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Conceptual and Methodological Arguments against the Use of Location Quotient as an Area-Based Measure of Residential Segregation: A Measurement Perspective

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Abstract: Among a wide range of practical applications, the location quotient (LQ) has been used as an area-based measure of residential segregation by race/ethnicity in some studies. However, it does not correspond to any of the five dimensions of residential segregation. Rather, an application of LQ in demographic data analyses brings about an atypical way to quantify the population composition of areal units by race/ethnicity. To clarify misconceptions, the purpose of this study was to demonstrate the relationships between proportions, percentages, and LQs of six racial/ethnic groups in the conterminous United States (US). Since populations change over time, demographic data on race and ethnicity were obtained from the 2000, 2010, and 2020 Census through the US Census Bureau's website. Using census tracts and counties as the units of analysis, a sequence of scatterplots and associated Pearson's correlation coefficients (r) was used to display the analytical results of census-tract- and county-based measures at three different time periods. Despite the different levels of aggregation, the relationships between proportions, percentages, and LQs of six racial/ethnic groups consistently showed perfect positive correlations at three different time periods (r = 1.00). These suggest that census-tract- and county-based measures expressed as the proportion, percentage, and LQ of a racial/ethnic group capture the same distributional pattern, but the units of measurement simply differ from one another. Hence, the study of residential segregation and its societal consequences needs to be specific to the dimension under study and to build upon the conceptual and methodological foundations established by sociologists-demographers and geographers.

Keywords: location quotient; proportion; percentage; population composition; racial and ethnic groups

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1. Introduction

The location quotient (LQ) [1] has been widely used in location or regional analysis since the 1940s [2], particularly in the study of economic development (e.g., Refs. [3–7]). It has been used to assess the concentration of an industry or an occupation in a local area relative to the concentration of such an industry or an occupation in an entire study area. In the United States (US), for example, the census tract boundary or the county (inclusive of county equivalents) boundary has been commonly used to demarcate a local area for understanding the distributional pattern of an industry or an occupation and its spatial clustering within a metropolitan area, a state (including the District of Columbia), a region (i.e., a collection of contiguous states), or the entire nation.

The usefulness of LQ [1] lies not only in its simple calculation, but also in its straightforward interpretation. By definition, a value of LQ equal to 1.00 indicates the relative quantity of an industry or an occupation in a local area being the same as the overall quantity of such an industry or an occupation in a given study area. Therefore, a value of LQ greater than 1.00 indicates over-represented (or above-normal) areas, and a value of LQ less than 1.00 indicates under-represented (or below-normal) areas. In general, a minimum value of LQ sits at 0.00, but a maximum value of LQ depends on the central tendency and variability of data and tends to vary across geographic areas and/or over time. While the standard formulation of a cut-off value does not exist [8], values of LQ beyond a certain threshold (e.g., 1.25, 2.00, or 3.00) have been used to signify the concentration of an industry or an occupation in a given study area. With an increasing availability of geographic information systems (e.g., ArcGIS Desktop or Online, QGIS, and Microsoft Excel), a visualization of industrial or occupational concentrations came to be known as a useful analytical tool for understanding spatial clustering patterns and for guiding decision-making, strategic planning, research, and other purposes.

Besides the traditional realm of economic data analyses, a use of LQ grew in popularity across fields of study, such as in criminology (e.g., Refs. [9,10]) and healthcare (e.g., Refs. [11,12]), around the turn of the twenty-first century. Among a wide range of practical applications, the LQ [1] has been used (or conceived) as an area-based measure of residential segregation by race/ethnicity in some studies (e.g., Refs. [13–15]) where such a use occasionally appears in more recent studies (e.g., Refs. [16–18]). From a conceptual and methodological standpoint, however, the LQ [1] and the existing indices [19–22] for capturing the concentration dimension of residential segregation only share the division process in their formulation. More importantly, the LQ [1] does not correspond to any of the five dimensions of residential segregation identified by Massey and his colleagues [19,20]; see also the US Census Bureau's summary [23] for a helpful explanation on the distinct dimensions of residential segregation identified by Massey and Denton [19] and a family of segregation indices for capturing each dimension. In fact, LQs of racial/ethnic groups (or other population groups) quantify the population composition of a local area by race/ethnicity (which has typically been expressed either as proportions or percentages), regardless of the spatial size of areal units.

Notwithstanding the usefulness of LQ [1] in enumerated data analyses, a misuse (or an abuse) of LQ would undermine the study of residential segregation and its societal consequences in the US and elsewhere. To avoid confusion, the purpose of this study was to demonstrate the relationships between proportions, percentages, and LQs of six racial/ethnic groups in the conterminous US (i.e., the contiguous US). Given the complexity and multidimensionality of residential segregation [19–22], main conceptual and methodological approaches to the measurement of residential segregation are also explained in a later section. These explanations are intended to clarify a common misconception about the interchangeability between area-based measures of population composition and residential segregation.

2. Materials and Methods

2.1. Data

Demographic data on race and ethnicity were obtained from the 2000, 2010, and 2020 Census through the US Census Bureau's website [24]. The US Census Bureau collects these data in accordance with guidelines provided by the US Office of Management and Budget (OMB) guidelines; based upon self-identification, the racial and ethnic categories included in the census questionnaire reflect a social definition of race and ethnicity and do not reflect any biological or genetic aspects of a respondent [25].

In reference to the US Census Bureau's information [25], five minimum categories required by the OMB and included in the census questionnaire are: (i) White, (ii) Black (or African American), (iii) American Indian or Alaska Native, (iv) Asian, and (v) Native Hawaiian or Other Pacific Islander. Here, the "White" category refers to a person having origins in any of the countries in Europe, the Middle East, or North Africa and the "Black" category refers to a person having origins in any of the racial groups of Africa. Since the concept of race differs from that of Hispanic or Latino/a, the terms "non-Hispanic White" and "non-Hispanic Black" were used to refer to "White alone, not Hispanic or Latino/a" and "Black alone, not Hispanic or Latino/a," respectively. By setting apart the Hispanic or Latino/a category from the five aforementioned categories, therefore, six racial/ethnic groups were considered in this study.

Among the various areal units for which the US Census Bureau tabulates information on demographic, social, economic, and housing characteristics [26,27], census-tract- and county-based estimates population have been used in a wide array of research studies. Hereafter, the term "county" or "counties" refers not only to county or counties, but also to county equivalents (i.e., the District of Columbia, parishes in the State of Louisiana, boroughs in the State of Alaska, and independent cities in the States of Virginia, Maryland, Missouri, and Nevada); also, the term "state" or "states" encompasses the District of Columbia, unless otherwise specified. With regard to the hierarchical alignments of areal units [26], census tracts, counties, and states form a nested structure where census tracts belong to a county and counties belong to a state (i.e., census tract boundaries never cross a county boundary and county boundaries never cross a state boundary). Taking these under consideration, census-tract- and county-based population estimates at three different time periods were considered in this study.

As a brief explanation of areal units, census tracts are a manifestation of national democratic governance informed by local input and created in accordance with uniform standards [28]. While the spatial size of census tracts varies quite considerably depending on the density of human settlements (i.e., smaller in urban settings and larger in rural settings), they are designed to enumerate a population size between 1200 and 8000 residents, with an optimum size of 4000 residents [29]. Depending on the degrees of population change, census tracts are split or merged to account for population growth or decline over time. Note that block groups (a subdivision of a census tract) may be considered as an alternative areal unit. However, block-group-based population estimates are generally quite unreliable with relatively large margins of error and accompanied by fair amounts of missingness in comparison with the census-tract-based population estimates. For these reasons, block groups were not considered in this study.

Counties and states are two major legally defined administrative and political units of the US and serve as the primary areal units for which the US Census Bureau tabulates a variety of data from numerous surveys [27] despite the lack of uniform standards. The formation of counties and states closely reflects the political and social history of the US; as the nation expanded westward, the county form of local government followed [27]. In reflection of government structural reforms within each state, however, the name, boundary, and borders of counties have changed even during the recent decades [30]. Therefore, some counties do not have any governmental powers. Due to the difference in historical contexts and government structural reforms, the population size varies significantly across counties and states, the number and spatial size of counties differ from state to state, and the spatial size of states ranges greatly from the largest state (i.e., the State of Alaska) to the smallest state (i.e., the State of Rhode Island) or the District of Columbia.

Since the States of Alaska and Hawaii are often regarded as geographic outliers located far to the west and separated from other states (i.e., do not share a border with any state), the 48 states and the District of Columbia (collectively referred to as the conterminous US or the contiguous US) were used as the study area. In adherence with the racial and ethnic categories classified by the US Census Bureau, a brief description of the study area is provided in Table 1.

Table 1. Description of the conterminous United States.

	2000 Census	2010 Census	2020 Census
States [a]	49	49	49
Counties [b]	3109	3109	3108
Census Tracts	64,999	72,539	83,776
Total Population	279,583,437	301,940,492	324,412,244
Non-Hispanic White	193,814,289	195,821,918	195,505,036
Non-Hispanic Black	33,666,024	37,081,247	39,946,803
Hispanic or Latino/a	35,125,134	47,573,707	59,155,395
Asian	9,548,203	13,473,926	17,616,202
American Indian or Alaska Native	1,993,483	1,950,766	1,969,909
Native Hawaiian or Other Pacific Islander	232,388	330,499	402,728
Some Other Race	444,454	683,111	1,012,112
Two or More Races	4,759,462	5,025,318	8,804,059

[a] Including the District of Columbia; [b] Including county equivalents.

2.2. Area-Based Measures

When quantifying the population composition from enumerated data, it is calculated either as a proportion or a percentage. Using a general formulation, the proportion of group G is defined as

$$p_i = \frac{g_i}{t_i}$$

where g_i is the number of group G in areal unit i and t_i is the total population in areal unit i. For calculating the percentage of group G in areal unit i, it is simply multiplying p_i by 100 (i.e., $p_i \times 100$).

Keeping the notation for g_i and t_i consistent, the LQ of group G is defined as

$$LQ_i = \frac{\frac{g_i}{t_i}}{\frac{G}{T}}$$

where G and T are the overall number of group G and the total population in a given study area, respectively. While the notations used herein are different from the ones used in previous studies (e.g., Refs. [13–18]), the formula and its specification of a population group are the same.

To quantify the proportions, percentages, and LQs of six racial/ethnic groups for census tracts and counties, g_i was substituted by the number of non-Hispanic White population, non-Hispanic Black population, Hispanic or Latino/a population, Asian population, American Indian or Alaska Native population, and Native Hawaiians or Other Pacific Islander population; in LQ_i, G was also substituted by the overall number of their respective racial/ethnic groups in the entire study area (i.e., the conterminous US). Note that both t_i and T not only include six racial/ethnic groups but also some other race and two or more races.

2.3. Data Analysis

Upon calculating the proportions, percentages, and LQs of six racial/ethnic groups for census tracts and counties as well as for three different time periods, the relationships between area-based measures were examined in a sequence of scatterplots and associated Pearson's correlation coefficients (r). In creating scatterplots, semi-transparent dots were used to visualize the amount of overplotting, and thus darker lines indicate more overlapping dots, whereas lighter lines indicate fewer overlapping dots. To account for the population change over time (Table 1), separate analyses were conducted for the 2000, 2010, and 2020 Census data. Figures 1–3 and 4–6 show the results of census-tract- and county-based measures, respectively.

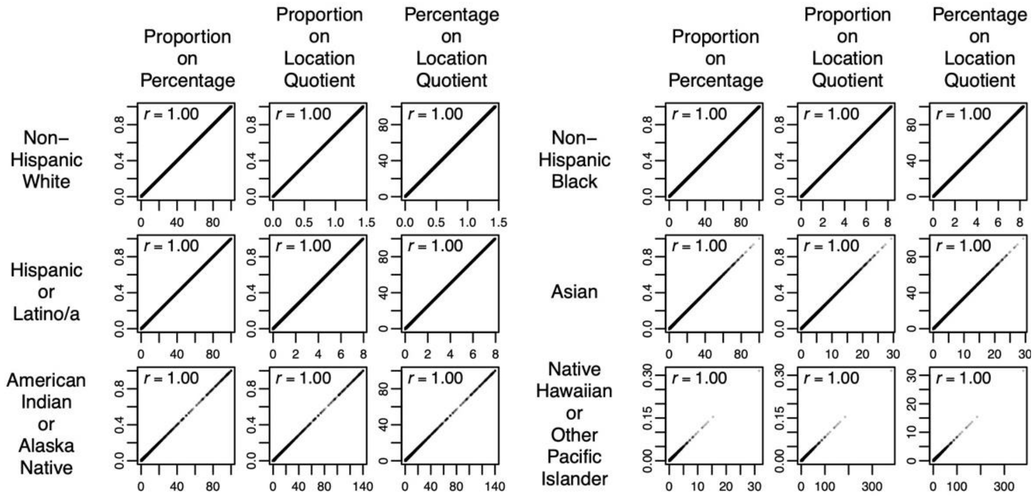

Figure 1. Relationships between census-tract-based measures in the conterminous United States (2000).

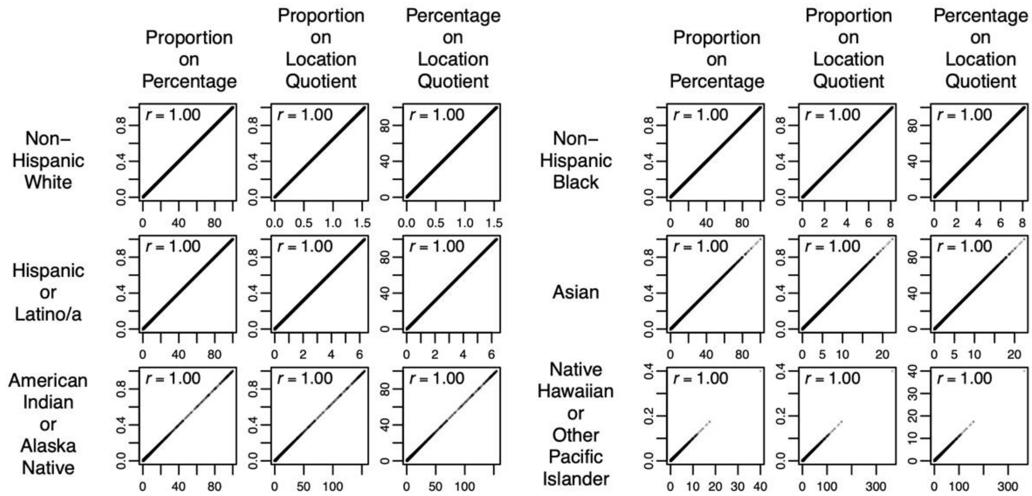

Figure 2. Relationships between census-tract-based measures in the conterminous United States (2010).

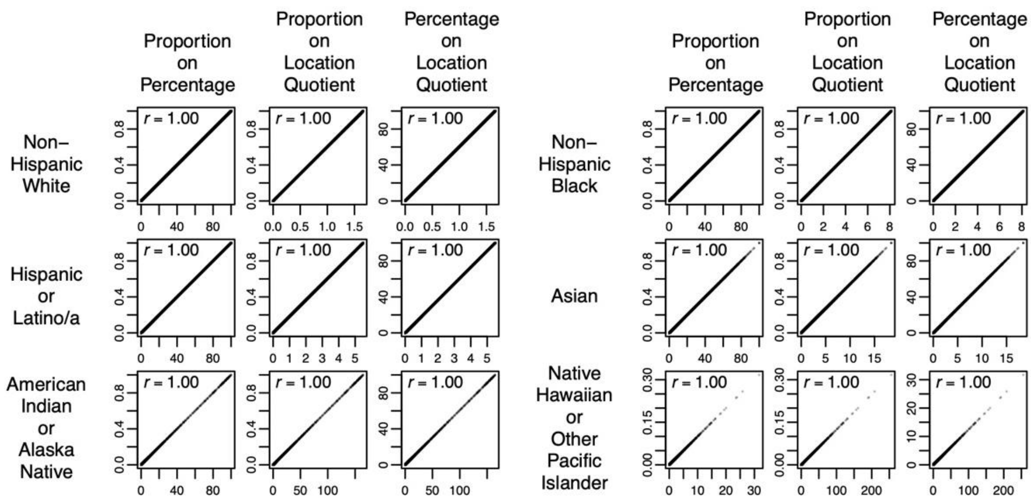

Figure 3. Relationships between census-tract-based measures in the conterminous United States (2020).

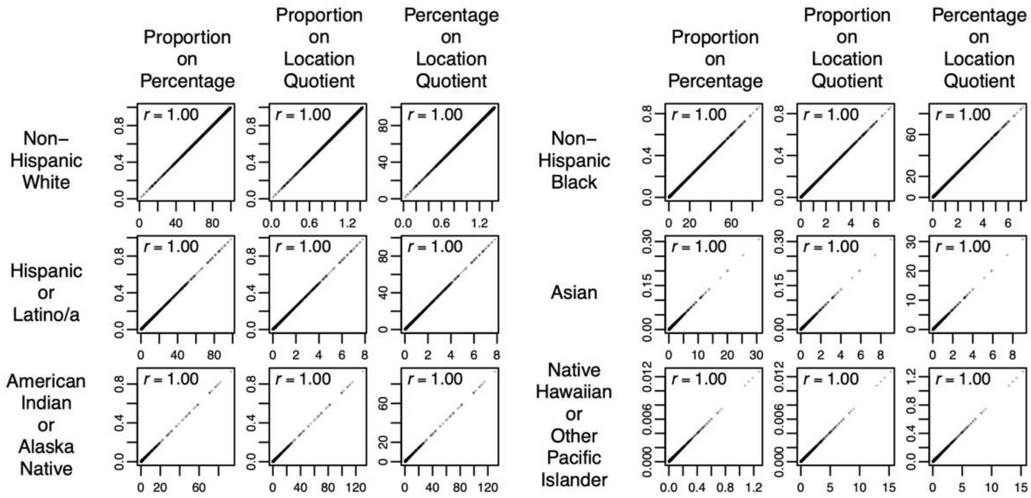

Figure 4. Relationships between county-based measures in the conterminous United States (2000).

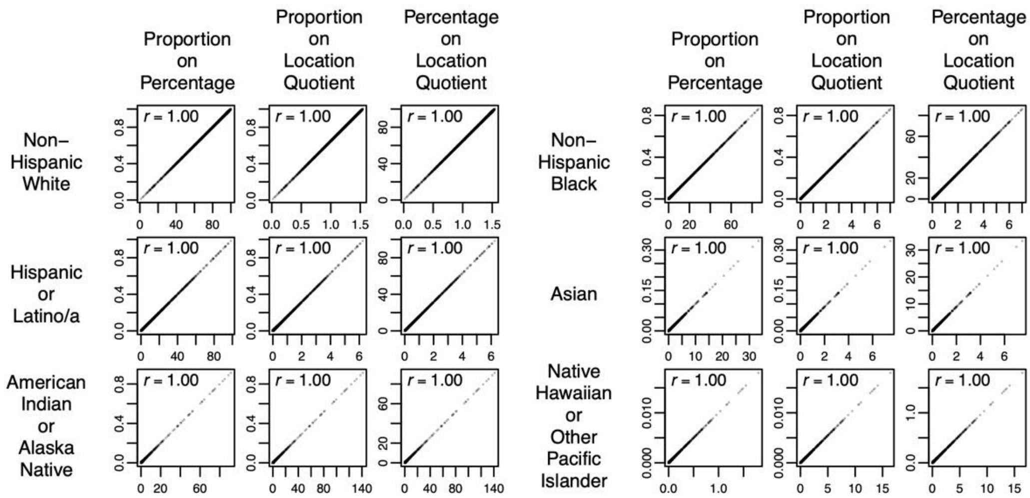

Figure 5. Relationships between county-based measures in the conterminous United States (2010).

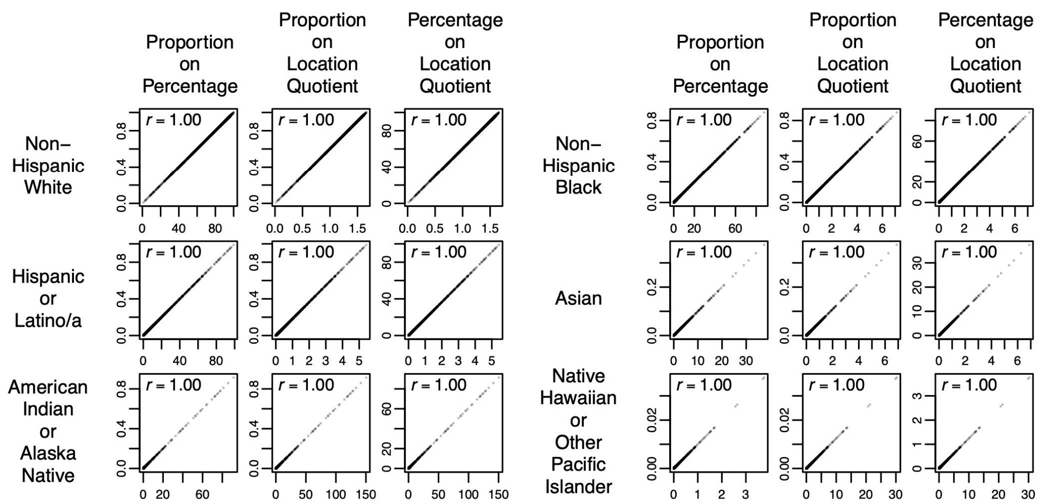

Figure 6. Relationships between county-based measures in the conterminous United States (2020).

Since the spatial size varies substantially from state to state and the number of census tracts differs considerably within each state, state-specific calculations and its subsequent analyses for census-tract-based measures were also conducted to better understand whether the size and internal structure of geographic ranges (i.e., variations in the geographic extent of a study area and its population size and population structure) would affect the relationships between proportions, percentages, and LQs of six racial/ethnic groups. The results for each state at three different time periods are shown in Supplementary Materials (Figures S1–S147). However, state-specific calculations and the subsequent analyses for county-based measures were not considered in this study because of a very small number of counties in most states. In brief, the District of Columbia does not contain any county, 20 out of 50 states (40%) contained less than 50 counties, 22 out of 50 state (44%) contained more than 50 counties but less than 100 counties, and only 8 out of 50 states (16%) contained more than or equal to 100 counties.

Data management, calculation of area-based measures, and visualization of the relationships between area-based measures were carried out in R version 4.3.0 [31]. Here, the cor function in the base R stats package was used to compute Pearson's correlation coefficients (*r*). Otherwise, all computational processes were carried out by a combination of basic functions.

3. Results

As shown in Table 1, there were 3109 or 3108 counties in the conterminous US, which reflects government structural reforms in some states, between 2000 and 2020. The number of census tracts grew from 64,999 in 2000 to 83,776 in 2020 (roughly a 1.3-fold increase) and closely mirrored the population growth from about 279.6 million people in 2000 to about 324.4 million people in 2020 (roughly a 1.2-fold increase). Irrespective of the steady population growth rate during these decades, the changes in population structure by race/ethnicity were quite noticeable.

In adherence to the US Census Bureau's classification, the non-Hispanic White population was the largest racial/ethnic group, which comprised about 195 million people (Table 1) and represented 69.3%, 64.9%, and 60.3% of the total population in 2000, 2010, and 2020, respectively; the overall non-Hispanic White population increased by about 1.7 million people between 2000 and 2020. While the overall non-Hispanic Black population gradually increased from about 33.7 million people in 2000, to about 37.1 million people in 2010, and on to about 39.9 million people in 2020 (Table 1), they consistently represented a little over 12% of the total population between 2000 and 2020.

Among the four ethnic groups, the overall Hispanic or Latino/a population increased from about 35 million people in 2000, to about 47.6 million people in 2010, and on to about 59.2 million people in 2020 (Table 1); with a total increase of about 24 million people during these decades (roughly a 1.7-fold increase), their share of the total population rose from 12.6% in 2000, to 15.8% in 2010, and on to 18.2% in 2020. In a similar fashion, the overall Asian population increased from about 9.5 million people in 2000, to about 13.5 million people in 2010, and on to about 17.6 million people in 2020 (Table 1); since the total increase was about 8.1 million people between 2000 and 2020 (roughly a 1.8-fold increase), their share of the total population rose only from 3.4% in 2000, to 4.5% in 2010, and on to 5.4% in 2020.

With respect to the other two ethnic groups, the overall American Indian or Alaska Native population remained the same, which comprised of slightly less than 2 million people between 2000 and 2020 (Table 1) and consistently represented less than 0.72% of the total population during these decades. The overall Native Hawaiian or Other Pacific Islander population increased from about 0.2 million people in 2000, to 0.3 million people in 2010, and on to 0.4 million people in 2020 (Table 1); with only a total increase of about 0.2 million people during these decades (although roughly a 1.7-fold increase), they represented less than 0.13% of the total population during these decades.

In addition to the six racial/ethnic groups, the overall number of people who identified themselves as some other race increased from about 0.5 million people in 2000, to 0.7 million people in 2010, and on to about 1 million people in 2020 (Table 1); with roughly a 2.3-fold increase during these decades, however, they consistently represented less than 0.32% of the total population. Similarly, the overall number of people who identified themselves as two or more races increased from about 4.8 million people in 2000, to about 5 million people in 2010, and on to about 8.8 million people in 2020 (Table 1); by virtue of roughly a 1.8-fold increase during these decades, their share of the total population rose from about 1.7% in 2000 and 2010 to about 2.7% in 2020.

Based on demographic data from the 2000, 2010, and 2020 Census, the conterminous US became more populous and more racially and ethnically diverse (Table 1), primarily due to the rapid growth of the Hispanic or Latino/a population, Asian population, and people with different racial backgrounds (a combination of some other race and two or more races). Using census tracts as the unit of analysis, however, the relationships between proportions, percentages, and LQs of six racial/ethnic groups consistently yielded perfect positive correlations ($r = 1.00$) at three different time periods (Figures 1–3). Keeping the unit of analysis consistent, a sequence of state-specific analyses also yielded perfect positive correlations ($r = 1.00$) at three different time periods (Figures S1–S147). Equally important, the perfect positive correlations ($r = 1.00$) between proportions, percentages, and LQs of six racial/ethnic groups at three different time periods remained unchanged when using counties as the unit of analysis (Figures 4–6).

The results of census-tract- and county-based measures (Figures 1–3 and 4–6, respectively) suggest that proportions, percentages, and LQs of six racial/ethnic groups capture the same distributional pattern, but the units of measurement simply differ from one another. At least for census-tract-based measures, the results shown in Figures S1–S147 collectively suggest that the relationships between proportions, percentages, and LQs of six racial/ethnic groups had not been affected by the size and internal structure of geographic ranges (i.e., variations in the geographic extent of a study area and its population size and population structure). Taken together, the consistency of perfect positive correlations in Figures 1–6 and S1–S147 corroborate an analytical thinking that an application of LQ in demographic data analyses brings about an atypical way to quantify the population composition of census tracts and counties (i.e., a proportion of areal units harmonized by an overall proportion of a study area).

4. Discussion

Similar to how some studies (e.g., Refs. [13–18]) have used (or conceived) LQs of racial/ethnic groups as area-based measures of residential segregation by race/ethnicity, other studies (e.g., Refs. [32–37]) have used (or conceived) proportions or percentages in a similar manner. As Johnston et al. [38] pointed out, however, segregation indices have been developed for a reason, and thus an inappropriate approach to the measurement of residential segregation obscures a meaningful understanding more than it reveals. By the same token, Oka and his colleagues [39–41] discussed the conceptual and methodological differences between area-based measures of population composition and residential segregation and also partially untangled a common misconception about the interchangeability between the two. To better differentiate and/or distinguish one from another, main conceptual and methodological approaches to the measurement of residential segregation are summarized below.

Residential segregation refers to the extent to which population groups live apart from one another in different neighborhoods [19,20]. By and large, population groups have been characterized by residents' racial/ethnic background, but sometimes by their citizenship or socioeconomic status, and neighborhoods have been denoted by census tract boundaries in the US or by census-tract-equivalent boundaries outside the US [42,43]. Since different population groups tend to be "segregated" in various ways, Massey and Denton [19] conducted an in-depth review (often regarded as a milestone piece) by analyzing the 1980 Census data and deduced five dimensions: evenness, exposure (isolation), concentration, centralization, and clustering. Building upon this review, almost a decade later, Massey et al. [20] conducted a follow-up study by analyzing the 1990 Census data and ascertained the five dimensions of residential segregation. While the term "segregation" generally implies the separation of a particular population group from its counterpart or from other population groups, the distinct dimensions of evenness, exposure (isolation), concentration, centralization, and clustering collectively refer to "segregation" when studying the differential patterns of population groups in residential space, unless otherwise specified.

To capture each of the five dimensions of residential segregation, global and local indices have been developed and used for different purposes [21,22]. On the one hand, global indices quantify the extent of residential segregation within counties, metropolitan areas, or states, and thus derived area-based measures have been used for inter-county, inter-metropolitan, or inter-state comparisons. On the other hand, local indices quantify the extent of residential segregation across census tracts (i.e., neighborhoods), and thus derived area-based measures have been used for inter-census-tract (i.e., inter-neighborhood) comparisons. Because the effectiveness of traditional segregation indices had been hindered by their aspatial nature, which overlooked the importance of spatial relationships between population groups living in different neighborhoods, spatial indices have been developed since the 1980s. Note that the term "aspatial" (not "non-spatial") refers to the insensitivity of analytical results to the spatial arrangement of areal units. In the development of spatial segregation indices (global and local indices alike), for example, a spatial binary function or a spatial kernel function has been implemented to quantify the extent of residential segregation more effectively. In more detail, see Wong [21] for a useful review of historical progress in the measurement of residential segregation and Yao et al. [22] for a methodological review of spatial segregation indices.

While the five dimensions identified by Massey and his colleagues [19,20] remain a cornerstone for the study of residential segregation and its societal consequences, more recent studies have incorporated spatial elements into the equation and argued for two composite dimensions: evenness-clustering and exposure-isolation [44]; evenness-concentration and clustering-exposure-isolation [45]; and centralization-concentration and unevenness-clustering-exposure-isolation [46]. Despite the apparent lack of agreement, these composite dimensions provoke analytical thinking that the evenness and exposure (isolation) dimensions may in fact be distinct from one another [39]. In the midst of ongoing discussions about the "true" dimensions of residential segregation [21], four review articles [47–50] suggested the isolation dimension to be most relevant for the health of racial and ethnic groups in the US. Among a family of segregation indices [19,20], the P^* index, which was developed by Shevky and Williams [51], modified by Bell [52], and popularized by Lieberson [53], has been regarded as the only segregation index capable of capturing the isolation dimension of residential segregation [44]. By implementing different spatial functions, spatial global and/or local versions of the P^* index have been developed by Reardon and O'Sullivan [44], Feitosa et al. [54], and Oka and Wong [55].

By definition, the P^* index [51–53], as well as its spatial indices [44,54,55], quantifies the extent of residents' exposure to and/or social interaction with the same population group in their place of residence. For instance, high degrees of residential isolation among the non-Hispanic Black population in the US correspond to the general notion of predominantly non-Hispanic Black population or segregated areas of non-Hispanic Black population (often denoted by census tract or county boundaries). While LQs (e.g., Refs. [13–18]) and proportions or percentages (e.g., Refs. [32–37]) had been used to quantify the "concentration" of racial/ethnic groups in their respective study area, the interpretation of such area-based measures described in those studies closely resemble the isolation dimension of residential segregation, not the concentration dimension or any other dimensions. In order to avoid a misuse (or an abuse) of LQ, therefore, either a global spatial index or a local spatial index [44,54,55] needs to be incorporated in future studies for a better understanding of the societal consequences of residential isolation by race/ethnicity across different geographic settings in the US and elsewhere.

In order to ensure an effective dissemination of research findings and its successful translation to policymakers, however, two inherent limitations warrant mentioning (see

Reardon and O'Sullivan [44], Feitosa et al. [54], and Oka and Wong [55] for other limitations associated with their isolation index).

Among the common sources of measurement uncertainty in geospatial data analysis, the quality of demographic data [56] would affect the measurement of residential isolation [44,54,55] in any given study area. Primarily attributed to the population sizes of areal units, demographic data for small areal units (e.g., census tracts in the US) are less reliable (with relatively large margins of error) than for large areal units (e.g., counties or states in the US). In general, small areal units in sparsely populated areas tend to be less reliable than those in densely populated areas. While the sampling design (e.g., stages of sampling, probabilities of selection, sampling units, and sample sizes) differs from one country to another, demographic data for small areal units would be coupled with a certain degree of uncertainty. Since segregation indices [19–22] have been developed on the basis of small areal units, the quality of demographic data casts a layer of uncertainty over the area-based measures of residential isolation derived from a global spatial index or a local spatial index [44,54,55] in the US and elsewhere.

Over and above the quality of demographic data, the modifiable areal unit problem (MAUP) [57] would also affect the measurement of residential isolation [44,54,55] in any given study area. The MAUP is another common source of measurement uncertainty in geospatial data analysis that emerges from the arbitrariness of artificial boundaries. In other words, areal units are artificial demarcations overlaid onto a geographic space, and thus modifying the size, shape, and/or orientation of areal units alters the arrangement of population groups. Consequently, areal units with different spatial sizes tend to produce different analytical results. While the hierarchical structure of areal units differs from one country to another, computational analyses of areal units would be coupled with a certain degree of uncertainty. Since different types of areal units have been developed for different purposes, the MAUP casts another layer of uncertainty over the area-based measures of residential isolation derived from a global spatial index or a local spatial index [44,54,55] in the US and elsewhere.

For all intents and purposes, the measurement of residential isolation [44,54,55] would be subject to some degree of uncertainty in any given study area. While the magnitudes of measurement uncertainty would vary by study designs and/or across countries, the quality of demographic data [56] and the MAUP [57] would pose a constraint for the study of residential segregation and its societal consequences irrespective of the country under study. Since no solution has been found to address these two inherent limitations, research and policy implications must be fully acknowledged and clearly explained in future studies to avoid any misunderstanding or confusion. From a research communication standpoint, a collective effort focused on research transparency is likely to foster an effective dissemination of research findings and its successful translation to policymakers within and across countries.

5. Conclusions

The results of this study (Figures 1–6 and S1–S147) corroborate analytical thinking that LQs of racial/ethnic groups correspond to the population composition of census tracts and counties by race/ethnicity (i.e., a proportion of areal units harmonized by an overall proportion of a study area). While a relatively large number of segregation indices have been developed since the 1950s [21,22], the LQ [1] corresponds to neither of the five key dimensions identified by Massey and his colleagues [19,20] nor the two composite dimensions proposed by Reardon and O'Sullivan [44], Brown and Chung [45], or Johnston et al. [46]. As with all fields of study, measurement matters for a meaningful understanding of a phenomenon under study. In order to gain a better grasp of the differential patterns of racial/ethnic groups (or other population groups) in residential space [38], therefore, a misuse (or an abuse) of LQ would undermine the study of residential segregation and its societal consequences.

Despite the dearth of empirical clarification, no reasonable basis has been formulated to justify or support a notion of interchangeability between area-based measures of population composition and residential segregation. As Oka and his colleagues [39–41] emphasized, the study of residential segregation and its societal consequences needs to be specific to the dimension under study and to build upon the conceptual and methodological foundations [19–22] established by sociologists-demographers and geographers. Since previous studies (e.g., Refs. [13–18]) appear to have used the LQ [1] for quantifying the degree of residential isolation by race/ethnicity, future studies need to incorporate a global spatial index or a local spatial index developed by Reardon and O'Sullivan [44], Feitosa et al. [54], or Oka and Wong [55]. With increasing racial and ethnic diversity around the world [42,43], such efforts are likely to improve the quality of research synthesis not only in the US, but also in other countries.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/soc13120256/s1. The relationships between census-tract-based measures for each of the 48 contiguous states and the District of Columbia (in alphabetical order) are provided in Figures S1–S147 for a better understanding of the applicability of consistent findings shown in Figures 1–3.

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