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Assessing the Methods in Identifying Rural Food Deserts: A Quantitative Systematic Review

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ABSTRACT

It has been around two decades that the food desert concept was introduced to assess the geographic accessibility of healthy food stores in deprived urban and rural communities. Despite the contribution of this strong tool in evaluating food insecurity, the methodological aspects especially in rural areas have been less discussed in the literature. The aim of this study is to explore and compare different methodologies in identifying rural food deserts based on the related major elements. A systematic review was conducted on published English language studies that used quantitative methods to identify rural food deserts up to December 2015. Twenty studies met the criteria and were included in this study. The results from these studies indicated the four major key elements (food availability, geographic accessibility, deprivation indicator(s), and geographic unit of analysis) were used and quantified by researchers in their methodology to identify rural food deserts. We also found out that measuring food deserts involves a high degree of sensitivity, as any changes in quantifying the elements may significantly impact the final results. Thus, the advantages and disadvantages of quantifying each element is discussed in a greater detail in this study. This will help researchers to develop a better food desert methodology which produce more comprehensive and accurate results in future.

Key Words: Rural Food deserts, Food Availability, Geographic Accessibility, Geographic Unit of Analysis, Deprivation Indicator

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1. Introduction

Food plays a vital role in providing essential nutrients and calories to promote physical and mental health throughout the life-cycle (Hans, 2014; Siefert et al., 2004). Several studies have indicated that community nutrition environments (especially when measured in terms of the availability of outlets selling healthy food) play a crucial role in providing healthy foods to individuals (Glanz et al., 2005; Khan et al., 2012; Story et al., 2008; Thornton et al., 2010). However, due to the uneven distribution of healthy food outlets (e.g., supermarkets and grocery stores, and famers' markets) as well as financial barriers, not all people have equitable access to healthy food choices to adhere to a healthy diet (Drewnowski et al., 2010; Hatfield and Gunnell, 2005; Soulis, 2012). Regions where vulnerable populations have access to few healthy food outlets are referred as 'food desert' (Cummins and Macintyre, 1999; Wrigley et al., 2002). The food desert term, not only assesses the geographic availability of healthy food stores, but also examines the socio-economic and demographic disparities between neighbourhoods using non-geographic variables such as income, ethnicity and poverty rate (Dai and Wang, 2011). Because the study of food deserts has been approached in different ways across academic disciplines, the definition of food deserts varies across studies. Morrow et al. (2011) stated that "Food deserts are easy to comprehend and yet difficult to explicitly define" (p. 3). Leete et al. (2012) broke down the conceptual definition of food desert into four key elements including geographic unit of analysis, disadvantaged people, availability, and accessibility of healthy and affordable foods. The divergence exacerbates where researchers seek to quantify the food desert elements based on study objectives and available data. For example, Bonanno (2012) stated that "Identifying and measuring food deserts is not easy, as it depends upon what food stores one decides to consider, on how "neighborhoods and communities" are defined and on the meaning given to "affordable and nutritious food" (p. 1). As a result, comparative studies that applied different food desert approaches and data in a specific geographical area indicated significant variation in areas which were classified as food desert (Sparks et al., 2011; Roes et al, 2009). These variations in developing methodologies to identify food deserts have aroused ambiguities among researchers and policy-makers.

Despite the pervasiveness of food desert studies in the past two decades, the methodological aspects especially in rural areas have been less discussed in the literature. The aim of this study is to explore and compare different methodologies in identifying rural food deserts based on the related major elements. Moreover, the advantages and disadvantages of quantifying each element will be disused deeply in this study.

2. Methodology

We sought to retrieve English language studies that used quantitative methods to identify rural food deserts in this systematic review. The keyword "rural food desert" was searched in the online databases such as Social Sciences Abstracts, ScienceDirect, FRANCIS, Google Scholar, Web of Science, PubMed, ProQuest, and Open Access Theses and Dissertations (OATD) since the inception of the database through December 2015. It should be noted that priority was first given to peer-reviewed articles, however, few studies of rural food deserts employed quantitative methods, theses and dissertations were also included in this review. Moreover, we used a "snowball method" to maximize the potential number of articles based on the relevant studies in the reference lists. Early studies in UK (e.g., Fury et al., 2001; Shaw, 2006) that used qualitative techniques such as focus groups and direct observation were excluded from this review. In addition, articles which used pre-identified food desert methods by organizations (e.g., United State Department of Agriculture [USDA] 2011; Centers for Disease Control and Prevention

[CDC] 2011) to investigate the associated diet-related outcomes were not included in this study. The methodologies in the studies which met the inclusion criteria were extracted and broken down based on major food desert elements for in-depth analysis and comparison in this review.

3. Results

We found 286 abstracts in the initial search of online databases. After incorporating the inclusion criteria and eliminating the replicate and irrelevant studies, 20 studies were selected for the final review. The studies consist of 15 peer-reviewed articles, one scholarly report, three master theses, and one doctoral dissertation. Unlike, urban food desert studies, which were conducted in many different countries (e.g., United States, UK, Canada, Australia, New Zealand, Japan, and Paraguay), almost all rural food desert studies were conducted in the United States. Only one recent food desert study by Karizan et al. (2014) in rural Slovakia was found in the literature. The methods of quantifying each major element in identifying rural food desert are elaborated in this section. The results are summarized in Table 1.

3.1. Geographic Unit of Analysis

A crucial step in identifying food deserts is choosing the geographic unit of analysis. In most studies, the geographical unit delineates the study area based on pre-defined administrative boundaries such as census tract, dissemination area (DA), Census Block Group (CBG), or neighbourhood (Arsenault et al., 2013). Food desert researchers usually, but not always, select geographic unit of analysis for two main purposes. First, they seek to examine which proportion of the geographic units or the related proxies (e.g., geometric centroid, population weighted centroid (PWC), and center of zip code) in the study area falls beyond a reasonable access distance or time to a healthy food destinations. Second, they retrieve and aggregate socio-economic and demographic information from geographic units to classify low-income and/or deprived areas.

In this review, of 20 eligible studies, five (Barnier 2014; Liese et al., 2014; McCracken et al., 2012; McEntee and Agyeman, 2010; Richard, 2012) used census tract, eight studies (Aviola et al., 2013; Blanchard and Mattews, 2007; Hill and Zhang, 2014; Hubly, 2011; Jiao et al., 2012; Mulangu and Clark, 2012; Opfer, 2010; Theiolf, 2012) used CBGs, two studies (Hendrickson et al., 2006; Rigby et al. 2012) used neighborhood, one study (Karizan et al., 2014) was of a municipality, and one study (Schafft et al., 2009) used school districts as the geographic unit of analysis. It is noteworthy that in three studies (Grauel and Chambers, 2014; Van Hoesen et al., 2013; Whitley, 2013), geographic units were not taken into account in developing the food desert methodology.

3.2. Food Availability

In the context of food deserts, researchers usually seek to identify and locate the food stores that provide a wide range of healthy and affordable food options in a given geographical region. In most of the eligible studies, supermarkets and grocery stores, and to a much lesser extent, farmers' markets were identified as the main healthy food suppliers. Among 20 studies in this review, eight researchers (Blanchard and Matthews, 2007; Grauel and Chambers, 2014; Hendrickson et al., 2006; Hubly, 2012; Jiao et al., 2012; Mulangu and Clark, 2012; Opfer, 2010; Richard, 2012) focused solely on supermarkets and 11 researchers (Aviola et al., 2013; Barnier, 2014; Hill and Zhang, 2014; Krizan et al., 2014; Liese et al., 2014; McCracken et al., 2012; McEntee and Agyeman 2010; Rigby et al., 2012; Schafft et al., 2009; Thierof, 2012; Whitley, 2013) included both supermarkets and grocery stores as the major healthy destinations. Only, Van Hoesen et al. (2013) incorporated farmers' markets along with supermarkets and grocery stores in their study. It should be noted that several studies (e.g., Guthman, 2008; Lucan et al., 2015; McCracken et al., 2012; Tong et al.,

Table 1: Summary of Quantified Elements in Identifying Food Desert in Each Study

Author(s) year	Study Area	Food Availability			Measuring Geographic Accessibility			Geographic Unit of Analysis	Socio-economic & Demographic Variables
		Food Store Type(s)	Food Store Data Acquisition	Food Store Qualification	Exposure Assessment Tool(s)	Reasonable Access and Travel Mode	Distance Construct		
Aviola et al. (2013)	Arkansas State	Supermarket Grocery Store	Dan & Bradstreet	SIC & Annual Sale Over $500,000	Proximity	10 miles Driving Distance From PWC	Euclidian	CBG	Income
Barnier (2014)	Alabama State	Supermarket Grocery Store	InfoUSA	SIC & Annual Sale Over $200,000	Proximity	10 miles Driving Distance Service Area	Euclidian	Census Tract	Income
Blanchard & Matthews, (2007)	Rural America	Supermarket	County Business Pattern	Over 50 Employees	Proximity	10 miles Driving Distance From Center of Zip Code	Euclidian	CBG	Income
Grauel & Chambers (2014)	Williamette Vally, Oregon	Supermarket	Google Earth	NAICS	Proximity	10 miles Driving Distance From Residential Addresses	Euclidian	N/A	Income Ethnicity
Hendrickson et al. (2006)	Minnesota Rural areas	Supermarket	On-site Visiting	NAICS & Over 20 Employees	Density	N/A	N/A	Neighbour-hood	Income

Author(s) year	Study Area	Food Availability			Measuring Geographic Accessibility			Geographic Unit of Analysis	Socio-economic & Demographic Variables
		Food Store Type(s)	Food Store Data Acquisition	Food Store Qualification	Exposure Assessment Tool(s)	Reasonable Access and Travel Mode	Distance Construct		
Hill & Zhang (2014)	Washington & Beafort Counties, North Carolina	Supermarket Grocery Store	ReferenceUSA Google Map On-site Visiting	NAICS	Proximity	2 miles Walking &10 miles Driving Distance Service Area	Road Network	CBG	Income
Hubley (2011)	Somerset County, Rural Maine	Supermarket	On-site Visiting	N/A	Proximity	10 miles Driving Distance Service Area	Euclidian	CBG	Income
Jiao et al. (2012)	King County Washington State	Supermarket	Public Health Seattle & King County	National or Regional Chain	Proximity	10 minutes Walking, Biking, Riding Transit & Driving Time Service Area	Road Network	CBG	Income Car Ownership
Karizan et al. (2014)	Rural Bratislava	Large Grocery Store	N/A	N/A	Proximity	10 minutes Driving Time Service Area	Road Network	Municipality	N/A
Liese et al. (2014)	South Carolina	Supermarket Grocery Store	InfoUSA	Over 50 Employees	Proximity Density	10 miles Driving Distance Service Area	Euclidian Road Network	Census Tract	Income

Author(s) year	Study Area	Food Availability			Measuring Geographic Accessibility			Geographic Unit of Analysis	Socio-economic & Demographic Variables
		Food Store Type(s)	Food Store Data Acquisition	Food Store Qualification	Exposure Assessment Tool(s)	Reasonable Access and Travel Mode	Distance Construct		
McCracken et al. (2012)	Washington State	Supermarket Grocery Store	Zip Codes Business Pattern	NAICS & Over 50 Employees	Proximity	10 miles Driving Distance From PWC	Road Network	Census Tract	Income
McEntee & Agyeman (2010)	Vermont, New England	Supermarket Grocery Store	Reference-USA	NAICS & Size Over 2500 sq.ft	Proximity	10 miles Driving Distance From Residential Addresses	Road Network	Census Tract	Income
Mulangu & Clark (2012)	Marion County, Ohio	Supermarket	InfoUSA	NAICS & Size Over 40000 sq.ft	Proximity	1 mile Walking Distance & 10 minutes Driving Time Service Area	Road Network	CBG	Income
Opfer (2010)	Coos & Curry Counties, Oregon	Supermarket	Reference-USA	NAICS	Proximity	1 km Walking & 10 miles Driving Distance From PWC	Euclidian	CBG	Income
Richard (2012)	Appalachian Mountains	Supermarkets	Hoover’s	NAICS & Annual Sale Over $2,000,000	Proximity	20 minutes Driving Time Service Area	Road Network	Census Tract	Nation Index Value • Unemployment • Income • Poverty Rate

Author(s) year	Study Area	Food Availability			Measuring Geographic Accessibility			Geographic Unit of Analysis	Socio-economic & Demographic Variables
		Food Store Type(s)	Food Store Data Acquisitio n	Food Store Qualificatio n	Exposure Assessment Tool(s)	Reasonable Access and Travel Mode	Distance Construct		
Rigby et al. (2012)	Leon County, Florida	Supermarket Grocery Store	Reference-USA & USDA	NAICS, Size Over 15000 sq.ft & SNAP Acceptance	Density	N/A	N/A	Neighbour-hood	Income Ethnicity
Schafft et al. (2009)	Pennsylvania	Supermarket Grocery Store	Zip Codes Business Pattern	NAICS & Over 50 Employees	Proximity	10 miles Driving Distance From PWC	Euclidian	School District	N/A
Thierolf (2012)	Sandhill, Nebraska	Supermarket Grocery Store	Reference-USA	SIC	Proximity	10 miles Driving Distance Service Area	Euclidian	CBG	Income
Van Hoesen et al. (2013)	Rutland County, Vermont	Supermarket Grocery Store Farmers' Market	Rutland Area Farm and Food Link & SNAP	N/A	Proximity	10 miles Driving Distance From Residential Addresses	Road Network	N/A	N/A
Whitley (2013)	Perry County,	Supermarket Grocery Store	N/A	Over 10 Employees	Density	N/A	N/A	N/A	N/A

2012) suggested that due to limited hours of operation, distribution pattern and relatively higher price of healthy food items of farmers' markets, these locations should be considered as alternate sources of healthy foods rather than as major sources such as supermarkets and grocery stores. In other words, food deserts should be identified according to availability of supermarkets and grocery stores and then investigate the role of farmers' market in attenuating the effects of food deserts.

3.3. Defining Healthy Food Stores

In order to define healthy food stores such as supermarket and grocery stores, researchers often use standard commercial business definitions (e.g., North American Industry Classification System (NAICS) and Standard Industrial Classification (SIC)), food stores characteristics (e.g., size, sale volume, and number of employees) or a combination of both approaches to classify food store types and include healthy food providers in their study. For example, in this review, three researchers (Grauel and Chambers, 2014; Hill and Zhang, 2014; Opfer, 2010) only used NAICS codes in their study. Likewise, Thierolf (2012) solely relied on SIC codes to obtain healthy food stores. In terms of food store characteristics, the number of employees was the factor which were used in three studies (Blanchard and Matthews, 2007; Liese et al., 2014; Whitley 2013) to identify healthy food stores. In nine studies (Aviola et al., 2013: Barnier, 2014; Hendrickson et al., 2006; McCracken et al., 2012; McEntee and Agyeman 2010; Mulangu and Clark, 2012; Richard, 2012; Rigby et al., 2012; Schafft et al., 2009) NAICS or SIC codes were used along with food store characteristics such as annual sale volume, size, and number of employees to classify supermarkets and/or grocery stores. Jiao et al. (2012) only included supermarkets which belong to national or regional chain companies. In the remaining three studies (Hubly, 2011; Karizan et al., 2014; Van Hoesen et al., 2013), the authors did not explain the criteria of selected healthy food stores in their articles.

3.3.1. Measuring Geographic Access

In the broader literature, proximity and density are the most two common tools used to measure geographic access to certain food stores within a given study region. Proximity is simply distance to the closest food stores whereas density reflects the number of food stores within a specified pre-defined or defined boundary (Borguine et al., 2013; Mhurchu et al., 2013). In food desert studies, researchers tend to use proximity to estimate geographic access to healthy food stores. In this review, proximity was used in 17 studies and a density approach in the remaining three studies (Hendrickson et al., 2006; Rigby et al., 2012; Whitley, 2013).

3.3.2. Reasonable Access Distance/Time

People use variety of traveling modes such as walking, bus riding, and driving to reach healthy food stores. In food desert studies, there is an assumption that residents in rural communities are more likely to drive to healthy food stores than using other modes of transportation. In all the 17 distance-based studies, driving was the main mode of transportation. However, some researchers (Hill and Zhang, 2014; Jiao et al., 2012; Mulangu and Clark, 2012, Opfer, 2010) used alternate modes of transportation (e.g., walking, biking, and public transit) in addition to driving in their studies.

The reasonable driving distance in rural areas for residents to reach the nearest healthy food store is 10 miles according to point-to-point driving speed of 40 miles per hour in 15 minutes (Ver Ploeg et al., 2009; Wilde et al., 2014). This 10 mile threshold was applied in all the 13 distance-based studies which measured the reasonable distance to healthy food stores by driving mode of transportation (see Table 1).

In order to measure the reasonable driving distance to healthy food stores, researchers often use Euclidian distance or road network methods to identify the low-access areas (Borgoine et al., 2013; Yamashita and Kunkle, 2012). Among the 13 distance-based studies in this review, seven studies (Aviola et al., 2013; Barnie, 2014; Blanchard and Mattews, 2007;

Grauel and Chambers, 2014; Hubly, 2011; Opfer, 2010; Schafft et al., 2009; Thierolf, 2012) was the method to measure the driving distance. On the other hand, in five studies (Hill and Zhang, 2014; Liese et al., 2014; McCracken et al., 2012; McEntee and Agyemen, 2010; Van Hoesen et al., 2013) researchers measured the reasonable driving distance along the road network. Recently, a growing body of literature has suggested to measure driving time instead of driving distance along the road network and take the speed limits into account to produce more realistic results especially in rural areas Charrire et al., 2011; Dai and Wang, 2011; Mhurchu et al., 2013). Out of 17 distance-based studies, measuring reasonable driving time (e.g., 10 to 20 minutes) to reach healthy food destinations, was performed in three studies (Jiao et al., 2012; Karizan et al., 2014; Richard, 2012).

3.4. Socio-economic and Demographic Variables

Locating of a given area beyond the reasonable geographic access to a healthy food store is necessary but not sufficient to be classified as a food desert. Thus, researchers often use socio-economic and demographic variables to define deprived (or disadvantaged) areas as the sufficient condition in identifying food deserts. However, in four studies of this review (Karizan et al., 2014; Schafft et al., 2009; Van Hoesen et al., 2013; Whitley, 2014), researchers did not explicitly defined deprived communities in identifying food deserts.

Substantial studies has indicated that income is the key determinant of defining deprived areas (Guy et al., 2004; Ver Ploeg et al., 2009; Walker et al., 2010). In this review, income variable was used in 12 out of 16 studies in defining deprived communities. A growing body of literature has suggested that aside from income criteria, other socio-economic factors, such as age, ethnicity, education, car ownership, and housing, should also be incorporated in defining deprived areas (Apparicio et al., 2007; Beaulac et al., 2009; Gould et al., 2012; Smith et al., 2010). For example, Grauel and Chambers (2014) and Rigby et al. (2012) added ethnicity as an indicator of vulnerability in their studies. Jiao et al. (2012) consider vehicle ownership along with income in identifying food deserts. In a more advanced method, Richard (2012) used a composite index based on income, unemployment, and poverty rate to classify deprived areas.

4. Discussion

By comparing the developed methodology of each study in this review, it is conspicuous that scholars quantified the food desert elements in a unique way based on their interests, data availability, and field of expertise. These tremendous variations can significantly reduce the generalizability of food desert results across studies. To put it another way, the results of food desert studies are highly sensitive and even a slight change in quantifying an element (i.e., applying thresholds) leads to different outcomes. For example, McCracken et al. (2012) changed the threshold in defining healthy food stores based on number of employees from 50 to 20 controlling for other elements. As a result, more healthy food stores were qualified to be included in their study which caused the reduction of identified food desert census tracts by 41%. In another study, Karizan et al. (2014) increased the reasonable traveling time to healthy food stores form 10 minutes to 15 minutes controlling for other elements and consequently the number of food desert municipalities diminished from 23 to 9.

4.1. Methodological Challenges in Identifying Food Desert

Despite the lack of generalizability of food desert results, researchers and policy makers can still benefit from them in that specific study area. However, there are some methodological challenges which impact the accuracy and validity of the results in a given area. At some point, a researcher can overestimate or underestimate food deserts and produce less realistic results. More importantly, negligence of some methodological issues might lead to production of inverse results. In this section, some of the most important and repetitive methodological problems which appeared in the several studies of this review will be discussed in detail.

4.1.1. Modifiable Areal Unit Problem (MAUP)

As food desert is an area-based concept in nature, it inherently incurs from MAUP due to the choice of geographic unit of analysis (Ver Ploeg 2015). The MAUP arises when “arbitrarily defined boundaries are used for the measurement and reporting of spatial phenomena” (Heywood et al., 1998, p. 119). It consists of two main components: the *scale* (or spatial resolution) effect and the *zoning* (or aggregation) effect (Clark and Scott, 2014, Jelinsky and Wu, 1996). The scale effect occurs when the results are sensitive to the size of geographic unit of analysis in a given area (Mitra and Buliung, 2012). The magnitude of scale effect in more pronounced in the food desert studies where researchers use density-based approaches to measure the geographic access to healthy food destinations. For example, Ver Ploeg et al. (2015) discussed that smaller geographic unit are more likely to be classified as food deserts due to lower probability of healthy food store establishments. In contrast, there is higher chance of availability of at least one healthy food store in relatively large geographic units. In other words, depending on the size of the geographic unit of analysis, a given area might or might not classified as a food desert. The zoning effect refers to changes in configuration (or partitioning) the geographic unit at a fixed scale of analysis (Clark and Scott, 2014; Miller, 1999). Defining deprived areas which is highly important in identifying food deserts can be influenced by zoning effect and hence lead to produce dissimilar results in a given geographic unit. For example, Schuurman et al. (2007) compared deprivation indices between original census tracts and newly adjusted census tracts based on DAs aggregation in Vancouver, British Columbia and found significant differences in generated results. Prouse et al. (2014) pointed out that different levels of data aggregation within a given geographic unit change the contours of deprivation patterns.

As MAUP tremendously impact the performance and the results of geographic studies, scholars sought to investigate the proper methods to deal with this unavoidable phenomenon. It has been discussed that using individual-level data is the only way to solve MAUP (Butkiewicz et al., 2010; Clark and Scott, 2012; Yang, 2005). However, for the sake of confidentiality of households, individual-level data are often aggregated to administrative units. Inevitably, they have no option but to minimize the MAUP effects. The suggested solutions include, but not limited to, using the most possible disaggregated geographic units (e.g., CBG and DA), network distance, and grid-based approaches, kernel density estimation (Apparicio et al., 2008; Carlos et al., 2010; Hurvitz et al., 2009; Morganstern, 2015; Ver Ploeg et al., 2015).

4.1.2. Secondary Sources of Food Stores

One of the crucial steps in identifying food deserts is to obtain the accurate and valid data on healthy food stores. Undoubtedly, direct observation (or on-site visiting) is the most precise method to include the target healthy food stores in the study. However, due to time and monetary constraints especially in macro-scale food desert studies, researchers rely on secondary datasets such as internet-derived, government registers, and commercial lists (Clary and Kestene, 2013; Fleischhacker et al., 2013). Out of 20 studies in this review, secondary datasets were used in 17 of them. Higher tendency of using commercial business lists (e.g., ReferenceUSA and InfoUSA) were found in this review. However, using secondary datasets are subject to biases that can dramatically alter the results of food deserts from different perspectives. First, as food environment is highly dynamic, a healthy food store can be listed in a secondary dataset which is not operational any longer in a given area. Thus, the food desert results will be overestimated. In contrast, a newly opened healthy food store which is not listed in the secondary dataset will lead to underestimation the food desert results. Grimm et al. (2013) discussed that the probability that a newly opened food store to be listed in secondary datasets varies from 55% to 89%. Second, as food desert researchers are interested in healthy food stores, misclassification of an unhealthy food store to a healthy food stores will cause generating bias results. For example, 7-eleven food stores are classified as supermarket (based on NAICS codes) in InfoCanada business lists. Powell et al. (2011) indicated that the chance of listing supermarkets and grocery stores without misclassification in Dan & Bradstreet and InfoUSA were 46% and 54%, respectively.

Recently, scholars (e.g., Fleischhacker et al., 2012; Han et al., 2012; Paquet et al., 2008 has sought to examine the validity of secondary food store datasets. Regardless of the type of data providers, there is consistency among the results that secondary datasets do not represent the actual food environment. Moreover, the divergence in accuracy between secondary datasets and direct observation approaches exacerbates in rural and remote areas (Gostafon et al., 2010; Longacre et al., 2011; Powell et al., 2011). Studies suggested that combining at least two secondary datasets increases the accuracy of food stores data especially for supermarkets and grocery stores in a given food environment (Liese et al., 2010; Lyseen and Hansen 2014; Runno et al., 2015). To sum up, secondary datasets should be improved and used with cautions to avoid the systematic errors in identifying food deserts.

4.1.3. Distance Computation: Euclidian and Road Network

In the context of geographic food access, researchers seek to find the shortest possible path that residents should follow to reach the food destinations. As mentioned earlier Euclidian and road network were the two most-commonly used methods to compute distance in rural food desert studies in this review. Euclidian distance is the calculation of the ordinary (or straight-line) distance between two points of interest (Hutcheson, 2007; Lindow, 2013). The advantage of this method is that it has ease of implementation and properly represents the geographic coordinates such as the Universal Traversable Mercator (UTM) Coordinate (Chamberlin and Jayne, 2011; Cromley and McLafferty, 2012). However, it does not account for the natural (e.g., mountains, water bodies and vegetation) and built environmental (e.g., buildings, fences and highways) barriers, cost and time of travel (Jones et al., 2009; O'Donoghue et al., 2012). On the other side, the road network method measures the real travel distance or travel time from departure locations to destinations over a transportation network (Levinson and El-Geneidy, 2009; Shahid et al., 2009). Despite certain advantages of the road network method, such as reflecting topographical structures, traffic lights, one-way roads, and speed limits, in the measurements, it is time-consuming and requires more money, data and expertise (Crooks et al., 2012; Glazier et al., 2005; Mhurchu et al., 2013). Substantial research has suggested that computing distance by employing the road network method provides more accurate and realistic results than the Euclidian method (Dai and Wang, 2011; Nesbitt et al., 2014; Yamashita and Kunkel, 2012). Liese et al. (2014) compared the results of the Euclidian and road network distance in rural areas in the United States to examine the efficiency of each method. They concluded that the Euclidian method overestimated the food deserts about two times more than the road network method. Similarly, Thornton et al. (2012) applied multiple buffer ranges from 1 to 5 km using Euclidian and road network buffer methods in Glasgow. The results indicated significant differences in computing distance between Euclidian and road network methods for all scales. In order to increase the accuracy of food desert results, evidence suggested to use road network method especially where the network transportation in not consistent and grid-shaped (Neckerman, 2009).

5. Conclusion

The total of 20 rural food desert studies were summarized and investigated from methodological aspects in this review. The developed methodology in each study was broken down to related major elements for the sake of in-depth analysis and comparison. We observed significant variations in quantifying the food desert elements across the literature. The developed methodology in identifying food deserts was relatively unique in each study which cause low generalizability of generated results. Moreover, the rampant methodological errors which could alter or reduce the accuracy of food desert results were discussed in-detail in this review.

This review attempted to shed lights on complexities in identifying food deserts. Although an ideal and universally-accepted food desert methodology cannot be developed, scholars can take advantage of the outcomes of this study to produce more accurate and precise results by avoiding or optimizing crucial methodological errors. This review can also be beneficial to policy-makers not only by understanding the credibility of food desert results, but also by implementing the proper policy to eradicate or improve the disruption in food retail system in deprived areas.

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