



Modeling the influence of social ties and transportation choice on access to oral healthcare for older adults



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ABSTRACT

The current U.S. demographic shift toward an older population and the importance of intervening before conditions become severe warrant a concerted effort to ease the burden of access to healthcare for older adults. With regard to oral healthcare, more integrated services for older adults are needed to effectively serve their complex medical and dental needs. Using an agent-based simulation model, this paper examines the influence of social ties and transportation mode choices on opportunities for older adults to participate in community-based preventive screening events and access needed oral healthcare. This approach accounts for the heterogeneity of behavior that arises for a population exhibiting diversity in terms of social factors, including socioeconomic means and social support. In the context of older adults living in urban environments, the availability of different transportation modes ought to be taken into consideration. To explore alternative scenarios for the accessibility of preventive screening events offered at senior centers in northern Manhattan, an agent-based model (ABM) was created with a geographic information system (GIS) to simulate the influence of social ties and transportation choices on older adults seeking preventive screening services and oral healthcare. Results of simulation experiments indicate preferences for public transportation and inequities in accessibility that may be mitigated with social support. This simulation model offers a way to explore social support as an important factor in making transportation mode choices that mediate oral healthcare accessibility and thus oral health outcomes for older adults.

1. Introduction

A particularly vexing problem in the United States is the historical existence of and enduring inequities in access to healthcare for poor and disabled populations. Medicaid expansion under the Affordable Care Act (ACA) was intended to partially alleviate this injustice, even as the ACA is currently under threat of repeal or rollbacks in its benefits. Further, racial/ethnic minority and immigrant populations continue to suffer disproportionately from oral diseases such as dental caries, periodontitis, and oral cancers as compared with the white majority and native-born populations due in part to inadequate access to oral healthcare. Inequities in oral healthcare access are exacerbated for older adults upon retirement and subsequent loss of employer-sponsored oral healthcare coverage. These injustices are then compounded by difficulties in conducting daily activities and navigating the built environment due to chronic diseases and disabilities, the inability to afford out-of-pocket expenses required by most private and public health insurance plans, and discriminatory treatment when they do visit

healthcare providers (Andersen, 1995; da Costa et al., 2017; Park, 2009).

Access to healthcare is a complex and multi-dimensional concept that has been advanced from multiple perspectives (Berk & Schur, 1998; Neutens, 2015; Russell et al., 2013). Penchansky and Thomas (1981) summarized the concept of access to healthcare in both the healthcare system and patient aspects with more specific dimensions that include availability, geographic accessibility, accommodation, affordability, and acceptability. Specifically, the dimensions of availability, geographic accessibility, and accommodation evaluate the ease of access to care in time and space through volume, geographic location, and organization of the healthcare system. In contrast, affordability and acceptability describe the socioeconomic characteristics of patients and their attitudes toward service providers. As an alternative to the static view of access to healthcare, Khan and Bhardwaj (1994) emphasize the dynamic processes underlying access as determined by the interplay between the healthcare system and the characteristics of potential patients. Both of these concepts consider access to healthcare

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as a complex problem with underlying dynamic interactions between and within the characteristics of the healthcare system and the characteristics of patients and providers.

Geographic accessibility measures are important for managing healthcare provision and reducing health inequalities between population groups. In particular, geographic accessibility of healthcare refers to the ease with which residents of a given area are able to reach health services and is primarily calculated using GIS software (Langford & Higgs, 2006, pp. 294–306). Many healthcare disparities result from uneven geographic population distributions (Messinger-Rapport, 2009, pp. 179–185), health facilities, and the transportation networks between them (Todd, Seekins, Krichbaum, & Harvey, 1991). Methods for examining geographic accessibility range from simple to complex and include travel distance or time (Brabyn & Skelly, 2002), gravity models (Schuurman, B'erub'e, & Crooks, 2010), and kernel density approaches (Guagliardo, Ronzio, Cheung, Chacko, & Joseph, 2004, pp. 273–283). Efforts to advance geographical research on healthcare accessibility have pointed to opportunities for more dynamic and individualized conceptualizations of accessibility (Neutens, 2015), in keeping with the agent-based simulation approach undertaken in this study. More broadly, this study extends the geographical research on healthcare accessibility by considering the effects of social support in mediating access to care via transportation choice.

Social support refers to assistance provided by other people, groups, and the larger community through social ties (Lin, Ensel, Simeone, & Kuo, 1979) and plays an important role in mitigating multiple barriers to healthcare access. Social communication affects awareness of, attitudes toward, and behaviors regarding healthcare. Instrumental support to individuals through social ties directly improves their access to healthcare. In this study, social support is simulated as an influence on access to oral healthcare for older adults via preventive screening and restorative treatment opportunities as mediated by transportation choices. This simulated social support influences access to care through the dimensions of geographic accessibility as well as acceptability.

1.1. Study aim

The aim of this study is to model social support as a pathway to improved oral healthcare accessibility and thereby utilization. By considering a community-based program in which social support has the potential to improve healthcare accessibility, this study points to opportunities for health geography research that incorporates social dynamics that may influence care-seeking behaviors. This approach contrasts with previous research on healthcare accessibility that has focused on assessing population needs and healthcare service supply using Floating Catchment Area methods (Jamtsho, Corner, & Dewan, 2015; Li, Vo, Randhawa, & Fick, 2017; Luo & Wang, 2003; Mao & Nekorchuk, 2013). The transportation mode choice mechanism implemented in this study is based upon previous work by Jin (2014). This mechanism was also adapted by Zhang, Northridge, Jin, and Metcalf (2018) to include spatially explicit road transportation networks, travel time, and a van sharing option. The social influence mechanism of the model presented herein extends beyond the earlier work of Jin (2014) by incorporating a dynamic social network that is affected by shared experiences at community centers. This dynamic network mechanism also builds upon the work of Wang et al. (2016) in a model that did not account for transportation choice.

1.2. Oral health and healthcare

Oral health is fundamental to maintaining and promoting overall health and quality of life for older adults. Poor oral health adversely impacts quality of life through processes involving declines in nutritional intake, social engagement, and economic productivity; these may in turn exacerbate adverse social, psychological, and economic circumstances, resulting in further deteriorations of overall health

(Petersen & Kwan, 2011). An aging U.S. population requires both more comprehensive care for older patients and improved access to care for underserved population groups, in addition to technological solutions such as interactive self-management platforms that are developed with the active engagement of older adults (Jongstra et al., 2017).

The present study is motivated by the *ElderSmile* program, a community-based initiative operated by the Columbia University College of Dental Medicine and its partners. Its clinical program provides oral and general health screening at senior centers and other places where older adults gather throughout the medically and dentally underserved neighborhoods of northern Manhattan, New York City with the overarching goal to improve health and care-seeking behaviors for primarily racial/ethnic minority older adults (Marshall et al., 2009). Screened program participants are then referred to their own primary care and dental providers or an affiliated community-based treatment center whenever indicated.

ElderSmile exerts positive influences on the oral healthcare access of racial/ethnic minority older adults through the dimensions of availability and accommodation. Social support links the dimensions of geographic accessibility and acceptability through social ties. Communication through “word of mouth” about *ElderSmile* program events has a reinforcing effect on health seeking behavior as expressed through increased participation of older adults in *ElderSmile* screenings (Chakraborty et al., 2017; Kum, Wang, Wang, et al., 2015; Metcalf et al., 2013; Zhang et al., 2018). Moreover, social support may also increase the geographic access of older adults to screening and restorative opportunities through extending their transportation mode choices via, e.g., arranging a car or van ride to an *ElderSmile* event or treatment center.

Current research on healthcare accessibility has centered on population needs and healthcare service supply using a family of methods known as Floating Catchment Area (Jamtsho et al., 2015; Li et al., 2017; Luo & Wang, 2003; Mao & Nekorchuk, 2013). This study extends this body of research by considering a “real world” community-based program in which social support has the potential to improve oral healthcare accessibility. A hybrid agent-based model using GIS and social networks was created to simulate both the social support of older adults and their multi-modal transportation choices that may affect their access to oral healthcare, based upon the experiences of providers and patients in the *ElderSmile* community-based screening program in northern Manhattan. This model formalizes the hypothesis that the social support of older adults improves their access to oral healthcare. It operates by providing motivation for older adults to engage in social activities and seek oral healthcare through multiple dimensions. It also extends access to oral healthcare for older adults through the transportation mode choice by, e.g., arranging a car or van ride. Policy scenarios are then tested to examine the efficiency of the *ElderSmile* program on improving oral health outcomes and exploring potential opportunities to improve oral health equity for racial/ethnic minority older adults.

2. Conceptual framework

The conceptual framework presented as Fig. 1 is a causal loop diagram created to better understand the complexity of oral healthcare access, here represented as feedback mechanisms involving the oral healthcare system and older adults. In particular, it illustrates how social support affects oral healthcare access through social ties and highlights the positive influence of utilization of the preventive screening program.

In essence, a causal loop diagram is designed to identify possible dynamic behaviors of a system and consists of a set of variables and the causal links between them. The positive and negative causal links mean that the two variables change in either the same or opposite directions, respectively. Causal loop diagrams display how the feedback loops operate in the model, which is particularly useful in communicating

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