Association of Residential Segregation and Disability: A Multilevel Study Using Iranian Census Data

Seyed Saeed Hashemi Nazari, Mahmood Mahmoodi,
Mohammad-Ali Mansournia, and Kourosh Holakouie Naieni

ABSTRACT *The association of racial segregation and health outcomes has been reviewed recently in the literature, but the health effect of other contexts of segregation with respect to residential environment has not as yet been fully reviewed. Besides, most of the literature on segregation has been performed in Western countries. Here, we undertake a multilevel analysis of residential segregation of socioeconomic and demographic factors and disability rate in an Eastern developing country in order to elucidate the effects of this aspect of segregation on disability rate. The latest Iranian national census in 2006 was used to measure segregation indices and perform the analysis. Information theory index and its ordinal form were applied to measure evenness dimension of segregation of categorical and ordinal variables, respectively. Segregation of contextual and structural characteristics of residential environment, which are important determinants of socioeconomic status in Iran, had different relations with disability rate. Provinces which were segregated by type of occupation of residents, sex, and ownership of a motorcycle had a lower individual disability rate, while age segregation and house ownership had a positive effect on the rate of individual disability in the province. The findings also showed that almost all the aforementioned segregation indices had the same effect on the rate of family disability. The unique contribution of this study is that it considers how segregation with respect to aspects of social characteristics other than race affects health outcomes. Further studies in this regard may reveal new insights into health outcome inequalities.*

KEYWORDS *Residential segregation, Disability, Information theory segregation index, Multilevel modeling*

INTRODUCTION

One of the most interesting topics in the fields of epidemiology and social science is the relation between patterns of health outcomes and residential environment.^{1,2} During the past decade, researchers have shown interest in how contextual factors influence health. Measures of segregation are remarkable tools for the analysis of social inequality. These indices describe complex structural patterns by just one

Hashemi Nazari, Mahmoodi, Mansournia, and Holakouie Naieni are with the Tehran University of Medical Sciences, School of Public Health, Tehran, Iran.

Correspondence: Seyed Saeed Hashemi Nazari, Tehran University of Medical Sciences, School of Public Health, Tehran, Iran. (E-mail: saeedh_1999@yahoo.com)

quantity. The indices are mostly used to measure the amount of disparity in the distribution of different racial groups over different residential neighborhoods.³

Residential segregation refers to the differential distribution of groups across a geographical location. It measures the degree to which diverse individuals reside in different neighborhoods. It is commonly believed that residential segregation affects individuals' choices and their economic, educational, and occupational opportunities by restricting access to facilities within neighborhoods. Furthermore, it serves to accumulate poverty in disadvantaged areas and contribute to social exclusion and isolation. It also affects intergroup connections in society.⁴

Many papers have explored the effects of living in more segregated communities on health disparities and the links between residential segregation and health outcomes, including the relation between racial residential segregation and overall death,^{5,6} tuberculosis,⁷ cardiovascular diseases,⁸ high body mass index,⁹ pre-term birth in black populations,¹⁰ and also social outcomes such as early adolescent sexual activity,^{11,12} black homicide rates,^{13,14} poor self-rated health,^{9,15} access to employment, educational inequalities, crime, and other aspects of social and economical well-being.¹⁶ So far, our literature review has shown that the relation between segregation and disability has not yet been investigated.

According to the WHO, approximately 650 million people live with disabilities of various types, and the number is increasing due to the rise of chronic disease, injuries, road traffic accidents, falls, violence, and other causes such as aging. Of this total, 80 % live in developing countries.¹⁷ Reported prevalence rates of disability vary dramatically across the world. For example, the rate varies from under 1 % in Kenya and Bangladesh to 20 % in New Zealand because of variants in disability definition and methods of data collection.¹⁸

Previous work on segregation is limited in several ways. Firstly, so far, literature on the effects of segregation on health has mostly considered the effect of racial segregation. The health effect of other contexts of segregation, with respect to residential environment, has not been reviewed. A second limitation concerns the methods used for measuring segregation. Most papers on segregation have used two-group indices of segregation. These indices are not appropriate for multigroup nominal or ordinal variables.

Thirdly, the majority of segregation research has focused on Western countries, and little work has been done on Eastern developing countries. In Iran, this article is the first in the field of segregation.

In light of the aforementioned limitations to the existing literature in this study, with the help of recent advances in measuring multigroup segregation indices, we intend to respond to the following question in the context of an Eastern developing country. Could residential segregation of socioeconomic and demographic factors explain differences in the prevalence of disability, adjusted for individual factors, between provinces of Iran?

MATERIAL AND METHODS

Database

The general population and housing census is one of the largest data-gathering projects in Iran, and it is undertaken every 10 years. A variety of information regarding demographic and socioeconomic factors is gathered through this process. A special feature of the recent census in 2006 was that in addition to standard census questions, some questions specific to health outcomes were added. Some of these questions were related to the existence of disability in individuals and families.

The census data were presented as two large, stratified random sample databases from the Iranian National Statistic Center. One sample database contained individual data and the other contained family data. Variables relating to individuals were to be found in the individual database, and variables relating to families were found in the family database. Since some of the key demographic variables in the individual database were completed only for persons over 10 years old, we limited the analysis in the individual dataset to the population of those over 10 years of age.

Variables

The specific variables in the individual database, predicting socioeconomic status, which were used for the analysis are as follows: age (as a continuous variable which was centered to mean in the analysis); sex; nationality (Iranian versus non Iranian); migration (whether the person has immigrated from another place to their current location in the previous 10 years); level of education (illiterate, primary school, guidance school, high school, university degree), for which four dummy variables were created; occupation (unemployed, employed in a fixed job or worked at least 1 h in the previous week, student, homemaker, income from other sources, other), for which five dummy variables were created; marital status (unmarried, married, widowed or divorced), for which two dummy variables were created; and existence of disability.

On the premise that wealthier families are more likely to own a given set of assets and characteristics, our work, like the work of Hosseinpour et al.¹⁹ measuring socioeconomic inequality in the field of infant mortality in Iran, also used the following variables which existed in a separate family database: number of family members (in six ordered categories containing one, two, three, four, five, six, and more individuals, which was centered to median in the analysis); percentage of literate individuals within a family; percentage of individuals with employment in a family; percentage of family members who are students; ownership of a car in the family; access to the Internet by family; accommodation size (<50, 51–75, 76–80, 81–100, 101–150, 151–200, and more than 200 m); numbers of rooms per capita in the home; existence of a separate kitchen in the home; use of natural gas for cooking and heating; house ownership; ownership of a motorcycle; existence of a separate bathroom in the house; effluent disposal system; and the existence of at least one disabled individual in the family. The data on these factors were extracted from more than 334,000 families and more than 1,100,000 individuals.

Segregation Indices

Residential segregation relates to the uneven distribution of subgroups of a particular characteristic (e.g., racial subgroups, educational subgroups) across a region, perceived in terms of the degree to which various groups of individuals (e.g., those belonging to different educational levels) reside in different neighborhoods within a region. The term segregation does not apply to the individual neighborhood but describes the larger region.²⁰

Massey and Denton, in 1988, through a systematic analysis on 19 segregation indices which were identified from the review literature, argued that segregation is not a unidirectional construct, but has five distinct dimensions: evenness, exposure, clustering, centralization, and concentration.²¹

In this paper, to measure residential segregation, we used the information theory index which measures evenness dimension of segregation. Most work on segregation measurement has been limited to measuring segregation between two population

groups (e.g., literate and illiterate). In 2002, Reardon and Firebaugh²² introduced multigroup measures of segregation. For binary and multigroup nominal categorical variables, we used their work for measuring multigroup segregation. But these indices are not appropriate when the categories of the variables are ordinal. Hence, to study residential segregation among groups defined by educational attainment, housing area, and other ordinal variables using the work of Reardon,²³ we applied the ordinal information theory index.

According to Reardon et al.,²⁴ information theory index is superior to other indices of multigroup segregation. It is the only index that satisfies “the principle of transfer” and also has “additive group decomposability” and “additive organizational decomposability.”²⁵ This index is one of the most widely used segregation indices after the dissimilarity index.²⁶

Information theory index measures variation in diversity across subareas (municipality zones), and diversity of the population is defined as the entropy (E) of the population.

$$E = \sum_{m=1}^M \pi_m \ln \frac{1}{\pi_m}$$

M defines the levels of the variable for which segregation is measured, such as education levels or age groups. The information theory index is defined as

$$H = \sum_{r \in R} \frac{t_r(E - E_r)}{TE}$$

where E_r is the entropy of municipality space r , t is the population of municipality space r , and T is the population of province.²⁵ Ordinal information theory index measures the extent to which ordered groups of variables (such as ordered levels of educational attainment) are evenly distributed across neighborhoods (municipality zones).²³

Segregation indices were measured for every province among the “municipal spaces” of each province. In 2006, the Islamic Republic of Iran was composed of 30 provinces and 1,012 cities. Among the 1,012 cities, major cities such as Tehran, with a population of more than 7.5 million (more than 10 % of the country), were included. Because of the size of its population, it would have been absurd and analytically useless to consider all of its residents in one unit of analysis; hence, in a way similar to the work of Ethington²⁷ on Los Angeles city, we divided each major city into municipal districts and considered these as units of analysis. In total, there were 1,135 municipal zones in the country. These municipal zones were standard census units in the Iranian national census of 2006.

Contextual Variables

The contextual variables in the model were the segregation indices which were computed for variables, which are defined in Table 1.

Outcome Definition

Any person with at least one of the following problems was considered a disabled person: blindness, deafness, speech disorders, amputation at any level of an upper or lower limb, any physical or functional disorder in an upper limb, lower limb, or torso, and any mental disorder. This definition was the standard definition for

TABLE 1 Description of contextual variables (segregation indices)

Segregation index	Description	Mean (SD)	Min–Max
Age ^{a,b}	Categorical variable with three age groups: under 15 years, 15–65 years, over 65 years	6.22 (1.65)	2.44–10.23
Sex ^{a,b}	Binary variable	0.10 (0.08)	0.03–0.48
Education ^{c,b}	Ordinal variable with five ordered categories	2.64 (1.31)	0.57–6.96
Immigration ^{a,b}	Binary variable	14.50 (5.47)	6.73–32.69
Occupation ^{a,b}	Categorical variable with six nominal categories	4.50 (1.36)	1.93–7.98
Marital status ^{a,b}	Categorical variable with three nominal categories	4.63 (1.11)	2.61–7.70
Number of family members ^{c,d}	Ordinal variable with six ordered categories	2.09 (0.89)	0.82–4.33
Percentage of family members in employment ^{c,d}	Ordinal variable with four ordered categories	1.33 (0.66)	0.23–3.84
Percentage of literacy among family members ^{c,d}	Ordinal variable with three ordered categories (none, at least one literate, all literate)	3.21 (1.15)	1.13–5.09
Number of rooms per capita ^{a,d}	Binary variable	15.05 (4.28)	8.57–25.86
Existence of vehicle in family ^{a,d}	Binary variable	17.04 (4.66)	8.85–26.62
Access to Internet by family ^{a,d}	Binary variable	4.43 (2.34)	0.87–11.29
Household size ^{c,d}	Ordinal variable with seven ordered categories	3.37 (2.01)	1.28–10.96
Effluent disposal system ^{a,d}	Binary variable	54.08 (16.85)	29.36–90.47
Existence of bathroom in house ^{a,d}	Binary variable	23.00 (7.44)	11.62–42.79
House ownership ^{a,d}	Binary variable	13.47 (5.49)	5.47–28.99
Ownership of a motorcycle ^{a,d}	Binary variable	28.53 (7.92)	8.78–41.02
Use of natural gas for heating and cooking ^{a,d}	Binary variable	50.61 (19.03)	9.81–78.21
Separate kitchen ^{a,d}	Binary variable	42.13 (12.75)	12.60–62.68

^aInformation theory index^bIndividual dataset^cOrdinal information theory index^dFamily dataset

disability according to the technical guideline of the census and accords to the medical definition of disability.²⁸

The first outcome of interest was the existence of disability in the individual; the second outcome of interest was the existence of disability in the family.

Modeling

We used a two-level logistic model to account for the clustering of individuals within geographical units (provinces) while allowing for the estimation of effect of contextual factors after controlling for individual covariates. Bryk and Raudenbush²⁹ claim that although any number of levels could be represented, the essential statistical features are found in this basic two-level model. Analyses were performed with STATA version 11.

Goal 1 To assess whether disability varies across provinces

The gross variance in disability associated with the provinces was initially estimated with a random intercept model (model 1), which was equipped without any covariates and contained only an intercept and error term. This model provided a basis for decomposing the total variance in disability into the sum of individual-level and contextual-level variances.

$$\text{Ln} \left[\frac{\pi_j}{1 - \pi_j} \right] = \beta_0 + u_{0j} \sim N(0, 1) \quad (1)$$

Goal 2 To evaluate the relationship between level 1 variables (individual and family variables) and the existence of disability in an individual or family, respectively

We added explanatory level 1 variables to model 1 to estimate the net effect of these variables (X_{mij}) on the outcome of interest (model 2). The slope of these level 1 variables was considered fixed, as opposed to random, because we did not assume a priori that the effect of these variables on disability varied among provinces.

$$\text{Ln} \left[\frac{\pi_{ij}}{1 - \pi_{ij}} \right] = \beta_0 + \sum_m \beta_m X_{mij} + u_{0j} \quad u_{0j} \sim N(0, 1) \quad (2)$$

where π_{ij} is the probability of the dependent variable, existence of disability in individual or family i in province j , and u_{0j} is the group effect or level 2 residual

Goal 3 To determine whether contextual explanatory variables (segregation indices) account for variation in disability across provinces

Model 2 was expanded by adding segregation indices (S_{nj}) to determine whether they account for the variation in disability among provinces (model 3).

$$\text{Ln} \left[\frac{\pi_{ij}}{1 - \pi_{ij}} \right] = \beta_0 + \sum_m \beta_m X_{mij} + \sum_n \beta_n S_{nj} + u_{0j} \quad u_{0j} \sim N(0, 1) \quad (3)$$

As shown by the subscript j , S_{nj} is measured at level 2 (province level) and varies across provinces, but X_{mij} is measured at level 1 and varies across individuals or families which are nested in provinces.

Descriptive statistics for the outcome were calculated with the SVY procedure and multilevel modeling with XTMELOGIT procedure in the Stata software package. The default method used by xtmeologit is adaptive Gaussian quadrature with seven quadrature points per level.³⁰

RESULTS

According to the 2006 national census, the Iranian population above 10 years of age was 58,421,420. The country has 30 provinces and there are 1,135 municipal zones within these provinces, as defined by the Iranian National Center for Statistic. The prevalence of disability of those aged 10 years and over in the population was

1.75 % (1.61–1.89). Nationwide, 5.54 % (5.07–6.05) of families had at least one disabled person. A summary of segregation indices, which are measured for the contextual variables, are provided in Table 1.

Association of Individual Disability and Segregation Indices

The analytic sample size contained more than 1,100,000 individuals over 10 years of age. The prevalence of individual disability in different provinces of the country is depicted in Figure 1. In 15 of the provinces, the rate of individual disability was lower than the national average rate; in four provinces, it was higher than the average.

The log-odds of disability in an average province (with $u_{0j}=0$) was estimated as $B_0=-4.045$ (odds=0.017). The intercept for province (j) was equal to $-4.045+u_{0j}$, where the variance of u_{0j} was estimated as: $\sigma^2_{u_j} = 0.21$.

The likelihood ratio statistic for testing the null hypothesis that $\sigma^2_{u_j}=0$ was 363.7 ($p=0.0000$). The results of models 2 and 3 are presented in Table 2. The likelihood ratio test of comparing model 2 to model 1 was significant. Female sex, higher education level, history of migration, and marital status had a negative relation with disability. As the level of education increases, the probability of disability decreases. The odds of disability in illiterate persons were 10.2 (9.33–11.34) times those with

FIGURE 1. Prevalence of individual disability in Iranian provinces according to 2006 Iranian census data.

TABLE 2 Regression of disability in individuals on individual factors and segregation indices

		Model 2: OR (95% CI) ^a	Model 3: OR (95% CI) ^a
Individual: Level 1 covariates	Age (10-year increments)	1.06(1.04–1.07)***	1.06(1.04–1.07)***
	Sex (Male=0)	0.47(0.45–0.49)***	0.47(0.45–0.49)***
	Nationality (Iranian=0)	0.31(0.26–0.36)*	0.31(0.26–0.36)*
	Migration (No=0)	0.94(0.89–0.99)***	0.94(0.89–0.99)***
	Marital status		
	Single	1	1
	Married	0.27(0.25–0.29)***	0.27(0.25–0.29)***
	Widowed or divorced	0.26(0.24–0.27)***	0.26(0.24–0.27)***
	Education level		
	Illiterate	1	1
	Primary school	0.33(0.32–0.35)***	0.33(0.32–0.35)***
	Guidance school	0.18(0.17–0.19)***	0.18(0.17–0.19)***
	High school	0.10(0.10–0.11)***	0.10(0.10–0.11)***
	University degree	0.10(0.09–0.11)***	0.10(0.09–0.11)***
	Occupation		
	Unemployed	1	1
	Work >1 h in week	0.46 (0.43–0.50)***	0.46 (0.43–0.50)***
	Student	0.90 (0.82–0.98)*	0.89 (0.82–0.97)*
	Homemaker	3.03 (2.80–3.28)***	3.03 (2.80–3.28)***
	Income from other means	4.06 (3.78–4.35)***	4.06 (3.78–4.35)***
	Other	0.78 (0.73–0.84)***	0.78 (0.73–0.84)***
Segregation indices: Level 2 covariates	Age		1.29 (1.04–1.59)*
	Sex		0.84 (0.75–0.93)***
	Education		1.07 (0.78–1.47)
	Migration		1.06 (0.96–1.17)
	Occupation		0.64 (0.50–0.80)***
	Marital status		0.91 (0.68–1.21)
	No. of family members		1.18 (0.85–1.64)
	Percentage of family members in employment		0.85 (0.73–1.00)
	Percentage of literacy among family members		1.04 (0.74–1.48)
	No. of rooms per capita		0.88 (0.74–1.04)
	Existence of vehicle in family		0.97 (0.76–1.23)
	Existence of Internet in family		1.10 (0.87–1.38)
	Household size		0.77 (0.66–0.89)***
	Effluent disposal system		0.92 (0.85–1.00)*
	Existence of bathroom in house		0.89 (0.81–0.99)*
	House ownership		1.21 (1.02–1.44)*
	Ownership of a motorcycle		0.83 (0.73–0.94)**
	Use of natural gas for heating		1.19 (1.06–1.34)**
	Existence of separate kitchen		1.34 (1.18–1.52) **
Intercept	_Const	0.14 (0.13–0.16)***	0.20 (0.16–0.25)***
Variance	Level 2 variance	0.042	0.0059
Likelihood ratio test	Compared to previous model	$p > \chi^2 (15)^b$: 0.000	$p > \chi^2 (19)^b$: 0.0001

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$ ^aFor segregation indices, odds ratio was calculated for one standard deviation increment in segregation index^bDegree of freedom

university degrees. Disability was more prevalent in singles than in married couples, widows, or divorced individuals. Different occupations were related differently to disability. Individuals who were employed tended to have a lower probability of suffering from a disability compared to those unemployed, but homemakers and those who had sources of income other than employment tended to have a higher probability of suffering at least one disability compared to those unemployed. Age had a positive effect on disability. Level 2 variance of model 2 increased when compared with level 1, indicating that controlling for individual covariates increased the proportion of variance between provinces.

In model 3, the segregation indices were added to model 2. The likelihood ratio test of comparing model 3 to model 2 was significant. As shown in Table 2, the coefficient of individual covariates has not changed much. Among the segregation indices, the coefficients of segregation measured for sex, occupation, accommodation size, effluent disposal system, ownership of a motorcycle, age, house ownership, use of natural gas for cooking and heating, and existence of a separate kitchen in the house were associated with the existence of disability. The first five had negative effects and the remaining four indices had a positive effect on disability. Level 2 variance in model 3 is much smaller than in model 2, indicating that segregation indices account for some variation among provinces with respect to disability prevalence.

Association of Existence of Disability in Family and Segregation Indices

The analytic sample size contained 336,419 families. The prevalence of existence of disability in families in different provinces of the country is depicted in Figure 2. In 12 provinces, the rate of family disability was lower than the national average; in eight provinces, it was higher than the average.

The log-odds of families with at least one disability in an average province (with $u_{0j}=0$) was estimated as $B_0=-2.81$ (odds=0.06). The intercept for province (j) was equal to $-2.81+u_{0j}$, where the variance of u_{0j} was estimated as: $\sigma_{u_{0j}}^2=0.022$.

The likelihood ratio statistic for testing the null hypothesis that $\sigma_{u_{0j}}^2=0$ was 424 ($p=0.0000$). The results of models 2 and 3 are presented in Table 3. The likelihood ratio test when comparing model 2 to model 1 was significant. Almost all family characteristics, except family size, decreased the rate of disability. The odds ratio of the existence of disability in families for a one person increase in the number of individuals living in a family is 1.43 (1.41–1.45). As the percentage of employment, literacy, and students in a family increases, the odds of disability decreases. The odds of disability in families who have a private vehicle, motorcycle, access to the Internet, and a larger house is lower than that of other families. Owning a house which has a separate kitchen, separate bathroom and an effluent disposal system, and is connected to the public natural gas network also decreases the odds of disability in the family.

The likelihood ratio test when comparing model 2 to model 3 was significant. The coefficient of individual covariates has not changed much in model 3. Among the segregation indices, the coefficients of segregation measured for sex, occupation, percentage of family members in employment, household size, existence of bathroom in the house, house ownership, access to public network, natural gas for cooking and heating, and existence of a separate kitchen in the house were associated with the existence of disability. The first five segregation indices had a negative effect and the remaining three indices had a positive effect on disability.

FIGURE 2. Prevalence of family disability in Iranian provinces according to 2006 Iranian census data.

Level 2 variance in model 3 is much smaller than in model 2, indicating that segregation indices account for some variation between provinces with respect to disability prevalence.

DISCUSSION

Iran is a relatively large country in the Middle Eastern Region of Southwest Asia. Its current population is approximately 75 million, of which approximately 60 % live in urban areas and the remainder in rural areas. Different accounts of the number of disabled people in this country have been reported, most based on estimates from other countries rather than on confirmed studies. The most reliable study in this respect in Iran is the data gathered through the 2006 national census, in which the number of people with disability was 1,332,402.

There are several ways of defining disability. The most widely used is the medical definition indicating a disability as a physical, mental, or psychological condition that limits a person's activities.³¹ There is also a social definition of disability which has recently replaced the medical definition. According to this definition, disability is the outcome of the interaction of a person with its environment and thus is neither person- nor environment-specific.¹⁸ In the Iranian national census, disability was measured according to the medical model.

TABLE 3 Regression of existence of disability in families on family characteristics and segregation indices

		Model 2: OR (95% CI) ^a	Model 3: OR (95% CI) ^a
Family: Level 1 covariates	No. of family members	1.43(1.41–1.45)***	1.43(1.41–1.45)***
	Percentage of literacy among family members	0.27(0.25–0.29)***	0.27(0.25–0.29)***
	Percentage of students	0.37(0.33–0.41)***	0.37(0.33–0.41)***
	Percentage of family members in employment	0.26(0.23–0.28)***	0.26(0.23–0.28)***
	No. of rooms per capita	1.01(0.98–1.05)	1.01(0.98–1.04)
	Existence of vehicle	0.71(0.68–0.74)***	0.71(0.68–0.74)***
	Access to Internet	0.84(0.78–0.90)***	0.84(0.77–0.90)***
	Household size	0.98(0.97–0.99)***	0.98(0.97–0.99)***
	Existence of separate kitchen	0.87(0.83–0.92)***	0.87(0.83–0.92)***
	Use of natural gas for heating and cooking	0.93(0.90–0.97)***	0.93(0.90–0.97)***
	Ownership of a motorcycle	0.79(0.77–0.82)***	0.79(0.76–0.82)***
	House ownership	0.76(0.73–0.79)***	0.76(0.73–0.79)***
	Existence of bathroom in house	0.91(0.87–0.95)***	0.91(0.87–0.95)***
	Effluent disposal system	1.03(1.00–1.05)*	1.03(1.00–1.05)*
Segregation indices: Level 2 covariates	Age		1.18(0.95–1.47)
	Sex		0.86(0.77–0.97)**
	Education		1.17(0.84–1.63)
	Migration		1.03(0.93–1.15)
	Occupation		0.66(0.52–0.84)**
	Marital status		1.04(0.77–1.40)
	No. of family members		1.13(0.80–1.58)
	Percentage of family members in employment		0.84(0.71–0.99)*
	Percentage of literacy among family members		0.94(0.65–1.35)
	No. of rooms per capita		0.92(0.77–1.10)
	Existence of vehicle in family		0.94(0.73–1.21)
	Existence of Internet in family		1.12(0.88–1.42)
	Household size		0.78(0.67–0.90)***
	Effluent disposal system		0.92(0.85–1.00)
	Existence of bathroom in house		0.88(0.79–0.99)*
	House ownership		1.24(1.04–1.49)*
	Ownership of a motorcycle		0.88(0.77–1.00)
	Use of natural gas for heating		1.15(1.02–1.30)*
Intercept	Existence of separate kitchen		1.38(1.20–1.57)***
	_Const		0.44(0.36–0.55)***
Variance	Level-2 variance	0.045	0.006
Likelihood ratio test	Compared to previous model	$p > \chi^2 (14)^b: 0.000$	$p > \chi^2 (19)^b: 0.000$

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$ ^aFor segregation indices, odds ratio was calculated for one standard deviation increment in segregation index^bDegree of freedom

To date, there have been a limited number of studies on residential segregation and health, and the majority of previous research has focused on racial residential segregation and different health outcomes. This study narrows the scope to

disability, a more specific health outcome. This study is the first to show the specific distribution of disability in Iran and its association with a number of contextual characteristics of residential location at a provincial level.

The findings now show that residential segregation is associated with differences of disability prevalence between provinces, in both individuals and families, and this association is independent of those characteristics of individuals or families that are known to influence health outcomes.

Level 1 variables associated with a lower rate of disability include: individual characteristics such as lower age, female sex, foreign nationality, being married, higher level of education, and employment and family characteristics such as smaller family size, higher percentage of literacy, and employment in the family. A higher economic status of a family, characterized by larger household size, land ownership, or existence of a separate kitchen and bathroom in the house, was also associated with a lower rate of disability. These findings are consistent with results obtained internationally. In a study with respect to demographic factors associated with disability in the general population, sex, race, age, education level, number of inhabitants at a residence, family income, work environment, marital status, and physical activity were correlated with disability prevalence.³²

In a survey of disability carried out in Australia, families with a disabled child tended to be larger in size to those families without a disabled child. The educational status of family members was also associated with the prevalence of disability in this study, and the prevalence of disability when neither of the parents had completed secondary school was twice that of other families. In the Australian survey, the prevalence of disability in families in which both parents were employed was lower than in other families.³³ In our study, the odds of disability when all members of a family were illiterate was 3.67 (3.45–3.92) times the odds of disability when every family member was literate. The odds of disability increased 1.43 (1.41–1.45) times for each unit increase in family size and increased 3.9 (3.6–4.2) times when none of the family members were employed.

Different contextual characteristics had different effects on disability. Segregation of some factors had a positive effect and of others had a negative impact. Provinces segregated by type of occupation, sex, and ownership of a motorcycle had a lower individual disability rate, while age segregation and house ownership had a positive effect on the rate of individual disability in the province. In another words, in those provinces in which the diversity of age groups and house ownership were lower in their municipality zones, which resulted in higher segregation at a provincial level, the rate of disability in the province was higher than in more diverse provinces. In provinces in which occupational groups and the existence of a motorcycle in the family were not evenly distributed among their municipality zones, which resulted in higher segregation at a provincial level, the rate of individual disability was lower.

Segregation of structural characteristics of residential environment, which are important determinants of socioeconomic status in Iran,¹⁹ also had different relations with disability rate. Provinces segregated by household size had a lower disability rate, but those provinces segregated with respect to the existence of a separate kitchen in the house and access to the public network of natural gas for heating and cooking had a higher disability rate. Houses without a separate kitchen and no access to the public gas network are usually located in the poorer areas of a province, and provinces segregated according to these characteristics usually have a lower economic status than other provinces. Such economic factors may be the intermediate cause of this association. The association of inequalities in health

outcomes and socioeconomic status has been examined in many studies. In a study of nine developing countries, it was shown that an unequal distribution of consumption was associated with higher child mortality.¹⁹ In a health survey conducted in India, levels of socioeconomic status composed of income, education, housing condition, and house ownership were associated negatively with child mortality rates.³⁴ In a study in a Brazilian city, the geo-economic classification of the city was correlated negatively with infant mortality.³⁵

The findings also showed that almost all of the aforementioned segregation indices had the same effect on the rate of family disability, except the effect of segregation of age groups, which was not significant.

The nonrandom clustering of different social groups in different municipality zones is not inherently good or bad. Segregation measures this departure from random distribution of housing, but the health-related effects of segregation are not due only to the patterning of residents; they are a result of a series of characteristics that force people to select different municipality zones, which results in varying social exposures, economic opportunities, and influential social interactions. In Western communities, the most important characteristic which differentially allots individuals to different residential zones is race.³⁶ In Iran, the stigma of a municipality zone is the key factor which influences people's choice and produces segregated areas. This itself is under the influence of cultural settings and the physical and contextual characteristics of the area, including the socioeconomic status of its residents, the mean level of education, occupations of inhabitants, crime prevalence, poverty concentration, infrastructural decay, and access to social, medical, and welfare facilities.

But is such segregation detrimental to health? A number of mechanisms have been suggested for the disadvantageous effects of segregation. According to these mechanisms, residential segregation gives rise to an individual socioeconomic status which is related to health. Segregation perpetuates and reinforces an unhealthy environment and contributes to changes in individual behavior with respect to risk factors.³⁶ The concentration of individuals of lower socioeconomic status in a municipality zone also results in reduced educational opportunities because there is evidence that schools in poor areas have an inferior quality of teaching, administration, and test scores when compared with schools located in more affluent areas.^{36,37}

There is also evidence to support the positive effect of segregation.^{38–40} Segregation in a geographic area, such as a province, is accompanied by a clustering of individuals of the same social group in smaller municipality zones inside that province. Studies evaluating the effects of neighborhood characteristics have also studied the effect of these “group densities” on health. According to Pickett and Wilkinson,³⁸ members of low-status minority communities, which live in an area with a higher proportion of their own group, tend to have better health than those who live in areas with a lower proportion. In other words, segregation in a geographic area is the result of integration in subareas, and such integration through a “group density” pathway and the subsequent support, which similar groups give to each other, may override the negative effect of segregation itself.

Limitations

Our results are subject to limitations associated with the use of census data. Disability was measured by specific questions put to individuals in the census by specifying a number of medical conditions according to the medical model of

disability, which may underestimate the true prevalence of disability according to a social model, yet may be a good estimate according to the medical model.¹⁸ Information theory index was used in the study because of its unique statistical characteristics, but in most studies, the dissimilarity index or isolation index has been used. Further studies are necessary to determine the best segregation index for measuring the effect of segregation of markers of socioeconomic status on health.

The choice of variables was limited to variables which were standard questions in the Iranian national census. This method is beneficial because of its consistency of repetition in subsequent censuses and the ability to perform time series cross-sectional analysis across decades to determine health changes associated with changing segregation. But, on the other hand, other variables may exist related to the context of where individuals live, in which their segregation better describes health disparities between provinces.

CONCLUSION

In this study, the effect of segregation of specific contextual factors on one specific health outcome was reviewed. It is extremely valuable because it considers how segregation with respect to aspects of social characteristics other than race affects health outcomes, which has not, as yet, been fully reviewed.

Most studies focusing on segregation and health have hypothesized that segregation influences health indirectly through the formation of different neighborhood environments and by shaping the socioeconomic achievements of minority groups. Few studies have tested these pathways to see whether monitoring the quality of a neighborhood can explain the effects of segregation or not.⁸ Further studies on the effect of segregation with controlling the concentration of the addressed contextual factors are recommended to test whether segregation of a contextual factor acts through the concentration of that factor or other contextual factors at a provincial level.

REFERENCES

1. Snow J. *On the Mode of Communication of Cholera*. London: John Churchill; 1855.
2. Durkheim E, Spaulding JA, Simpson G. *Suicide: A Study in Sociology*. New York: Free Press; 1997.
3. Kalter F. Measuring segregation and controlling for independent variables. *Arbeitspapiere-Mannheimer Zentrum für Europäische Sozialforschung* 2000, 20.
4. Iceland J. *Where We Live Now: Immigration and Race in the United States*. Berkeley: University of California Press; 2009.
5. Fang J, Madhavan S, Bosworth W, Alderman MH. Residential segregation and mortality in New York City. *Soc Sci Med*. 1998; 47: 469–476.
6. Shihadeh ES, Flynn N. Segregation and crime: the effect of black social isolation on the rates of black urban violence. *Social Forces*. 1996; 74: 1325–1352.
7. Acevedo-Garcia D. Residential segregation and the epidemiology of infectious diseases. *Soc Sci Med*. 2000; 51: 1143–1161.
8. Acevedo-Garcia D, Lochner KA, Osypuk TL, Subramanian SV. Future directions in residential segregation and health research: a multilevel approach. *Am J Public Health*. 2003; 93: 215.
9. Chang VW. Racial residential segregation and weight status among US adults. *Soc Sci Med*. 2006; 63: 1289–1303.
10. Mason SM, Messer LC, Laraia BA, Mendola P. Segregation and preterm birth: the effects of neighborhood racial composition in North Carolina. *Health Place*. 2009; 15: 1–9.

11. Brewster KL. Neighborhood context and the transition to sexual activity among young black women. *Demography*. 1994; 31: 603–614.
12. Browning CR, Leventhal T, Brooks-Gunn J. Neighborhood context and racial differences in early adolescent sexual activity. *Demography*. 2004; 41: 697–720.
13. Peterson RD, Krivo LJ. Racial segregation and black urban homicide. *Social Forces*. 1993; 71: 1001–1026.
14. Peterson RD, Krivo LJ. *Racial Segregation, the Concentration of Disadvantage, and Black and White Homicide Victimization*. New York: Springer; 1999: 465–493.
15. Schulz AJ, Williams DR, Israel BA, Lempert LB. Racial and spatial relations as fundamental determinants of health in Detroit. *Milbank Q*. 2002; 80: 677–707.
16. Wilson WJ. *The Truly Disadvantaged: The Inner City, the Underclass, and Public Policy*. Chicago: University of Chicago Press; 1987.
17. Disability, including prevention, management and rehabilitation. <http://www.who.int/nmh/a5817/en/>. Accessed 20 Oct 2011.
18. Mont D. Measuring disability prevalence. *World Bank Social Protection Discussion Paper* 2007.
19. Hosseinpour AR, Mohammad K, Majdzadeh R. Socioeconomic inequality in infant mortality in Iran and across its provinces. *Bull World Health Organ*. 2005; 83: 837–844.
20. Reardon SF. A conceptual framework for measuring segregation and its association with population outcomes. In: Oakes M, Kaufman JS, eds. *Methods in Social Epidemiology*. San Francisco, CA: Jossey-Bass; 2006: 169–192.
21. Iceland J, Weinberg DH, Steinmetz E. *Racial and Ethnic Residential Segregation in the United States, 1980–2000*. Washington, DC: US Census Bureau; 2002.
22. Reardon SF, Firebaugh G. Measures of multigroup segregation. *Sociol Methodol*. 2002; 32: 33–67.
23. Reardon SF. Measures of ordinal segregation. In: Flückiger Y, Reardon SF, Silber J, eds. *Occupational and Residential Segregation*. vol, 17 of Research on Economic Inequality. Emerald, Bingley, UK; 2009. p. 129–155.
24. Reardon S, Yun J, McNulty T. The changing structure of school segregation: measurement and evidence of multi-racial metropolitan area school segregation, 1989–1999. *Demography*. 2000; 37: 351–364.
25. Oakes JM, Kaufman JS. *Methods in Social Epidemiology*. San Francisco: Jossey-Bass; 2006.
26. Fischer MJ. The relative importance of income and race in determining residential outcomes in US urban areas, 1970–2000. *Urban Aff Rev*. 2003; 38: 669.
27. Ethington PJ. Segregated diversity: race-ethnicity, space, and political fragmentation in Los Angeles County; 2000.
28. Iranian national census. Retrieved from www.amar.org.ir. Accessed 12 Jul 2011.
29. Bryk AS, Raudenbush SW. *Hierarchical Linear models: Applications and Data Analysis Methods*. Thousand Oaks: Sage; 2002.
30. Gutierrez RG. Nordic and baltic stata users' group meetings 2007. Retrieved from http://repec.org/nasug2007/gutierrez_boston07.pdf. Accessed 20 April 2011.
31. Adib-Hajbaghery M, Aghahoseini S. The evaluation of disability and its related factors among the elderly population in Kashan, Iran. *BMC Public Health*. 2007; 7: 261.
32. Cats-Baril WL, Frymoyer JW. Demographic factors associated with the prevalence of disability in the general population: analysis of the NHANES I database. *Spine*. 1991; 16: 671–674.
33. Point K. Australian social trends 2008. 2008.
34. Kutty VR, Thankappan K, Kannan K, Aravindan K. How socioeconomic status affects birth and death rates in rural Kerala, India: results of a health study. *Int J Heal Serv*. 1993; 23: 373–386.
35. Goldani MZ, Barbieri MA, Bettiol H, Barbieri MR, Tomkins A. Infant mortality rates according to socioeconomic status in a Brazilian city. *Revista De Saúde Pública*. 2001; 35: 256–261.

36. Kramer MR, Hogue CR. Is segregation bad for your health? *Epidemiol Rev.* 2009; 31: 178.
37. Lleras C. Race, racial concentration, and the dynamics of educational inequality across urban and suburban schools. *Am Educ Res J.* 2008; 45: 886.
38. Pickett KE, Wilkinson RG. People like us: ethnic group density effects on health. *Ethn Heal.* 2008; 13: 321–334.
39. Peach C. Good segregation, bad segregation. *Plan Perspect.* 2001; 11: 379–398.
40. Echenique F, Fryer RG, Kaufman A. Is school segregation good or bad? *Am Econ Rev.* 2006; 96: 265–269.