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Original Research Article

The Visualization of the Diet Style for Racial and Ethnic Groups in the United States: Multidimensional Scaling Approach

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ABSTRACT

Aim: This study attempted to present a visualization of the similarities and dissimilarities among diet style across different racial and ethnic groups.
Materials and Methods: To achieve this end, this study used data from the 2014 Behavioral Risk Factor Surveillance System and employed the multidimensional scaling. This study also constructed 32 groups combined by race and ethnicity, gender, SES, and obesity, and created 8 dietary variables from the data.
Results: The results revealed the hidden structure of the dietary styles for each group and supported the hypothesis. The same racial and ethnic groups were located closer together geographically regardless of obesity.
Conclusion: It implies that the current intervention effort that focused on the changing diet styles, which were healthier at the individual and at the community level, was not enough. There needs to be a consideration of race and ethnicity as a group.

Key words: Multidimensional Scaling (MDS), racial and ethnic group, obesity, dietary style.

INTRODUCTION

Obesity is a one the most important public health issues in the Unites States and, indeed, worldwide. The disease has been increasing in the past several decades and now even more than two-thirds of the Americans are obese. [(1-3)] Obesity costs approximately $360 billion in 2010 and is expected to increase. [(4)] Another grave consequence of obesity is when it is comorbidity with other chronic diseases such as cancer, heart disease, diabetes, and hypertension. [(2,5)] Obesity makes it more harmful to fight off other harmful diseases.

Prior studies have indicated medical, behavioral, and sociodemographic variables as contributing factors for obesity. [(6-10)] For instance, medical conditions such as hypertension and diabetes are well known to be associated with obesity. Furthermore, behavioral factors such as physical activity, smoking, drinking, and diet also have significant relationships with obesity. As for sociodemographic factors, obesity increases with age; minorities such as African Americans, Hispanics and Native Americans are more likely to be obese. Married people are more likely to be obese than non-married people. The higher degree of education one has, the lower their likelihood of being obese. As described here, most studies on obesity have concentrated only on the individual level and the community level of factors. However, racial and ethnic groups must be more clearly investigated.

The amount of food consumption and the type of food (for example, healthy or unhealthy) are other important factors that can lead to obesity. [(7,11-12)] Scholars have argued that taste and diet style could be interpreted as a part of culture, [(13)] and

that race and ethnicity are used as a proxy for culture. [(14)] This paper intertwines these two concepts. Furthermore, this paper assumes that the same racial and ethnic groups often eat similar food, called *ethnic cuisine*, such as Mediterranean cuisine or French cuisine. [(15)] From this point, this study argues that people in the same group will show the similar diet patterns regardless of obesity than ones in the other groups. This paper hypothesizes that a group that has a similar dietary style would be located closer geographically than those have different styles. To do so, this study will use the Multidimensional Scaling (MDS) as statistical analytical methods and utilize the Behavioral Risk Factor Surveillance System (BRFSS). The MDS will present a new aspect of the relationship between culture and diet from a racial and ethnic group perspective. A detailed explanation of procedure will be discussed in the next section.

MATERIALS AND METHODS

This paper uses the 2013 BRFSS data. The BRFSS is a representative-sample survey sponsored by the Centers for Disease Control and Prevention (CDC) that administers 500,000 random-digit-dialed telephone interviews to adult residents each year. The principal objective of the survey is to monitor state-level prevalence of the major behavioral risks among adults associated with premature morbidity and mortality by collecting data on actual behaviors, rather than on attitudes or knowledge, which is especially useful for planning, initiating, supporting, and evaluating health promotion and disease prevention programs.[(16)]

The BRFSS also collects various diet variables and uses 8 specific variables: eating fruits, vegetables, greens, beans, orange-colored fruits, fruit juices, soda and sweetened drinks. All diet variables are measured in terms of the amount of the weekly consumption; for instance, how many times a respondent consume each item on a weekly basis. Education is used to measure SES: higher SES means the respondent has a college or a greater level of education and a lower SES means that he or she has less than college degree. Obesity is defined as having a Body Mass Index (BMI) of 30 or greater based on the government recommendation. [(17)]

Then, this study constructs the different groups combined with three major sociodemographic factors such as race and ethnicity, gender, and SES, and an important public health variable, obesity. Those variables are reported as important contributing factors to obesity as described above.

The racial and ethnic factor has four different groups: White, African American, Hispanics, and Asian. Gender, SES, and obesity are measured as dummy variables (yes=1, no=0). Again, SES is divided relative to whether a respondent has at least a college degree. This constructs to a total of 32 groups, and each group has 8 diet variables, which were described above. Then, 32 groups are divided by SES for three reasons. First, SES influences the diet style: the higher the SES, the healthier the diet (Zhang & Wang, 2004). [(18)] When people are in the lower SES category, they consume great amounts of unhealthy food, including fast food. [(12,19)] Second, it is recommended to have at least 9 non-metric variables for 2 dimensional maps. This study decided to have 2 dimensional maps, as it is investigating 8 variables, which is close to 9. [(20)] Third, which is a practical issue, when the MDS presents 32 groups together, the map is crowded so it is hard to distinguish the group.

Statistical Analyses

Multidimensional Scaling (MDS) is one of the popular multivariate statistical models in the social sciences such as political science, psychology, economics, marketing, and even biology. [(21-24)] The MDS creates a conceptual mapping that aims to reveal the hidden structures of underlying data based on the similarities or dissimilarities among different groups; moreover, it considers the relative

positioning of each group, [20,25] which allows researchers to understand the results more intuitively. That is why the MDS is an exploratory method rather than an inferential one. [26] More specifically, this study uses the non-metric MDS, because the diet variables in this study are non-metric and have ordinal nature.

The most commonly used method for non-metric MDS was developed by Kruskal. His approach is to optimizing an explicit measure of "badness of fit" is called STRESS. The procedure of Kruskal's approach is as followed: [20] select the dimensionality of the space for scaling a solution, and then start configuration by placing each object somewhere on the map. The location of object *i* in our two-dimensional configuration is denoted by the vector $x_j = (x_{i1}, x_{i2})$. The next step is to calculate the distance between all pairs of points on the map to assess the correspondence between the distances in the configuration and in the dissimilarities. The interpoint distances are given in Euclidean space by the following formula (Shepard, 1980): [27]

$$d_{ij} = \sqrt{(X_{i1} - X_{j1})^2 + (X_{i2} - X_{j2})^2 + \ldots + (X_{ir} - X_{jr})^2}$$

Then, access the correspondence between the distances d_{ij} and dissimilarities δ_{ij}. One of the ways to present this correspondence graphically is via a Shephard diagram. In addition, Kruskal's STRESS measure captures the departure from monotonicity between the fitted distances and the observed dissimilarities mathematically: the closer the ordinal correspondence, the lower the STRESS. Kruskal's STRESS function can be represented as:

$$S = \sqrt{\sum_{ij} (d_{ij} - d^*_{ij})^2 / \sum_{ij} d^2_{ij}}$$

d_{ij} notes the predicted distances and d^*_{ij} the target distances, which is derived from the observed dissimilarities. The larger the differences between d_{ij} and d^*_{ij}, the greater the values of STRESS, the poorer the fit. According to Cox, [28] if the score of the STRESS is less than .05, the model fits really well; if it is between .05 to .10, the model fits well; and if is over .20, the model fits poorly.

Another way to see the model fitness of MDS is to run the shepherd diagram, which displays a relationship between predicted distances and observed dissimilarities. The STATA 14.0 version will be used to run MDS. [29]

RESULTS

Table 1: Descriptive Statistics of Lifestyle and Health Behavior by Racial and Ethnic Group - Higher SES

	Fruits	Beans	Green	Orange-colored fruits	Vegetables	Fruit Juice	Sugar drink	Sweetened drink
Obese white males	0.75	0.25	0.44	0.21	0.73	0.35	0.59	0.44
Non-obese white males	0.81	0.27	0.48	0.25	0.76	0.40	0.71	0.52
Obese white females	0.97	0.25	0.51	0.26	0.84	0.31	0.47	0.31
Non-obese white females	1.07	0.26	0.58	0.29	0.85	0.35	0.41	0.31
Obese black males	0.78	0.24	0.44	0.19	0.55	0.51	0.69	0.64
Non-obese black males	0.74	0.25	0.44	0.23	0.55	0.61	0.73	0.78
Obese black females	0.98	0.25	0.55	0.24	0.62	0.54	0.65	0.52
Non-obese black females	0.97	0.25	0.54	0.24	0.62	0.58	0.63	0.56
Obese Hispanic males	0.95	0.46	0.48	0.28	0.59	0.46	0.59	0.45
Non-obese Hispanic males	0.92	0.51	0.50	0.28	0.58	0.50	0.54	0.45
Obese Hispanic females	1.08	0.56	0.59	0.30	0.65	0.46	0.43	0.27
Non-obese Hispanic females	1.14	0.48	0.55	0.31	0.65	0.49	0.51	0.46
Obese Asian males	0.83	0.24	0.49	0.23	0.77	0.49	0.61	0.68
Non-obese Asian males	0.80	0.26	0.43	0.26	0.66	0.49	0.85	0.72
Obese Asian females	0.95	0.22	0.45	0.25	0.75	0.46	0.47	0.27
Non-Obese Asian females	0.93	0.24	0.56	0.27	0.72	0.45	0.56	0.34

Table 1 presents the descriptive statistics for the diet style among racial and ethnic groups, gender, and obesity for the higher SES groups. In general, non-obese

people show healthier diet styles than those of obese ones; they eat more fruits, beans, vegetables, greens, orange-colored fruits, and fruit juices. Drinking soda and sweetened drinks, however, show some interesting results: Non-obese black males and non-obese Hispanic males consume the greater amounts of sugar and sweetened drinks than their obese counterparts. Non-obese Hispanic females and non-obese Asian males consume the greater amounts of sweetened drinks than their obese counterparts.

Moreover, Table 2 presents the descriptive statistics for the lower SES groups and similar results: non-obese people show healthier diet styles than those of obese ones. It also has same interesting results: Non-obese white males, non-obese black males, non-obese Hispanic females, and non-obese Asian females consume the greater amounts of sugar and sweetened drinks than their obese counterparts. The difference with regard to the consumption for diet variables in black males and females in the lower SES model are smaller those in the higher SES one.

Table 2: Descriptive Statistics of Lifestyle and Health Behavior by Racial and Ethnic Group - Lower SES

	Fruits	Beans	Green	Orange-colored fruits	Vegetables	Fruit Juice	Sugar drink	Sweetened drink
Obese white males	0.91	0.27	0.55	0.26	0.81	0.35	0.30	0.27
Non-obese white males	1.05	0.30	0.62	0.30	0.83	0.44	0.26	0.24
Obese white females	1.22	0.28	0.64	0.32	0.97	0.26	0.24	0.19
Non-obese white females	1.40	0.31	0.76	0.37	0.99	0.31	0.15	0.15
Obese black males	0.96	0.28	0.59	0.28	0.63	0.62	0.38	0.45
Non-obese black males	0.92	0.31	0.58	0.28	0.75	0.62	0.40	0.49
Obese black females	1.23	0.24	0.70	0.26	0.73	0.46	0.35	0.45
Non-obese black females	1.12	0.27	0.77	0.35	0.74	0.53	0.33	0.28
Obese Hispanic males	0.90	0.42	0.53	0.31	0.71	0.46	0.34	0.21
Non-obese Hispanic males	0.93	0.41	0.60	0.33	0.69	0.52	0.36	0.26
Obese Hispanic females	1.16	0.38	0.68	0.32	0.74	0.35	0.38	0.18
Non-obese Hispanic females	1.26	0.41	0.73	0.37	0.78	0.42	0.20	0.29
Obese Asian males	0.78	0.25	0.57	0.25	0.91	0.47	0.38	0.33
Non-obese Asian males	1.00	0.35	0.66	0.38	0.86	0.61	0.19	0.89
Obese Asian females	0.94	0.36	0.66	0.36	1.25	0.37	0.34	0.37
Non-Obese Asian females	1.38	0.35	0.81	0.45	0.88	0.67	0.24	0.21

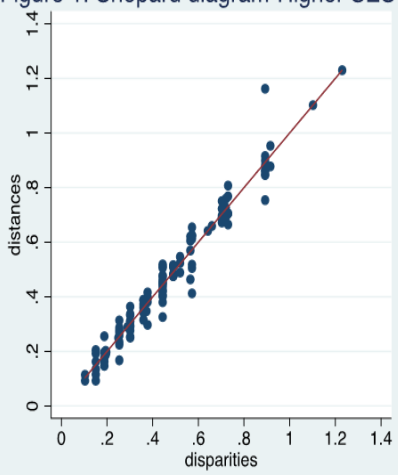
Finally, the lower the SRESS scores lead to the better fit for the model. The STRESS score for the higher SES model is 0.0917 and for the lower SES one is 0.0473, respectively. Both models fit well, yet the lower SES model fits better. The values of the Pearson correlations demonstrate higher values, ranging from .91 to .99 for the higher SES model, and from .97 to .99 for lower SES one. The Shepard graphs that display a relationship between predicted distances and observed dissimilarities present a linear relationship for both models (see Figures 1 and 2).

As hypothesized, the MDS map in Figure 3 shows that same racial and ethnic groups compared to different racial and ethnic groups that are located closely together, although the differences by obesity and gender do exist. In addition, non-obese people are located lower than their obese counterparts in the same racial and ethnic groups; females are located on the lower left side of the map compared to their male counterparts. Only Asians are not closely concentrated; they show no pattern on the map. It may imply that the diet styles of Asians are more distinctive between obese and non-obese than other groups in the higher SES model.

The lower SES model in Figure 4 also presents the similar results: the same racial and ethnic groups are located closely regardless of obesity, but their closeness in the lower SES model is stronger than that of the higher SES one. Moreover, non-obese people are located below the obese ones; females are located on the lower left side compared to their male counterparts as in the higher SES model. Unlike the higher

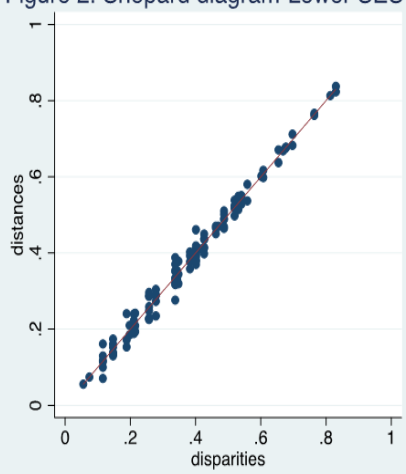
SES model, Asian males and females are also closely located.

Figure 1. Shepard diagram-Higher SES



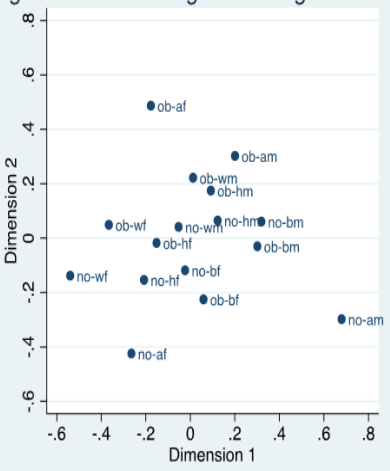
Modern MDS (loss=stress; transform=monotonic)

Figure 2. Shepard diagram-Lower SES



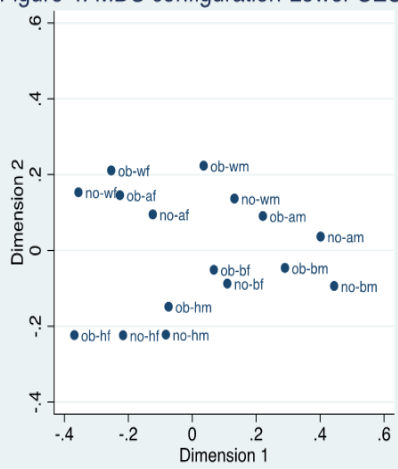
Modern MDS (loss=stress; transform=monotonic)

Figure 3. MDS configuration-Higher SES



Modern MDS (loss=stress; transform=monotonic)

Figure 4. MDS configuration-Lower SES



Modern MDS (loss=stress; transform=monotonic)

DISCUSSION

The goal of this study attempted to present a visualization of the similarities and dissimilarities among diet style across different racial and ethnic groups, which have not been thoroughly investigated. To do so, this study employed the MDS as statistical methods and constructed 32 groups combined by race and ethnicity, gender, SES, and obesity. The results not only revealed the hidden structure of the diet style for each group in both models, [20,25] but also supported the hypotheses, which proved the MDS as an appropriate choice. Although this study shows the differences in the diet style by gender and obesity, the main point of this study-the same racial and ethnic groups are located closer on the map regardless obesity-is valid. It implies that the current intervention effort that focused on the changing diet styles, which were healthier at the individual and at the community level, was not enough. There needs to be a consideration of race and ethnicity as a group.

This study, however, has limitations. As described above, the MDS is not the method to present the causal relationships between independent and dependent variables. It, instead, is an exploratory one. [26] This limits the generalizability of the results. Second, this paper only explores the similarities and dissimilarities of the diet

styles by using 8 different measurements, broadly categorized by of fruits, vegetables, and drinking. If we could expand the diet more comprehensively, it would improve our understanding of the diet on obesity.

CONCLUSION

This study presented a meaningful visualization of the similarities and dissimilarities among diet style across different racial and ethnic groups. The same racial and ethnic groups are located closer on the map regardless obesity. It implies that the current intervention effort needs to be a consideration of race and ethnicity as a group. As this study only has 8 dietary variables, it would be great to improve our understanding of the diet on obesity by having more comprehensive list dietary variables.

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