-squared) was higher in Model 2 than in Model 1. The range of R-squared in Model 2 for all categories of mortality was from 0.09 to 0.63.

Figure 1 shows the estimated adjusted means of all cause-mortality, cancer mortality, and cardiovascular mortality in each tertile group of the supply of primary care physicians. It shows that the adjusted means of all-cause mortality, cancer mortality, and cardiovascular mortality are negatively associated with the supply of primary care physicians.

Discussion

In this study, we explored the associations between the supply of primary care physicians and population health outcomes in Korea. The most important finding of this study was that a greater number of primary care physicians per 10,000 persons was associated with lower all-cause mortality, cancer mortality, and cardiovascular mortality. The work of Shi et al[16] suggested similar results in urban areas in the United States. In

Table 2

Multivariate Relationships of Health Outcomes With the Number of Primary Care Physicians Per 10,000 Population, Socioeconomic Variables, and Health Behavioral Factors

Predictor	*All-cause Mortality*		*Cancer Mortality*		*Cardiovascular Mortality*	
	Model 1	*Model 2*	*Model 1*	*Model 2*	*Model 1*	*Model 2*
	β *(SD)*	β *(SD)*	β *(SD)*	β *(SD)*	β *(SD)*	β *(SD)*
Primary care physicians per 10,000						
Lower tertile		0.00		0.00		0.00
Middle tertile		-14.07 (8.80)		-5.87 (2.55)*		-5.73 (3.60)
Upper tertile		-28.97 (10.33)**		-6.98 (2.96)*		-10.70 (4.18)*
Total beds						
<Median	0.00	0.00	0.00	0.00	0.00	0.00
≥ Median	15.10 (6.68)*	22.40 (7.10)**	2.52 (1.92)	4.29 (2.05)	6.71 (2.71)*	8.85 (2.90)**
Unemployment rate						
<Median	0.00	0.00	0.00	0.00	0.00	0.00
≥ Median	-5.43 (6.54)	-3.90 (6.96)**	-0.30 (1.88)	0.11 (1.87)	1.26 (2.65)	1.86 (2.64)
Local tax per person (1,000 won)						
<Median	0.00	0.00	0.00	0.00	0.00	0.00
≥ Median	-22.63 (7.00)**	23.34 (6.96)**	-3.34 (2.01)	-3.35 (2.01)	-3.97 (2.84)	-4.43 (2.84)
Education beyond high school						
<Median	0.00	0.00	0.00	0.00	0.00	0.00
≥ Median	-29.61 (12.48)*	-25.05 (12.45)*	4.06 (3.55)	4.42 (3.56)	3.60 (5.01)	4.34 (5.03)
Population size						
<Median	0.00	0.00	0.00	0.00	0.00	0.00
≥ Median	-23.88 (10.91)*	-25.60 (11.07)*	3.19 (3.08)	2.75 (3.17)	3.45 (4.35)	1.80 (4.47)
Over 65 age rate (%)						
<Median	0.00	0.00	0.00	0.00	0.00	0.00
≥ Median	12.42 (14.29)	16.51 (14.18)	10.78 (4.11)**	11.78 (4.10)**	1.80 (5.79)	3.41 (5.78)
Smoking rate						
<Median	0.00	0.00	0.00	0.00	0.00	0.00
≥ Median	23.30 (6.86)**	20.84 (6.90)**	2.80 (1.97)	2.02 (1.99)	10.70 (2.78)***	9.58 (2.80)**
Exercise rate						
<Median	0.00	0.00	0.00	0.00	0.00	0.00
≥ Median	-16.76 (6.51)*	-14.28 (6.48)*	-0.30 (1.87)	0.12 (1.87)	-3.64 (2.64)	-2.82 (2.65)
R-square	0.47	0.49	0.11	0.14	0.16	0.19
Prob>F	0.00	0.00	0.03	0.01	0.00	0.00

* Adjusted by the ratio of primary care physicians to specialists, marriage status, sex ratio, alcohol, obesity, stress level, and seat belt use. (They were not significant.)

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addition, higher socioeconomic level was also associated with lower all-cause mortality, cancer mortality, and cardiovascular mortality. The similar negative association between income inequality and cardiovascular mortality was reported in Korea by Kim et al.[17] The ratio of primary care physicians to specialists was not related to population health outcomes in our study.

This study analyzed not only all-cause mortality, cancer mortality, and cardiovascular mortality but also many other causes of mortality. Each mortality category was age-standardized mortality. It is not clear how the supply of primary care providers affects cancer mortality or cardiovascular mortality. Primary care physicians may affect mortality rates by increasing primary prevention through improved health behaviors or by increasing secondary prevention through early detection of diseases. However, we observed that primary care physicians in Korea spend more time caring for those with chronic diseases and cancer than the prevention of accidents. The supply of primary care physicians had no relationship with perinatal mortality. High-risk pregnant women may tend to visit tertiary hospitals rather than primary care physicians, but information about the discipline of the provider of prenatal and perinatal care is not available in the databases.

Table 2

(continued)

	Accident Mortality		***Suicide Mortality***		***Infection Mortality***		***Perinatal Mortality***	
	Model 1	*Model 2*	*Model 1*	*Model 2*	*Model 1*	*Model 2*	*Model 1*	*Model 2*
Primary physicians per 10,000	β *(SD)*	β *(SD)*	β *(SD)*	β *(SD)*	β *(SD)*	β *(SD)*	β *(SD)*	β *(SD)*
Lower tertile		0.00		0.00		0.00		0.00
Middle tertile		-2.83 (2.63)		0.10 (0.19)		-0.64 (0.72)		0.00 (0.08)
Upper tertile		-1.93 (3.09)		0.23 (0.22)		-0.47 (0.83)		0.04 (0.09)
Local tax per person								
<Median	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
≥ Median	-4.62 (2.07)*	-4.22 (2.08)*	-0.04 (0.15)	-0.02 (0.15)	-0.33 (0.56)	-0.30 (0.57)	0.16 (0.06)*	0.16 (0.06)*
Education beyond high school								
<Median	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
≥ Median	-11.98 (3.69)**	-11.26 (3.72)**	0.11 (0.26)	0.13 (0.26)	0.09 (0.99)	0.10 (1.00)	-0.05 (0.11)	-0.08 (0.11)
Population size								
<Median	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
≥ Median	-6.90 (3.23)*	-5.72 (3.31)	-0.12 (0.22)	-0.03 (0.23)	0.44 (0.86)	0.47 (0.89)	0.06 (0.10)	0.04 (0.10)
Over 65 age rate (%)								
<Median	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
≥ Median	10.21 (4.23)*	10.21 (4.24)*	0.48 (0.30)	0.43 (0.30)	1.72 (1.14)	1.78 (1.15)	0.02 (0.13)	0.02 (0.13)
Exercise rate								
<Median	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
≥ Median	-5.57 (1.93)**	-5.40 (1.94)**	0.14 (0.14)	0.12 (0.14)	0.75 (0.52))	0.77 (0.53)	0.03 (0.06)	0.02 (0.06)
Increased stress level								
<Median	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
≥ Median	2.61 (1.97)	-1.98 (1.99)	0.04 (0.14)	0.04 (0.14)	-1.39 (0.53)*	-1.33 (0.54)*	-0.10 (0.06)	-0.11 (0.06)
Seat belt use								
<Median	0.00	0.00						
≥ Median	4.97 (2.12)*	-4.80 (2.14)*						
R-square	0.62	0.63	0.13	0.14	0.10	0.10	0.08	0.09
Prob>F	0.00	0.00	0.01	0.02	0.06	0.14	0.19	0.22

* $P<.05$, ** $P<.01$

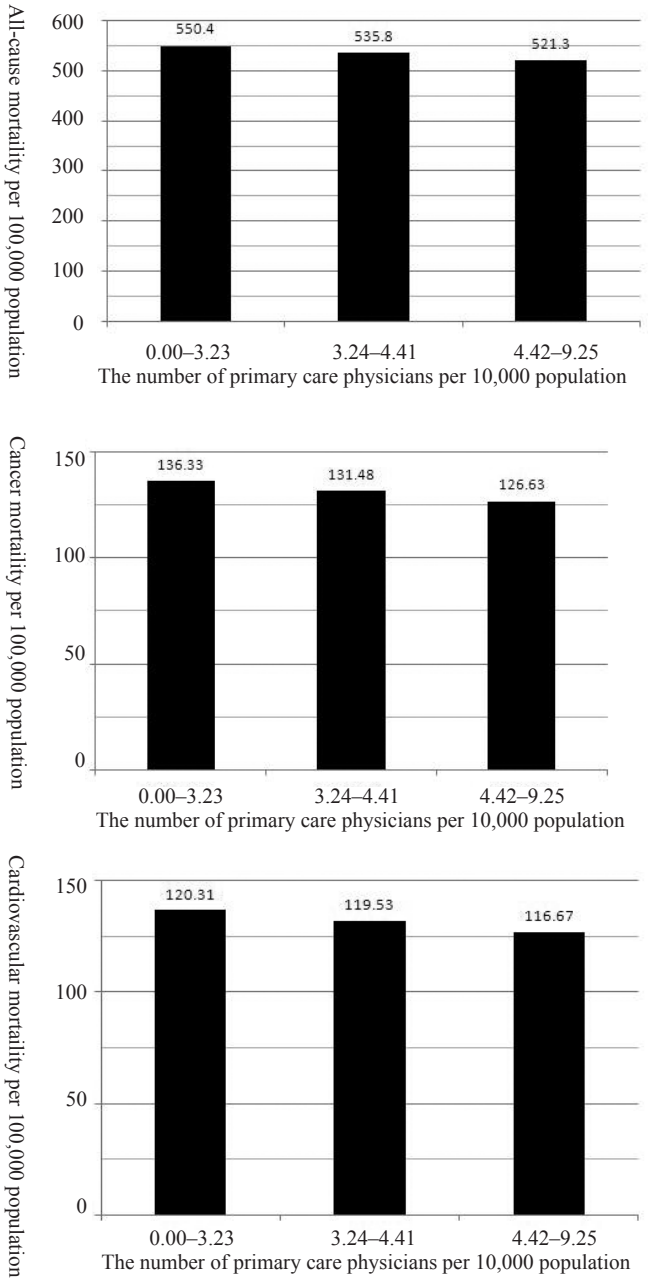
** Adjusted by the ratio of primary care physicians to specialists. Total bed per 10,000 population, unemployment rate, marriage status, sex ratio, smoking, alsohol, and obesity. (They were not significant.)

Among health behavioral factors, districts with higher smoking rates had significantly higher all-cause mortality and cardiovascular risk. The associations between cancer, cardiovascular diseases, and smoking have been well established in other studies. On the other hand, drinking rates were not associated with any health outcomes in our study. This might be explained by the Korean culture around drinking. A heavy drinker is defined in the medical literature as a man drinking more than 57 grams of ethanol per day (40 grams in women). In Korea, social drinking is common, and a previous study by Song et al[18] reported that there was no significant difference in drinking habits (heavy drinking) among different socioeconomic groups.

Accident mortality was negatively associated with the rates of exercise and seatbelt use. These results suggest that encouraging exercise and seatbelt use is important to prevent accidental deaths, and all physicians should be encouraged to emphasize these strategies in preventive counseling. Although we found that the supply of primary care physicians affected health outcomes, other variables such as the socioeconomic factors and population characteristics seem to have a more significant influence on population health outcomes in Korea.

Figure 1

The Adjusted Means of All-cause Mortality, Cancer Mortality, and Cadiovascular Mortality in Each Group of the Supply of Primary Care Physicians



Limitations

Some study limitations warrant mention. We chose to study mortality rate as the indicator of health outcomes. If primary care improves the quality of life or other health behaviors, our results may underestimate a beneficial effect of primary care. In addition, due to the structure of the Korean (private sector oriented) medical delivery system, many specialists likely play the role of primary care physician in their clinics. As a result, an accurate measure of primary care physicians is challenging in Korea.

Because the size of districts varies, the size of medical markets for primary care services can be different in each district. Ricketts et al[19] used geographically weighted regression to overcome this problem. However, our study did not use geographically weighted regression; we only adjusted for population size. Within districts, the relationship between the supply of primary care providers and mortality rates may vary regionally due to local practice patterns and the different pattern of primary care utilization across districts.

Conclusions

The results of this study strongly suggest that increased access to primary care providers contributes to better health outcomes of the population. The role of government is crucial in strengthening primary care access by establishing an efficient financing mechanism for primary care and organizing a primary care-centered health delivery system. Further study is required to examine the effect of primary care physicians on other population health outcomes, not only on mortality but also the incidence and prevalence of diseases. More studies are also needed to examine the effect of primary care providers on health behavior of the population that affects health outcomes.

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