HEARING HEALTH CARE IN THE UNITED STATES:
A MULTI-SCALE SPATIAL & POLITICAL ECONOMIC ANALYSIS OF HEALTH CARE POLICY AND ACCESS TO AUDIOLOGY SERVICES

BY

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DISSERTATION

Submitted in partial fulfillment of the requirements
for the degree of Doctor of Philosophy in Geography
in the Graduate College of the
University of Illinois at Urbana-Champaign, 2020

Urbana, Illinois

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Abstract

This project addresses hearing health care workers (audiologists) in the United States and the ways that structural, top-down pressures shape their spatial behavior and practice, which cumulatively affects the availability and accessibility of their services at multiple scales. Hearing loss is the third most prevalent disability in the United States, affecting 20 percent of the U.S. population and nearly half of older adults (≥75) (Agrawal, Platz, and Niparko, 2009). Moreover, despite the rising prevalence of hearing loss as the population ages, access to hearing health care services is sharply constrained by economic and geographical barriers and inequalities. The services to diagnose and treat hearing loss—audiology services—are not covered under most insurance plans, nor are they covered beyond a physician-referred assessment under Medicare; moreover, coverage of audiological services for adults under Medicaid varies state-by-state (Arnold, Hyer and Chisholm, 2017; Center for Medicare and Medicaid Services, 2016). Elderly and disabled people experience the effects of these limitations most acutely, due to their lower average household incomes and higher prevalence of hearing loss compared with the general population (Jung and Bhattacharyya, 2012). Therefore, this project examines audiologists, focusing on how their scope of practice and autonomy as professionals are constrained by health policy at the federal and state levels and the broader political economy of inter-professional practice in health care, all of which hinge on the classification of audiologists as non-medical "non-physician" care providers. Subsequent structural factors, such as low reimbursement rates and low professional autonomy, may influence the spatial behavior of audiologists, shaping tendencies in where they choose to locate, thus shaping the accessibility of their services. Situated in the context of an aging national population with growing hearing loss prevalence, this project also examines consumer access to hearing healthcare in the absence of comprehensive commercial insurance, Medicare, and Medicaid coverage of audiology services and hearing prosthetics/devices, which results from the path dependence of a health system formulated to address the needs of a young and 'working age' population. Employing GIS, spatial epidemiological, and spatial analytic methodologies, I examine the spatial, structural, and behavioral dimensions of hearing healthcare access on the part of providers and consumers.

Acknowledgments

I am grateful to every person who has contributed to this project in the form of social support, including, but not limited to providing a sounding board for nascent ideas and simply affirming my ability to complete this project. I would especially like to thank the members of my dissertation committee for their professional guidance and shared expertise in scientific research practice and dissemination. I would like to specifically express my gratitude to Dr. Sara L. McLafferty for her kind and considerate approach to mentoring as I developed my ideas, methods, and approaches. As my advisor and mentor, she has been a model of collegiality and ethical care in our scholarly pursuits as health and medical geographers. Importantly, she has also modelled balance and the importance of asking questions that matter.

As for personal support in my home life, I owe a debt of gratitude to my husband, Dr. Donald A. Planey, for his support as my constant companion and co-adventurer (Team Planey!). Moreover, I wish to thank my in-laws and chosen family for their encouragement and support along the way— and for collectively constituting my rich outer life beyond my role as a doctoral student.

This work would not have been possible without financial support from the state of Illinois' office of Vocational Rehabilitation, and the Robert Wood Johnson Foundation's Health Policy Research Scholars program. I would also like to thank the American Association of Geographers and the National Science Foundation for the travel grant that enabled me to present the second chapter of my dissertation at the August 2018 joint Canadian Association of Geographers-International Geographical Union (CAG-IGU) meeting in Québec City. I would also like to thank the University of Illinois librarians and library-based GIS experts who assisted me in the early stages of this project.

Finally, I dedicate this work to my best friend and big sister, Jessica 'Jess' Jacobs (1986-2016)**—** health care management and policy expert extraordinaire and fierce patient advocate**—** for helping me to define and ask the questions that matter. I draw hope and inspiration from you and your work to include "pre-existing condition" protections in the Patient Protection and Affordable Care Act (ACA). I hope to fan the spark that you started and play a role in expanding access to care for people with complex medical needs.

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1 INTRODUCTION

This dissertation project addresses multiple, spatial dimensions of access to audiologists — hearing and balance specialists — in the United States. By 2060, the number of older adults with hearing loss is expected to double (Goman, Reed, and Lin, 2017). Meanwhile the supply of audiologists is in slow decline. The decrease in audiologist supply is due, in part, to a 41 percent attrition rate– after controlling for retirement– between 1985 and 2012 (Windmill and Freeman, 2013), and declining enrollment in clinical audiology programs simultaneous to a halving of the number of audiology programs in the U.S. (Windmill 2013). There are several, multi-level factors underlying these trends, including low levels of reimbursement for services, constraints on ability to pay for services, and Medicare's policy of not reimbursing audiologist services except in the case of assessments to support a medical practitioner's diagnosis (Centers for Medicare and Medicaid Services, 2016). Although the growing need for audiology services is widely recognized, the patterns, drivers, and health impacts of unequal access to these services are poorly understood. This dissertation examines the accessibility of audiologist services in the U.S., first, examining overall availability and supply of audiologists at the county scale, followed by a finer grained analysis of audiologist accessibility relative to referring primary care providers in the metropolitan Chicago region. Finally, I develop a conceptual model of help-seeking and service use that accounts for the multi-scalar socio-ecological and healthcare policy contexts navigated by patients and providers in the United States.

Access to treatment for chronic conditions, such as hearing and balance disorders, is a salient matter as the U.S.'s health care system, typically oriented around acute care provision, must now meet the needs of an aging population with a heavier burden of chronic illnesses that require long-term care management (Anderson & Knickman, 2005). And this is layered atop the cumulative effects of inequity over the lifespan, manifest as health and wealth inequities among older adults that contour their healthcare service use. Importantly, access is a complex, multi-dimensional, and multi-scalar process whereby patient need and demand for healthcare services are met (or not) by a healthcare system or set of providers (Levesque, Harris, & Russell, 2013).

Specifically, in the case of managing chronic conditions prevalent among ageing patients, healthcare help-seeking and service use is an iterative process, requiring care continuity and coordination to address comorbid symptoms or diagnoses. Given the increased likelihood of constrained mobility-shrinking activity spaces (defined as the spatial or geographic range of their daily life activities) (Sherman, Spencer, Preisser, Gesler, & Arcrury, 2005) and shrinking distance tolerance among older adults (Mayer, 1983), it may be even more important that healthcare services are spatially accessible, in addition to being financially affordable. From the provider side, accessibility may be constrained by regional demographic patterns and broader patterns in healthcare, whereby graduates from both clinical audiology programs and medical schools receive their training in academic medical centers and tend toward practice in urban areas.

Being attentive to healthcare access requires a focus on the spatial-social distribution of healthcare resources relative to need. Inequity in access to audiologist services becomes apparent in terms of healthcare financing, spending, and the spatial allocation of healthcare provision. For example, the supply of audiologists is in slow decline, with a strong bias toward practice locations in high-income and low-need service areas (Planey, 2019). Further, this urban bias may reflect that the fact that audiologists tend to co-locate with primary care physicians and Ear Nose Throat doctors (Otolaryngologists- or surgically trained specialists whose scope of practice includes surgical interventions for hearing and balance disorders), due to their employment in hospitals and private practices (Bureau of Labor Statistics, 2019; Chapter 3). The inaccessibility of audiologist services has consequences for the health and well-being of our aging population. In the case of age-related and acquired hearing loss, studies suggest that untreated hearing loss among older adults is associated with increased risk of adverse events in acute care settings (Bartlett et al, 2008), and a threefold risk of falls (Lin et al, 2013).

This chapter fleshes out the social-theoretical and political-economic contexts underlying this dissertation project. In short, I aim to deepen an understanding of health care rationing by geography within the U.S.'s highly marketized health care system by establishing the grounding for health (care) policies that define care access, interprofessional hierarchies among health care workers, and the ways that 'patients' are defined in these debates. This undertaking begins with understanding policy as an articulation of a state's priorities. Frequently, studies of health care access and other facets of the spatialization of health systems enumerate observed disparities in access and care quality, but *why* they matter is often implicit in the analysis. In focusing on a political economy of health care— particularly hearing health care— this study contributes to the literature by expanding the scope of inquiry to account for underlying factors driving inequity in care access.

This chapter addresses, in turn, the political economy of healthcare in the U.S., beginning with a critical (re)appraisal of the concepts of "population" and "health", to contextualize the biomedicalization of hearing loss as an undercurrent in healthcare policymaking. Thereafter, I address healthcare policy as an articulation of a state's priorities, including the definition of citizenship itself. This insight is rooted in a historical lens that understands the path dependence of health(care) policies in the U.S. as being inextricable from historical conceptions of healthcare and social policy as preserving labor power. A key tension here is borne of the fact that neoliberal, austerity, policies have negative effects on the health of populations (Beckfield & Bambra, 2016), whilst those same populations are increasingly "responsibilized" or made responsible for their own health status and outcomes (Sparke, 2017). Finally, I pivot to the specific case of healthcare policy regarding hearing healthcare provision in the U.S., with focus on older adults, among whom hearing loss prevalence is expected to increase in the coming years.

This work draws principally upon on the insights of health and medical geographers, and health services researchers in other disciplines. Health and medical geography is, by definition, concerned with the health of populations in places. Decades of scholarship in human geography has fleshed out the concepts of 'place' (Massey, 1991; Kearns, 1993) and 'bodies' (Parr, 2002; Dorn & Laws, 1994), but 'health' and 'population' are worth revisiting as fundamental— and political— concepts. Critically, the work of health geographers, medical sociologists, and bioethicists has highlighted the 'negative' valuation of 'health' under biomedical frameworks- as the absence of disease or disability (Dorn & Laws, 1994; Metzl 2010; Viens, 2019). Further, health geography has a strong tradition of work addressing the commodification of health(care) and the production of new consumption-mediated citizenships (Brown, 2003; Kearns & Barnett, 1997; Kivela, 2018).

The work of disability geographers has been instructive for understanding the tight coupling of citizenship and health and disability status (Gaeta-Rayes, 2015; Imrie, 2000; Wilton, Hansen & Hall, 2017; Painter & Philo, 1995). For example, this scholarship highlights the centrality of work-readiness to definitions of citizenship and the concordant production and organization of social and physical space around the normative 'mobile' bodies of workers, which effectively reinforces the structural exclusion of disabled people from employment in the formal sector (Imrie, 2000; Patrick, 2012). This is also the production of what Painter and Philo (1995) termed, "spaces of citizenship." More recently, Wilton, Hansen and Hall (2017) examined the constrained mobilities of disabled immigrants deemed "medically inadmissible" at the Canadian border, reflecting the interests of a country whose relatively generous welfare benefits are not extended to sick and disabled immigrants, who are concomitantly framed as burdens who pose an "excessive demand" on social programs. Specifically, the Canadian 'population' is primarily defined as those possessing the ability to work, and 'health' is thus defined as the ability to work (Wilton, Hansen, & Hall, 2017; Tyner, 2019).

This parallels with current debates over the “public charge” rules issued by the U.S. Department of Homeland Security (DHS) under Trump. “Public charge” laws in the U.S. have their lineage in the enactment of “poor laws” in the 18th century which held taxpayers responsible for the indigent in their communities- in the context of chattel slavery (Klebaner, 1955). Specifically, the historical practice of making the manumission of enslaved Africans contingent upon their demonstrated ability to take care of themselves (conflating free status with absence of illness or disability) was intended to prevent slaveholders from ’freeing’ elderly and disabled slaves to evade their lawful responsibility to feed, house, and clothe those they enslaved when they ceased to be ‘productive’ (Klebaner, 1955). In other words, “public charge” laws were enacted to reduce the number of people who would rely on a pool of public social goods under “poor laws.” This modern-day “public charge” rule reinterprets the Immigration and Nationality Act (INA) § 212(a)(4) to expand the pre-existing definition of “primarily dependent” (immigrants who receive Temporary Assistance for Needy Families (TANF) and Supplemental Security Income (SSI)) to include immigrants’ use of publicly-funded health care insurance (Medicaid, Children’s Health Insurance Plan or CHIP), nutrition (Supplemental Nutritional Assistance Program or SNAP), and housing programs. To add insult to injury, the Trump administration released an executive proclamation which, effective November 2019, requires U.S. consulates to deny visas to immigrants who cannot demonstrate that they have health insurance and the means to pay for health care, effectively means-testing entry into the U.S..

Further, the reinterpreted Public Charge rule codifies a link between employment and healthcare insurance coverage by excluding both Medicaid coverage and subsidized insurance plans available to “lawful” immigrants on Affordable Care Act (ACA) marketplaces.[1] The cited justification for this rule change was the disproportionate share of immigrants who are un(der)insured, compared with citizens. This reasoning ignores the fact of employment discrimination and the tracking of immigrants into sectors where employer-sponsored insurance is rare (e.g. service industry jobs). The above examples highlight

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[1] New York Times. (October 4, 2019). Trump Will Deny Immigrant Visas to Those Who Can’t Pay for Health Care”. https://www.nytimes.com/2019/10/04/us/immigrant-visas-health-care.html (accessed 7 Oct, 2019)

“Mr. Trump issued a proclamation, effective Nov. 3, ordering consular officers to bar immigrants seeking to live in the United States unless they “will be covered by approved health insurance” or can prove that they have “the financial resources to pay for reasonably foreseeable medical costs.”

The president justified the move by saying that legal immigrants are three times as likely as American citizens to lack health insurance, making them a burden on hospitals and taxpayers in the United States. Officials cited a Kaiser Family Foundation study that said that among the nonelderly population, 23 percent of legal immigrants were likely to be uninsured, compared with about 8 percent of American citizens.”

the continued and growing centrality of (i) medical expertise in the definition of deservingness and belonging within nation-states, and (ii) the ‘ideal’ citizen as patient-consumer, in a context where health is a mandate despite a lack of a right to healthcare.

Further, health policy is an instructive link between health, populations, & place. Indeed, policy is “a prime site for the articulation of citizens and bodies” (Bacchi & Beasley, 2002). If we understand health care policy as an articulation of a country’s priorities, then it illuminates how ‘populations’ and ‘health’ are defined in practice. In this chapter, I outline how the path dependence of U.S. health care policies that have historically addressed the needs of a working-age population is reflected in major gaps in Medicare- or public insurance for older adults and adults of all ages with qualifying disabilities or conditions. Specifically, I discuss the lack of Medicare coverage of audiology services beyond “physician-referred assessments” (Centers for Medicare and Medicaid Services, 2016).

1.1 How does it feel to be a problem?: The production of problematic bodies

This section argues that biomedical definitions of health and healthcare result in definitions of bodies as problematics for which the solution is biomedicine. Specifically, it addresses the how bodies are individualized and problematized and what “fixes” are proposed to remedy their shortcomings, with emphasis on hearing loss and hearing health care. Biomedicalization refers to complex processes of knowledge production and subject-making that transform the subject into a patient whose body is always at risk of disease, and who must also meet the moral mandate to maintain the body they possess in a state of “health and wellness” (Rose, 2012; Clarke et al, 2003). The metrics of health and wellness are thus moving goalposts, and bodies themselves become “problems” (Benjamin, 2019). In the context of marketized healthcare, business and professional interests proliferate in order to leverage economic and scientific opportunities afforded by the production of these 'problematic bodies.'

Biomedicalization is also the process of transforming already-medicalized bodies into problematics that can be matched with technical, market-based “fixes.” Clarke and colleagues (2003) characterize this as a shift from normalization (‘universal Taylorized bodies’ as ideal) to customization (individualized bodies that are optimized and transformed). This shift was readily apparent in the post-WWII period, when the field of medicine moved away from the individual model of medicine (wherein the patient sought the physician’s expertise when they had a complaint, and the short-term treatment presumably returned the patient to a state of health) toward a mass model of medicine, wherein all bodies are suspicious, to be considered as at risk of unseen and unknown dangers to their health (Light and

Levine, 1988; Dumit, 2013; Clarke et al, 2003). The "default" body is no longer a healthy one, but one that requires work to remain in a "state of health." Here, health status is a mutable and moveable point, and not a point to which one returns. And here, health is not simply a state, but a property to be maintained through the vigilance of the biocitizen-consumer (Roberts, 2010). Arguably, this is an extension of Lockean definitions of 'property' whereby 'work' on said 'property' is a prerequisite for ownership— articulated by Chicago school economists who forwarded the theory of "human capital," which reformulated populations as an aggregate of individual bodies of varying utility in the labor market (Schultz, 1981; Becker, 1993; Sweetland, 1996). Sparke (2017) characterizes these consumption-mediated citizenships as the production of "biological sub-citizenship through exclusion and conditionalization" (pp. 288).

1.1.1 Connecting "Population" and "Health"

"Medicine is a social science, and politics nothing but medicine at a larger scale." - Rudolf Virchow

Pertinently, (bio)medical practice and public health share a common definition of "population"- as an aggregate or mass of individuals. Historian of science, Michelle Murphy critically defines population as a concept and subject of managerial practices thusly: "*Population, in the 20th century, became a calculative concept used to govern the stock of people in a nation-state for the sake of economic productivity*" (Murphy, 2018, page 103). In other words, the health of the population, or "vital capacities" have long been the subject of state governance (Kearns & Henry, 2009). This instrumental conception of the bodies of people bounded or contained within a national economy is essential for understanding the coupling of citizenship and health and disability status (Bacchi & Beasley, 2002). One could argue that the biological and instrumental conceptions of the bodies of citizens converge in the question of health: *"Does this body work as it should?"*[2] Nowhere is this maxim more clearly articulated than the history of U.S. health(care) policymaking.

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[2] Here, "work" has a dual meaning.

An early example of this instrumental conception of bodies, health, and the national economy can be seen in the contestations around the establishment of the Freedmen's Bureau. Post-Civil War debates over the Freedmen's Bureau were largely grounded in fears that provision of health and social care to formerly enslaved Black people would engender dependency and render them unable to participate in the national economy as "free labor" (Downs, 2012). Further, the practice of coupling of employment status and eligibility for care coverage has its genesis in this period, when the federal government made work readiness a prerequisite for receiving care in hospitals administered by the Bureau's Medical Division. In keeping with previous applications of "public charge" laws to prevent manumitted slaves from becoming recipients of public investments under "poor laws" (Klebaner, 1955), this resulted in the differentiation and marginalization of chronically ill and disabled freedmen, rendering them as subordinate even among "second-class citizens".

Public health, a "state-led citizenship project" (Rose, 2007) intervenes at the level of the population to prevent illness and disease, while healthcare provision is generally centered on the individual patient. Though they operate at different scales, both public health and healthcare share a biological view of the human body (King, 2010), and function to maintain labor power or enable a productive workforce (Tyner, 2019; Wiles & Rosenberg, 2009). In the case of primary healthcare provision, this is evidenced in the 1978 Alma Ata Declaration (WHO, 1978), which states that primary healthcare is "an integral part of the country's health system, of which it is the central function and main focus, and of the overall social and economic development of the community" (Wiles and Rosenberg, 2009, 83). This increasingly applies to older adults in the U.S., who increasingly remain in the workforce for multiple reasons.

Further, biomedical knowledge is often predicated on two assumptions: first, the notion that (i) bodies are discrete, an assumption rooted in methodological individualism, which defines the atomized individual or "rational man" as the base unit of society, and thereafter defines society as a sum of individual-level behaviors or social (inter)actions. (Goldberg, 2012; Tan, 2014).[3] Second, biomedical knowledge and practice typically treat (ii) disease as being sited in the body rather than the outcome of a process that is both biological (etiology) and social (socially constructed, transmitted, and negotiated).

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[3] Methodological individualism defines society as made up of the sum of individual-level social (inter)actions, and thereafter, "social outcomes are the by-products of choices made by individuals who rationally pursue to maximize their own interests" (Tan, 2014). The ideal participant in society, and ideal patient is thus a form of *homo economicus*, who maximizes utility (hence emphasis on "moral hazard" in health economics), and the recipient of social welfare is then defined as a diminished person who must be disciplined into "personal responsibility" (see Edmiston, 2017).

Health and medical geographers' work has historically been rooted in biomedical frameworks, though this grounding has been contested in debates amid the divergence between positivist medical geography and social theory-driven health geography. In the years since Dorn and Laws (1994) argued that "*a reformed medical geography must acknowledge and critically assess its intellectual heritage which understands the body as a site invaded by a disease with a specific etiology...*," health geographers overall have moved toward definitions of bodies as "permeable" and "socially emplaced" (Brown, 2006; Del Casino, 2010; Mol and Law, 2004). While these studies largely focus on infectious disease, this conception of disease can be applied to non-communicable diseases, such as chronic conditions partly caused by exposures to external stressors. In the case of hearing loss, most cases result from long- and short-term exposures to noise and ototoxins (chemical compounds that injure the vestibulo-cochlear system) which damage auditory system structures *in addition to* genetic and aging-related processes. This means that hearing loss is an exemplary case of disease as both biological and social.

The biomedicalization of hearing loss begins before birth. Specifically, D/deaf women of reproductive age are often pressured by medical practitioners to undergo genetic testing to screen for disabilities in their unborn offspring, even when their hearing loss has a non-genetic etiology, like a viral infection (Frederickson, 2019). Under regimes of "scientific motherhood" (Apple, 2006), disabled women are positioned as risky and incompetent before they ever bear a child. And shortly after birth, Universal Newborn Hearing Screening marks neonates as "passing" or "failing." Parents of infants in the latter category are referred for audiological assessments, which may or may not happen depending on the family's ability to cover the out-of-pocket cost of audiological services beyond assessments. If the parents reside in a state whose Medicaid program enforces the Early and Periodic Screening Diagnosis and Treatment (EPSDT) program (Medicaid.gov, 2017), these costs may be defrayed somewhat. In audiological practice, the technical fixes for hearing loss have become more complex and less affordable over time. Hearing aid prices reflect the cost of research and development (R&D) and biotech companies' push for profits, while cochlear implants' use grows in popularity among pediatric populations—primarily white, upper-middle-class patients in the US (Kirkham et al, 2009). This possibly exacerbates the racial and ethnic disparities driven by states' non-compliance with the Early and Periodic Screening Diagnosis and Treatment (EPSDT) program, whereby fewer than half of children were screened for hearing loss in California, North Dakota, South Dakota, and Mississippi, states with sizeable or concentrated Black, Hispanic, and Native American populations (Government Accountability Office, 2019).

Biomedicalization within audiology can be seen in the reconceptualization of hearing loss at the level of genes, molecules, and proteins (Clarke et al, 2003, 168), the molecularization of hearing loss, which then redefines what was considered a “disability” into a “disease.” Related to discourses of (bio)medicalization is a redefinition of hearing loss as a health issue. Audiology’s turn to neuroscience as a base of legitimacy and a deepening of expertise is reflected in the labeling of hearing losses (Møller, 2013).[4] Sensorineural hearing losses, or hearing losses whose etiology is damage or dysfunction in the cochlea, auditory nerve, and auditory nervous system, are defined in terms of where the suspected lesion is, and are increasingly remedied with surgically-implanted prostheses, like cochlear implants (CI) or auditory brainstem implants (ABI), which function by stimulating the auditory nerve endings and the cochlear nucleus [see **Figure 1.1**], respectively (Møller, 2013).

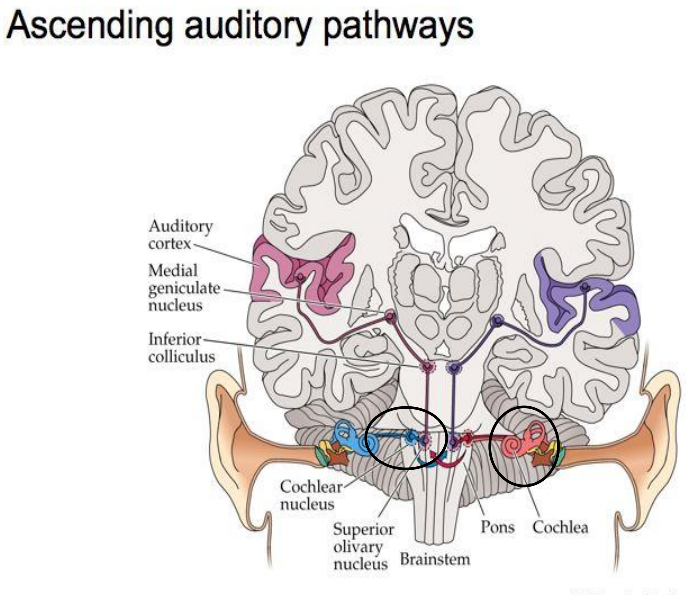

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***Figure 1-1** - Anatomical Figure of the Human Auditory System. By default, biomedical training abstracts the human body and its systems. The figure above illustrates the locations of the cochlea (inner ear) and the cochlear nucleus (in the brainstem).*

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[4] In technical terms, hearing loss is defined as audiometric thresholds above 25 dB HL (deciBels Hearing Level). The types of hearing loss include (i) conductive hearing loss (affecting the outer and middle ear anatomy and mechanisms), (ii) sensorineural hearing loss (affecting the inner ear mechanisms and pathways- including the Cochlea, and the Auditory Nerve (CN VIII)), (iii) Mixed hearing loss (Bone Conduction thresholds above 25 dB HL. Possible lesions to the outer and middle ear as well as to the inner ear) (Møller, 2013). And last, (iv) retro-cochlear hearing loss refers to damage to Auditory system structures above the Cochlea in the inner ear- which includes any point in the Central Auditory Nervous System (CANS, which includes the brainstem structures and pathways, thalamic relays, and primary and secondary auditory cortices). Research on the inner and outer hair cells often focuses on gene mutations and deletions that may be the cause of congenital and progressive hearing losses, just as research on Central Auditory Processing Disorder (CAPD) or Tinnitus will tend to frame the “disabling” effects of hearing loss (which occur in social spaces) as having a neural basis, and thus, individual-level, medical solutions.

Importantly, this shift from hearing loss as a disability toward hearing loss as a medical condition individualizes patients' bodies, reflecting, perhaps, the methodological individualist roots of biomedical research and practice (Tan, 2014). This has the effect of further estranging the epistemological grounding of the field of audiology from social models of disability, which begin by defining the body as socially situated. Put another way, hearing loss is detached from the disabling socio-political contexts that stigmatize hearing loss and facilitate the social exclusion of deaf/hard of hearing people. In this sense, we see what McRuer (2006) referred to as "compulsory able-bodiedness." Indeed, if the social problem of ableism can be sited in patients' 'dysfunctional' neurological systems, then the solution is of an individual nature (Mauldin, 2016). As such, the focus of clinical practice in audiology has shifted from the stated aim of rehabilitating disabled patients to a state approximate to that of a non-disabled person toward a framework of infinite risk, wherein one is always at risk of hearing and balance disorders and in need of vigilant care. When disability is literally in one's head or in one's genes, it is difficult to bring to the fore the material and social consequences of norms that exclude and discriminate against people whose bodies vary from the default non-disabled, "healthy" body. Similarly, within biomedical paradigms that site health in the body, it is difficult to apprehend bodies as socially contingent and "leaky" or permeable—that is, as shaped by exposures such as noise or ototoxic chemicals that affect their health status.

Moreover, medicalization can be situated within biopolitical discourses that posit health (implicitly defined as being able-bodied) as a moral imperative, demanding continual self-improvement (Crawford, 1980), and even "self-care" in ever neoliberal contexts in which healthcare access is increasingly rationed by income (Medicaid), geography (preferential location of health care facilities in high-income and high-density urban and suburban service areas), age (Medicare), parental status (Medicaid), and disability status (Medicaid, Medicare) (Hoffman, 2012). Specifically, neoliberalism is a threefold political and economic imperative: (1) expanding and intensifying markets, (2) minimizing government intervention (e.g. deregulation and the reduction of public sector spending through the withdrawal of the welfare state, which affects population health), and, (3) supporting the production of autonomous 'citizens' who act in the benefit of a state in need of productive labor (Ayo, 2012). The outcome of these political and economic policies and policies includes 'responsibilization' — or the production of responsibilized citizens for whom remaining healthy is a moral imperative (Clarke et al, 2003, 172; Edmiston, 2017). This last point is especially true when one considers how health insurance companies in the U.S. prioritize covering medical/surgical interventions to 'fix' hearing loss over adaptations to hearing loss as a disability. Thus, many insurers reimburse for cochlear implants and osseointegrated (bone-implanted) hearing devices while excluding hearing aids from the schedule of covered devices (Fifer, 2020).

Again, medicalization means that there is always a “solution” to fix what is deemed “abnormal,” and that it takes sacrifice and even self-work on the responsibilized individual’s part to make it work. Where there is an absence of a right to health care, medicalization also involves the production of consumption-mediated subjectivities, such as consumer-citizens who work toward the maintenance or improvement of their health status or mitigation of health risks, in what is effectively a “privatization of risk” (Kay and Williams, 2009). This is seen in the push to sell prostheses such as hearing aids or cochlear implants as remedies for hearing loss in the absence of comprehensive coverage of these treatments (Mauldin, 2016). The practitioner is herein positioned as an expert on a patient’s particular pathology, and this expertise overrides the patients’ lived experiences. Despite popular representations of biotechnological ‘fixes’ for hearing loss as instantaneous and miraculous, many hearing aid users are dissatisfied, and many cochlear implant users are inculcated in a context where the treatment and rehabilitation of their hearing loss is privatized and relegated to the private domain. In practice, this means that patients and caregivers devote countless hours and dollars into becoming “hearing” with their neural prostheses (Mauldin et al, 2019).

Whatever the path a patient chooses, the onus is on the patient to “comply.” In the context of audiological practice, compliance[5] is measured via surveilling technologies embedded in the hearing prostheses, which track whether a patient used the device, how many hours a day, and which settings they adjusted. In keeping with what Armstrong (1995) termed “the rise of surveillance medicine,” this information serves multiple purposes: it allows the audiologist to assess the patient’s actual usage, and it also subjects the patient to a particular gaze that scrutinizes their “compliance.” In some cases, it casts patients as unreliable narrators of their own experiences, reinforcing the common dichotomy of “subjective” patients and “objective” health care practitioners.

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[5] Compliance, in medicine, is a term that refers to how consistently and accurately a patient follows the regimen prescribed by a health professional or physician. For Audiologists, “compliance” can mean wearing one’s hearing aid as often and as long as possible, and this is measured and tracked by the hearing aid itself.

1.2 Health Policy as a Means of Understanding Health Citizenship

"A political economy of premature death, accordingly, recognizes that, under capitalism, 'health' is positioned as the capacity of workers in the abstract to remain productive as to facilitate the continued accumulation of wealth for capitalism." (Tyner, 2019, 40)

"The implications of the 'bad behavior' argument, as is often expressed, are that those who fail to fulfil their obligations to live healthily are less deserving of health care than those who meet their obligations." (Brown, 2012, 695)

Health policy is closely intertwined with conceptions of citizenship. I view the nation-state as a form of political society with rules for the inclusion (or exclusion) of individuals (Stevens, 1999, 56). Moreover, prerequisite to belonging as a citizen is the reciprocal relationship between duties (responsibilities, such as paying taxes or voting in elections) and entitlements or rights claims (Smith, 2009). thus, citizenship is not just a status, but a relation (Sassen, 2006), and it is contoured by hierarchies internal to the nation-state, such as social differentiation by assigned race, gender, class, disability status, and immigration status and attendant (dis)advantages (Crenshaw, 1996). Beginning with this understanding, this project is framed by a concept of "health citizenship" or "biological citizenship." Under health citizenship, belonging is manifest as the 'right' to inhabit social space and participate in political activities and the attendant 'duty' to maintain the ability to be both productive and responsible.[6] Further, belonging within a nation-state is conditioned upon the maintenance of one's health status through consumption of biotechnology products aimed at mitigating identified 'risks' to one's health (Roberts, 2010; Sparke, 2017). In the absence of a positive right to healthcare, health itself has become a moral mandate. Put another way, biological citizenship in the absence of a right to healthcare produces a consumption-mediated citizenship, where responsibilities (consuming healthcare products) are prerequisite to dwindling entitlements (benefits of social citizenship). In the case of hearing loss, access to hearing healthcare is literally a means toward maintaining one's status as a participating member of society. Indeed, in a world oriented around verbal communication, hearing loss is associated with social isolation, lack of incidentally occurring information, and subsequent information asymmetries (Pollard, Dean, O'Hearn, and Haynes, 2009; Pollard and Barnett, 2009). This dynamic has been observed in research on health literacy among deaf people, regardless of education level (Pollard & Barnett, 2009).

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[6] "Productive and responsible" persons are defined as having the "ability to participate fully as producers and consumers in the capitalist system" (Tyner, 2019, xiii). See also, Patrick (2012) and Schweik (2011).

Explicitly articulated in immigration law, health, or ”absence of disability” is a prerequisite for citizenship in the U.S. (Schweik, 2011). This tight coupling of health status and citizenship status— or health citizenship—differs from civic or social citizenship vis a vis *jus soli*, where citizenship is accorded on the basis of (i) birth to a citizen parent, or (ii) birth within a nation’s borders (Benhabib, 2004, 60). Note, however, that these formal legal and social definitions of citizenship do not preclude biological citizenship. Nation-making is foundationally a biologized concept. Defining the boundaries of the nation, who is included (or excluded), and who is considered a "true" or "ideal" rights-bearing citizen is a key task.

Moreover, austerity has meant a foreclosure of domains that have historically typified social citizenship, such as social welfare programs, public education, and a right to health care. In fact, less generous social welfare programs in the U.S. were associated with increased mortality between 1970 and 2010, compared with other wealthy Organization for Economic Cooperation and Development (OECD) member nations with higher investments in social policy (Bambra, 2011; Beckfield and Bambra, 2016; Ronzio, 2003). Neoliberal policies have served to subordinate social policy to the needs of the labor market, toward what Barnett (1999) termed a Schumpeterian workfare state. The advent of the economic theory of “human capital” as forwarded by Chicago School proponents like Friedman, Schultz, and Becker collapsed “labor” and “capital”, and recast the ’individual’ laborers as entrepreneurial subjects who view themselves as a means of production to be optimized, economizing social relations themselves (Tan, 2014; Foucault, 1979). Somers (2006) articulates the link between neoliberalism and market fundamentalism, and a broader shift toward the contractualization and commodification of citizenship thusly:

> “…increasing numbers of socially excluded stateless nationals—people who hold formal *de jure* citizenship, but from whom the state has withdrawn its institutions of social citizenship (via the privatization of public services, the decline of the social welfare state, etc.), even while expelling the bulk of the population from any meaningful participation in the political realm, and providing only the thinnest of connections to civil and legal rights.” (pp 50).

Indeed, what Sparke (2017) termed “biological (sub)citizenship” is produced through exclusion and the growing precariousness of citizenship status. As such, “*exclusion remains a useful term to describe the direct curtailment of access to health services by austerity*” (Sparke 2017, 289). The link between healthcare access and the enactment of citizenship ‘responsibilities’ is also borne out in empirical studies of associations between health insurance coverage and participation in elections, as observed in Oregon, where uninsured adults randomized into Medicaid eligibility were more likely to turn out to vote in the November 2008 presidential election (Baicker & Finkelstein, 2019).

Relatedly, Beatrix Hoffman's (2012) history of U.S. health policy foregrounds the lack of a positive right to health care through a discussion of the rationing of health care by price (co-pays and deductibles on private plans), employment status (employer-sponsored insurance), age (Children's Health Insurance Plan, Medicare), disability status (Medicaid), veteran status (Veteran's Administration; Tricare), and income (Medicaid). Core to rationing in social and health policy is the concept of 'desert'; that is, one must 'deserve' the social investments in their health and well-being by being a "responsible" citizen, and that is determined by means-testing, medical gatekeeping, and other forms of rationing. Relatedly, desert means individuals must bear the costs associated with outcomes of their health behaviors, rather than rely on a pool of social goods (Brown et al, 2019).

To illustrate this point, Hoffman (2012) cited Senator Clifford Hansen (WY-R; 1967-78) statement in a 1971 televised defense of cost-sharing provisions in the American Medical Association (AMA)-drafted "Medicredit" bill:

> *"I don't say it [health care] is a constitutional right, simply because we've been born in America, never to live in poverty, never to need any doctor, or never to have to serve in the military. I think along with the great privileges of citizenship go some personal responsibilities. And so specifically I would say I don't think it's a person's right to the best possible care."* (pp. 164)

A decade later, Richard S. Schweiker, Secretary of Health and Human Services under Reagan, levied a similar defense of cost-sharing, touting the potential to reduce health care utilization and "convince people how to take control of their own health" through "responsible personal behavior" (New York Times, June 1981). The Reagan administrative overtly set out to 'shrink' the welfare state wrought by the New Deal and the Great Society through spending cuts (such as cuts to Medicaid), privatization, and deregulation toward market fundamentalism (Hoffman, 2012).

Within neoliberal discourses of citizenship as articulated through health policymaking, health promotion and education (premised on behavioral fixes for health disparities), "health" is increasingly the domain of "responsibilized" citizens who are tasked with vigilance with regard to risks to their health and wellbeing (Clarke et al, 2003; Brown, 2012; Brown et al, 2019; Goldberg, 2012; Kay & Williams, 2009; Viens, 2019). These responsibilized citizens are concordantly "duties-bearing" citizens (Smith, 2009)—that is, to claim the status and entitlements accorded to a "rights-bearing citizen", one is also subject to the obligations of citizenship, which includes work-readiness (Patrick, 2012). Under (bio)medical knowledge regimes which socially produce illness and disease, health is always imperiled, and risk is ever present, increasingly quantified, and assigned to patients (Dumit, 2013). Biological citizenship is thus a shift from a rights-based belonging claim toward a consumption-mediated belonging that is contingent upon "self-care" through the consumption of healthcare goods and services to manage one's individual health risks (Ehlers & Krupar, 2017).

Moreover, under the conditions of neoliberalism and resulting withdrawals in social policy aimed at improving the health of marginalized populations via structural interventions, the responsibility of being healthy and maintaining a state of health is sited in the individual— a phenomenon called "healthism" (Crawford, 1980; Roberts & Weeks, 2018). Under "health citizenship," in part through state-led citizenship projects such as public health (Rose, 2007, 132), membership in the nation is ever more contingent, based on the "mandate" of health, whereby the 'individual' is compelled to act upon the possibility of risk by maintaining their body's state of health (Rose, 2012; Dumit, 2013). Fusco (2006) identified these patterns and practices as "western neoliberal health imperatives." This mandate takes a moral timbre evidenced in public health messaging and "health promotion" campaigns that emphasize both individual autonomy and individual-level blame attribution (Ayo, 2012; Lupton, 1995; Metzl, 2010). Dorothy Roberts (2010) writes, "…reliance on citizens' personal consumption of biotechnology to address social inequities [here: disadvantages associated with disability stigma] only supports the neoliberal shift of responsibility for public welfare from the state to the private realms of individual, family, and market" (p. 62). Indeed, if a nation is conceived as an "eternal organic body" (Arendt, 1945, 156, cited in Benhabib, 2004), then it is constituted by the bodies of those who belong to it. By extension, the spatial arrangements of society itself are telling of which bodies are 'belong'- for example, the production and organization of social and physical space (and place) around the normative 'mobile' bodies of workers- from inaccessible public transit to inaccessible spatial layouts of workplaces- which effectively reinforces the structural exclusion of disabled people from employment in the formal sector. In other words, where "work-readiness" is a prerequisite for being a "responsible citizen," policies and the related organization of society reflect the exclusion of sick and disabled people, who face ableist discrimination in labor markets.

1.2.1 Presumed Irresponsible: Welfare Subjects and Responsible Citizens

At the level of policy, healthism is reflected in social policies that treat poor health as a consequence of failure to modify one's health behaviors and other "modifiable" aspects of health status (Brown, 2012; Roberts & Weeks, 2018). Roberts and Weeks (2018) write, "Moreover, even if not motivated by animus, healthism can express a view that people who are unhealthy have lower social value, leading to stigma. Healthism can also worsen health outcomes and create or perpetuate health disparities" (pp 23). Given the health-wealth gradient, whereby people of lower socio-economic status typically have poorer health status (Marmot, 2001), there emerges a pattern of revanchist social policies aimed at lower-income people. In fact, the retrenchment of the welfare state under austerity can be understood as reframing impoverished, sick and disabled beneficiaries of social programs as “subjects”, in contrast with high status, high income people as ideal citizens (Edmiston, 2017). Indeed, “welfare austerity has been presented as a necessary step towards restoring economic productivity, but also a reformation of the welfare subject’s character and decision-making” (Edmiston, 2017, 316).

Beneficiaries of social insurance programs are thus framed as incapable of the responsibilities of citizenship and entrenched in a “culture of worklessness”, and the “solution” is to build in means testing and barriers to ‘nudge’ them toward being “active welfare subjects” (Wright, 2016; Viens, 2019). In the U.S., these policies include, but are not limited to “workfare,” which is manifest in myriad forms, including Medicaid work requirement provisions under Section 1115 research and demonstration waivers. Medicaid work requirements imposed administrative burdens in the form of what Moynihan and colleagues (2014) termed ‘compliance costs’ (required reporting on websites that shut down at a particular hour every day in states where broadband access is highly uneven), resulting in loss of coverage for tens of thousands of low-income, and chronically ill people in Arkansas and Kentucky (Wen, Saloner, and Cummings, 2019). This presumption of irresponsibility particularly affects Black people under policies that might be considered “race-blind”, like Michigan’s proposed Medicaid work requirements that exempt Medicaid beneficiaries in rural communities with higher unemployment rates, while erecting bureaucratic and administrative barriers to Medicaid eligibility in the state’s metropolitan areas, where the majority of Black and immigrant Michiganders reside. To be exempted from the work reporting requirements (80 hours of work-, school-, or job training- related activities per month) and health behavior modification requirements (smoking cessation), Medicaid beneficiaries must receive a diagnosis for a permanent disability, be a primary caregiver, or be an older adult. Under these developments, health care providers figure as increasingly important gatekeepers in the process of accessing social support programs as (bio)medical knowledge is used to further delineate the “deserving” from the “undeserving” in determinations of work fitness and eligibility for social programs (Wong, 2016).

Moreover, employed citizens in the U.S. do not escape the imposition of (arguably, ableist) measures of work fitness. At the heart of the Affordable Care Act is an irreconcilable tension between the putative ideals of “anti-discrimination” on the basis of health status and disability status, and the stated aim of preserving traditional private/for-profit health insurance, which relies on “risk adjustments” that explicitly account for health status and disability status to estimate potential costs (Roberts, 2012). Moreover, the logic of biomedicalization is further codified in the Affordable Care Act, which contains provisions for “workplace wellness” programs sponsored by employers with incentives for worker participation and penalties for abstention (Wiley, 2014). In keeping with employers’ concerns about rising health insurance costs, these programs— implemented by half of U.S. firms with >50 employees, covering 80 percent of employees in said firms— require medical information as a requisite for participation, with possible savings in household health insurance premiums (up to 30 percent savings on annual premiums) for participants, or penalties for those who do not participate (Roberts, 2012). These programs provide incentives to workers on the basis of their acquiescence to biometric screenings and the achievement of health-related markers, including, but not limited to, target weights, body mass index, blood pressure, cholesterol measures. Workplace wellness programs extend the logic and practice of employment-based health insurance as a means of maintaining "human capital" into the domains of personal responsibility on the part of the worker, whose body is measured and quantified (Roberts and Weeks, 2018).[7] In effect, these programs reward those who fit the cultural and social norms of "health," while shifting costs from third party payers to people with disabilities, chronic illness, and chronic pain- as well as people whose bodies are under greater scrutiny due to their size (Wiley, 2014). These programs continue to be popular despite mounting evidence that they do not achieve the stated aims of reducing health care expenditures (Jones, Militor, and Reif, 2019; Nash, 2015; Song & Baicker, 2019). Advocates and academics have expressed concern that employers' access to workers' medical records would be used against the most marginalized employees when decisions are made about raises, promotions, and layoffs.

1.3 The Case of Hearing Health Care

Policymaking can be defined as turning priorities into action. The U.S. health system— especially its provision and financing arms in the public and private sector (a hydra, really)— is historically oriented toward the treatment of acute conditions (Anderson and Knickman, 2005). This logic extends to national health data collection, which typically focuses on "working-age" populations to the exclusion of elderly and disabled people (Coleman and Wiles, 2018), who are more likely to be institutionalized (most CDC surveys specifically exclude institutionalized people, whose disability and chronic disease prevalence is estimated to be higher than the non-institutionalized population). Moreover, in its inception, Medicare ("Original Medicare" or Fee-for-Service (FFS) Medicare) was primarily intended to cover inpatient (hospital-based) acute care (Medicare Part A), and Medicare Part B (Supplementary Medical Insurance) was designed to cover outpatient physician visits and home-based care for older adult beneficiaries. Moreover, given (i) the role of health care provision in maintaining labor power (Tyner, 2019) and (ii)

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[7] "Group coverage, especially employer-provided plans, grew increasingly common for a variety of reasons. As noted, insurers targeted employers because they provided attractive risk pools and offered a single entry point for marketing and plan administration. For employers, it makes good business sense to offer health insurance because providing coverage helps maintain a healthy workforce, which in turn reduces absenteeism and holds down premiums." (Roberts and Weeks, 2018, 95)

employer-based insurance as the predominate means of accessing health insurance, U.S. health care policy has largely been concerned with the needs of a working-age population- with Medicare and Medicaid as notable- yet increasingly central- departures from this path dependence.[8] As a result, the U.S.'s highly marketized health care 'system' must adapt to an aging population with a growing burden of chronic, non-communicable diseases (NCDs) or conditions.

Among chronic conditions whose prevalence is expected to increase as the U.S. population ages, hearing loss is notable. Specifically, the number of adults with hearing loss is projected to double by 2060 (Goman, Reed, and Lin, 2017). However, the accessibility of hearing and balance specialist- or audiologist- services is subject to constraints borne of the path dependence of health care policies centered on the provision of treatment for acute conditions. In the 1930s and 1940s, treatment for hearing loss was largely provided to returning soldiers or veterans. Beyond the Veterans Administration and treatment of war-related hearing and balance complaints, hearing loss and its treatment were considered beyond the bounds of "medical necessity", just as audiologists were classed as "non-physician providers." (Centers for Medicare Services, 2016).

Moreover, when Medicare was created and implemented (1965-66), the treatments for hearing loss were considered 'low-cost' relative to the median income at the time (Glantz, 2017), and these thresholds were not updated as Medicare's beneficiaries grew in number and the cost of hearing aids increased (Whitson & Lin, 2014). The out-of-pocket cost of hearing health care has risen for both public (Medicare, Medicaid) and private (employer-sponsored insurance) plan beneficiaries. In 2013, the average cost for a pair of hearing aids was equivalent to 11 percent of the median household income- and even higher for households headed by older adults with out-of-pocket healthcare costs, or nearly 19 percent of the median income for Medicare beneficiaries.

The unaffordability of hearing aids, coupled with an expected device lifetime of 3 to 5 years, makes treatment of hearing loss cost-prohibitive for older adults and disabled people— demographic groups more likely to be on fixed incomes. Notably, these are also demographic groups with the lowest rates of workforce participation. Perhaps reflecting the priorities of a nation whose definition of citizenship includes work readiness, the costs of hearing healthcare are somewhat offset for low-income parents of Medicaid and CHIP-eligible children with hearing loss and working-age disabled adults with

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[8] Medicare and Medicaid are federal insurance programs that effectively "capture" subsets of the population excluded by employer-sponsored insurance (ESI)- older adults, and low-income, sick, and/or disabled adults. The existence of these programs does not contradict the claim that the health care system is generally oriented toward maintaining the health of working-age populations; rather, their existence is borne of that orientation.

access to a state vocational rehabilitation program aimed at work readiness. Further, some state Medicaid programs only cover hearing aids for adults when it is demonstrated that they need them to get or maintain employment (Arnold, Hyer, & Chisolm, 2017; Fifer, 2020). This, coupled with the relative ease of access for high-income adults (Planey, 2019), may be why high-SES older adults have higher rates of service use and hearing aid ownership, compared with their lower-SES counterparts (Kochkin, 2009; Mahmoudi et al, 2014).

1.4 Examining Audiologist Service (In)accessibility in Context

It is in this space that I situate this project. The tendency toward individual-level solutions to policy problems neglects the profound constraints posed by structural factors, such disparities in the spatial distribution of providers at the county scale (Chapter 2), and the spatial configuration of audiologists and the physicians who refer patients to them (Chapter 3). As such, through the lens of hearing health care policies and services, I apply spatial approaches to better understand the relations between health care policy and health care provision, including health care worker geographies (availability of audiologists across geographic space), and interdependencies between specialists and referring primary care providers. As Ricketts (2010) put it, "*the overall structure of the health care delivery system is viewed as, itself, the product of larger forces that have shaped how we view health in society and how we organize space*" (page 522).

Further, this work is grounded in the understanding that need for healthcare services is contoured by underlying health inequities, which themselves are socially patterned along axes of social difference and disadvantage. Thus, jointly considering measures of need for healthcare services with measures of service accessibility is the crux of this work.

To that end, the next three chapters address the following research questions through quantitative approaches:

i. Chapter 2: In what ways do health policies and population socioeconomic factors shape the spatial distribution of audiologists at the state and county scales?
ii. Chapter 3: Do the spatial patterns of audiologists relative to referring primary care providers reflect the health policies and insurance regulations regarding inter-professional practice and do the resulting patterns exacerbate socio-economic and racial disparities in access to health care?
iii. Chapter 4: How can we conceptualize help-seeing and healthcare use in a way that is attentive to access as a process in time and space, with multi-scalar dimensions?

The structure of this dissertation follows a 3-paper format, with each chapter as a standalone paper, with transitions added to aid the flow between them. I then conclude with a theoretical discussion that situates and ties together the findings.

Chapter 2, entitled, “Audiologist Availability and Supply in the United States: A Multi-Scale Spatial and Political Economic Analysis,” couples mapping and multilevel hurdle model approaches to examine policy, demographic, and socio-economic predictors of audiologist availability and supply at the county level. This study is the first to examine audiologist availability and supply spatially. This chapter was published in *Social Science & Medicine* (Planey 2019). Because it addresses both the supply and spatial distribution of healthcare workers (audiologists) relative to both demand (household income; insurance status) and need (aging populations with self-reported hearing difficulty) for services, this study contributes to both health geography and health services research.

The third chapter, entitled, “Health Care Provider Interdependencies & Resulting Access Disparities by Race and Class: The Case of Primary Care Physicians and Audiologists in Chicagoland,” pairs cluster analysis methods with spatial regression approaches to assess the co-location of audiologists and a pool of referring primary care providers who serve Medicare and Medicaid beneficiaries in the Chicago metropolitan area, and whether that co-clustering exacerbates disparities in spatial access across the axes of race, ethnicity, and class in a segregated metro area. This study contributes to health geography and health services research to examine whether co-location of specialists and primary care providers (PCPs), given health care policies that require PCP referral as a prerequisite for coverage of specialist services, reinforces existing inequities to primary care.

The fourth chapter of this dissertation ties the empirical findings together in a conceptual model of health care access as a multi-scalar process in space-time, bringing together behavioral and ecological models of healthcare help-seeking and access. This is important, because much work on care access treats access as episodic or an end unto itself, when a growing burden of chronic illness makes many ‘episodes’ of care necessary for the treatment and management of chronic conditions. In the concluding chapter, I reflect on the major findings of the work and discuss challenges, limitations, and future research directions.

1.5 Contributions

Audiologists- or hearing and balance specialists- have not been studied using spatial methods. As such, this dissertation contributes to the field of geography in multiple ways: (1) examining specialist healthcare worker location decisions and the subsequent inequities in the accessibility of their services, (2) embedding a reasserted political economic focus or orientation in quantitative geographic studies of healthcare access and outcomes (Bambra, Smith, and Pearce, 2019), and (3) applying existing spatial analytic and epidemiologic approaches to novel questions. This work is timely, addressing the needs of an aging population with a growing burden of (often comorbid) chronic conditions *and* healthcare systems that must shift their historical orientation toward acute care to address these needs. In this sense, this dissertation offers up applied geographic research and insights that can inform healthcare policy and planning toward healthcare equity.

Finally, I want to situate this work and foreground my positionality as a researcher. This work is indelibly shaped by my experiences as both a deafblind person and a former clinical audiology trainee. I acknowledge that the methods applied in the chapters that follow are far afield of this introductory chapter. At times, as I wrote this introduction, it felt like I was implicating myself- a health/medical geographer whose work has been primarily quantitative. After years of deliberation, I can hold that tension between the more qualitative and social theory-grounded work I was trained to do in the past as a history and political science student, and the quantitative methodologies that have been the focus of my doctoral training. To begin with, I undertook my studies with the deepest and broadest knowledge base that I could- informed by literature on the political economy of healthcare in the U.S., the history of healthcare professions, and the lineage of health and medical geography studies of healthcare access. The result is a dissertation that attends to the political economy of hearing healthcare (healthcare workforce supply, healthcare policy, clinical training landscapes), inequities in access to audiologist services, and outcomes associated with foregone treatment of hearing and balance disorders among older adults.

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2 AUDIOLOGIST AVAILABILITY AND SUPPLY IN THE UNITED STATES: A MULTI-SCALE SPATIAL AND POLITICAL ECONOMIC ANALYSIS

Abstract: This study[9] employs statistical modeling and mapping techniques to analyze the availability and accessibility of audiologists (practitioners who diagnose and treat hearing loss) in the United States at and the county scale. The goal is to assess the relationships between socio-demographic and structural factors (such as health policy and clinical programs which train audiologists) and audiologist availability. These associations are analyzed at the county level, via a mixed effects hurdle model. At the county level, the proportion of older adults reporting difficulty hearing is negatively associated with audiologist supply. The findings show that audiologists tend to locate in metropolitan counties with higher median household incomes, younger populations, and lower proportions of older adults reporting hearing difficulty, suggesting an inverse care-type relationship between audiologist availability and need for hearing health services. Notably, neither state legislation requiring insurance plan coverage of hearing services for adults or Medicaid coverage of audiology services were significant predictors of audiologist supply at the county level.

Research Highlights:

- As hearing loss prevalence rises, the shortage of audiologists in the US is worsening.
- Counties with a greater share of older adults reporting hearing difficulty have fewer audiologists
- Clinical audiology programs were a strong predictor of audiologist supply at the county level.

Key Terms: audiologists; audiology; health care providers; health care access; health care provider supply; health policy; hearing loss

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[9] Previously published in Social Science and Medicine. Republished with permission from the publisher.

Planey, A. (2019). Hearing Healthcare Availability and Access in the United States: A Multi-Scale Spatial and Political Economic Analysis, *Social Science and Medicine. 222.* 216-224. DOI: https://doi.org/10.1016/j.socscimed.2019.01.015

2.1 Introduction

Hearing loss and balance disorders are among the most commonly diagnosed health conditions worldwide, and their prevalence is increasing as populations age and as technologies for diagnosing and treating them improve. These trends are fueling need for hearing healthcare services; however, in many countries, such services are in short supply, and wide disparities in access– or mismatches between characteristics of populations in need of care and the health care delivery system– persist. In the U.S., for example, many people who experience hearing loss fail to be diagnosed and/or treated, indicating a sharp mismatch between hearing healthcare needs and service supply (National Academy of Sciences 2016). Little is known about geographical and social inequalities in the availability and accessibility of hearing healthcare services and how political and economic forces shape service availability.

Audiologists – non-medical, non-surgical professionals specializing in the assessment, diagnosis, and treatment of hearing and balance disorders – play a critical role in the hearing healthcare system. In the U.S., access to audiologist services is restricted by government regulations that classify audiologists as "non-physician" providers, a classification that sharply limits insurance coverage of audiologists' services as a result (McNeal, 2016). I argue that these political and economic considerations profoundly shape the uneven availability of audiologists thus affecting access to services. This work seeks to analyze the geographical availability and accessibility of audiologists in the U.S. and the ways in which structural, top-down pressures shape their spatial behavior and practice. I discuss how audiologists' scope of practice and autonomy as professionals are constrained due to legal, legislative, and corporate entities' policies, which hinge on the classification of audiologists as non-medical professionals. The implications of these processes for uneven spatial access to audiologists are examined by mapping audiologist supply at the state and county scales and by analyzing statistical associations between federal and state health policies, socioeconomic factors, and service supply.

This paper is the first to examine spatial access to audiologists across the United States across multiple geographical scales. Analyzing the availability and supply of audiologists at the county scale in relation to socio-demographic variables and state-level policies is valuable because it illustrates how multi-scalar factors affect hearing healthcare provider supply. A recent review paper by Curtis & Riva (2010) highlights the importance of multi-scalar variables and linkages in shaping healthcare availability and access in geographic space. In addition, by examining macroeconomic and contextual factors, this paper is an answer to Connell and Walton-Roberts (2016) call for critical geographies of the health care workforce, which in turn inform and shape healthcare accessibility.

2.1.1 Hearing Loss Prevalence and Access to Services in the United States

Hearing loss in adults is a significant and increasing concern in the United States (Goman, Reed, & Lin, 2017; Lin et al., 2011). Age is a key risk factor, as hearing loss prevalence rises sharply with age. This matters because the U.S. faces a demographic shift as its population ages. In 2015, there were 46 million people ages 65 and over, representing over 14 percent of the population– a fast-growing segment of the U.S. population (U.S. Census Bureau. 2016). The National Institute on Deafness and Other Communication Disorders (NIDCD) estimates that approximately 2 percent of adults in the U.S. ages 45-54 have "disabling hearing loss," which is defined as thresholds ≥35 decibels HL in the better ear, or the level at which soft speech in a quiet room becomes inaudible. Among adults ages 55-64, that rate is 5.8 percent. For adults ages 65-74 and ≥75 the estimated rates of "disabling hearing loss" are approximately 25 percent and 50 percent respectively (NIDCD, 2016).

These statistics, however, mask what Mayer (1982) identified as the unequal distributions of disease which translate into 'non-uniform patterns of spatial distribution" (pp. 223). For example, data from the American Community Survey show that 2013-17 county-level rates of elderly adults age ≥65 with self-reported hearing problems range from 3.2 percent (in Esmeralda County, Nevada) to 44.4 percent (in Dillingham Census Area, Alaska), with a mean of 17.7 percent [**Figure 2.1**]. Among older adults age ≥75, the county-level mean rate of self-reported hearing difficulty was 25.6 percent, with a range from 4.5 percent (Jefferson County, Mississippi) to 71.5 percent (Sublette County, Wyoming). Thus, the prevalence of self-reported hearing loss varies significantly among counties, even within elderly population groups. While self-reported hearing difficulty differs from objective, clinical definitions of hearing loss based on audiometric and physiological tests of the auditory system, it is notable that there is spatial variation in the share of older adults self-reporting hearing difficulty.

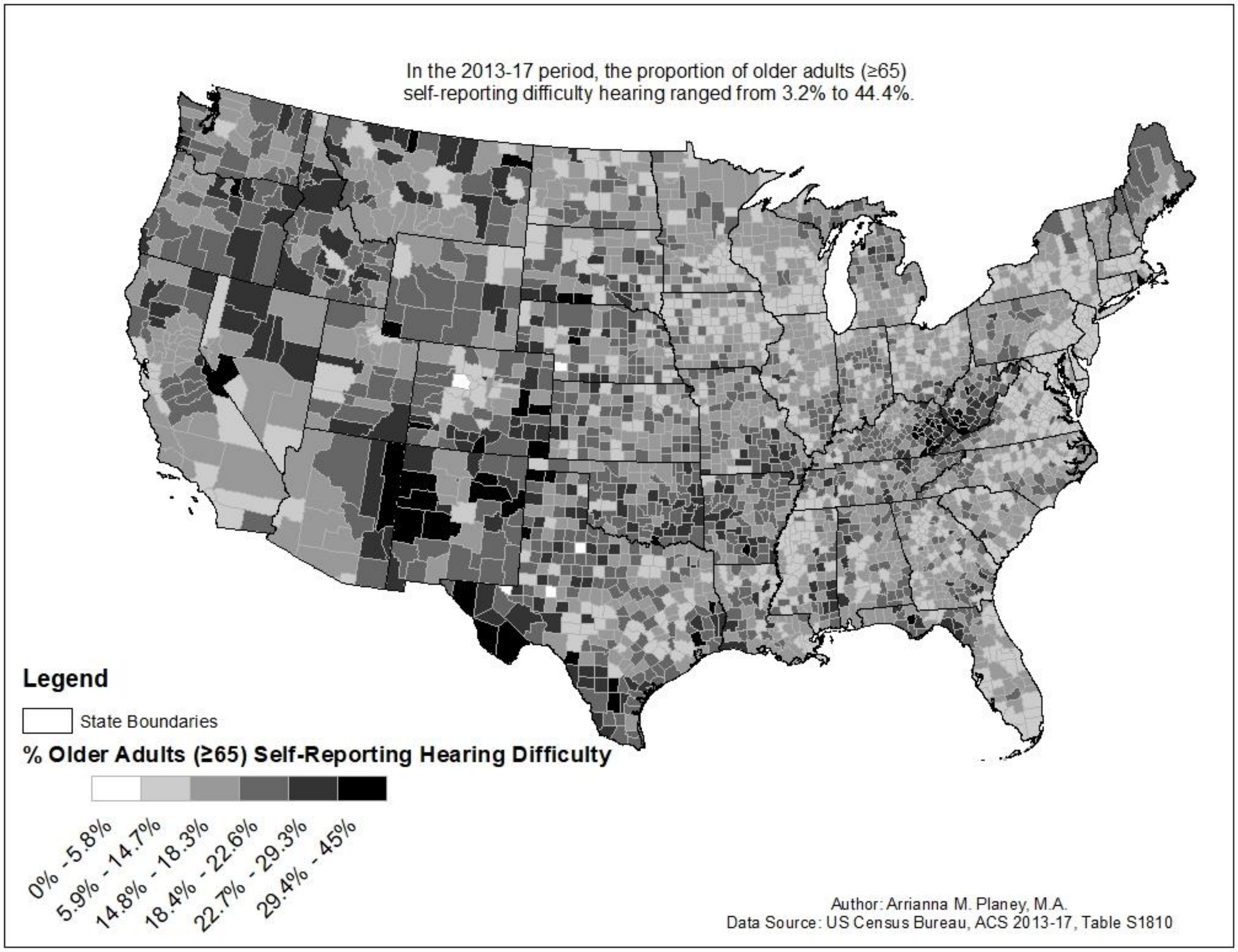


Figure 2-1 *- Estimated Percentage of County Population Aged ≥65 Reporting Hearing Difficulty (Data Source: U.S. Census Bureau, American Community Survey (ACS) 2013-17, Table S1810)*

Furthermore, age is a complicated demographic risk factor, as it corresponds with a higher likelihood of being prescribed ototoxic medication, or medications which cause damage to the auditory system's neural structures, often via damage to related vascular structures in the inner ear, such as the deprivation of oxygen. Ototoxic medications include many common chemotherapy drugs, analgesics, and antibiotics (Pratt et al, 2009). These medications can compound the typically slow progression of age-related hearing loss (Van Eyken et al, 2007). Beyond age and medication use, other risk factors for hearing loss include, noise exposure, and occupation (Agrawal et al, 2009; Nash et al., 2013; Van Eyken et al., 2007). Exposure to many of these risk factors is expanding in the U.S., leading to increasing prevalence of hearing loss and increasing need for hearing health services.

2.1.1.1 Access to Hearing Health Care Services

Health care access is a multi-dimensional concept broadly defined as to the ability of a person or population to access needed health care services (Cromley and McLafferty, 2012; Penchansky and Thomas, 1971). Health care access can be understood both as a noun and as a verb– the latter taking the form of a process beginning with recognition of need and subsequent help-seeking, leading to service use or what is termed ‘realized’ access (Cromley and McLafferty, 2012; Guagliardo, 2004). A key aspect of access is the availability of providers in geographic space. This study examines two dimensions of audiologist service availability— whether there are providers at the county level (availability) and how many providers there are (supply).

Wide inequalities exist in access to and utilization of hearing health services. One important pathway to or facilitator of problem recognition, help-seeking and subsequent hearing health care service use is screening programs. Under Medicaid, minors may receive periodic hearing screening and referral through the Early and Periodic Screening Diagnosis and Treatment (EPSDT) program (Medicaid.gov, 2017). Notably, the county-level mean share of minors (ages 5-17) reporting difficulty hearing is 0.7 percent, compared with 17.7 percent among older adults age ≥65 (US Census Bureau, ACS 5-year estimates, 2013-17, Table S1810). Despite the much higher risk of hearing loss among older adults, there is not an analogous hearing loss screening and referral program for adults. Studies indicate that hearing health services are greatly underutilized with low rates of screening, diagnosis, and treatment for hearing loss among adults (Crowson et al, 2016; Nash et al, 2013; Popelka et al, 1998). Kochkin (2009) estimates that only 15 percent of older adults in the U.S. receive a hearing screening. Research shows that most hearing aid users and owners are white and from middle-income (or higher) households, reflecting a stratification of the market based on income level, and insured status (Bainbridge and Ramachandran, 2014; CDC, 2012; Mahmoudi et al, 2018).

Recent studies on the accessibility of hearing health services among adult patients have found that rural residents have longer trips to access care, and longer periods prior to their adoption of hearing aids or cochlear implants (a surgically implanted neuro-auditory prosthetic device that stimulates the auditory nerve). Access barriers are exacerbated for rural cochlear implant users, whose options are further limited due to the even smaller subset of audiologists who can program their devices (Clinkard and LeBlanc, 2015; Hixon et al., 2016). Hixon and colleagues (2016) found a stronger association between hearing loss and loss of employment among rural respondents than for urban respondents, suggesting that for rural residents, restricted access to hearing health has large economic consequences. These findings complement prior work showing that people with hearing loss have lower incomes and lower workforce participation rates than those without (Jung and Bhattacharyya, 2012). Chan and colleagues (2017) found that rural participants reported mean travel time to audiologist appointments was more than double that of their urban counterparts (68 minutes vs. 32 minutes), with longer delays prior to hearing aid acquisition. Overall, many adults do not have regular hearing assessment, and among those who have, hearing aid uptake is low, ranging from 21 to 48 percent (Oberg et al, 2012; Popelka et al 1998; Smeeth et al 2002).

Audiologists are critically important providers of hearing healthcare services. The limited availability and accessibility of audiology services may partly account for these health and health care disparities. Previous studies on audiologist availability and accessibility have relied upon survey data from specific regions (Chan et al, 2017; Hixon et al., 2016). There has not been a nation-wide study audiologists' availability to evaluate urban and socioeconomic biases in locational patterns. This analysis considers the availability (supply) of audiologists by county across the U.S. within a broader political economy of healthcare provision, which includes socio-economic factors (income levels of residents, population density, and insured status), and contextual factors, such as legislation or policy regarding coverage of their services at the state level. It is important to note that this study focuses only on the availability and supply of audiologists – the number of audiologists by county – and its association with demographic, socioeconomic, and policy factors at the county and state scales. This research does not address the spatial accessibility of audiologists' services, which considers factors such as distance and travel time. In sum, this study is the first to analyze audiologists' uneven availability in geographic space at a national scale.

2.1.2 Political Economy of Audiology Services in the U.S.

2.1.2.1 Audiologist Supply Trends

Audiologists are non-medical health care providers who specialize in the assessment and treatment of hearing and balance disorders. Audiologists in the U.S. often work in hospitals and private practices alongside medical practitioners, such as otolaryngologists or ear, nose, and throat doctors (Bureau of Labor Statistics, 2016). Shortages of audiologists exist in many countries, reflected in low audiologist-to-population ratios, and concentrations of providers in urban areas (Bevilacqua, Caiuby Novaes, & Morata, 2008; Madriz, 2000a; Madriz, 2000b; Swanepoel 2006).

In the U.S., audiologists are a small profession that has historically had to fight to secure its scope of practice. Compared to physicians, audiologists comprise a small set of health professionals, with a total of 13,479 located in 4,303 U.S. cities across 1,365 counties (American Speech-Language Hearing Association dataset [ASHA], 2015). One example of constraints on audiologists' scope of practice was the American Speech-Language-Hearing Association's code of ethics which prohibited licensed Audiologists from selling and dispensing hearing aids, leaving market for dispensing hearing aids was left to Hearing Aid Dispensers until 1978 ("ASHA drops "non-profit" dispensing policy", Hearing Aid Journal, page 32, July 1978). These hearing aid dispensers only needed a High School degree and a certificate, in contrast with audiologists, whose entry-level degree was a master's degree. Moreover, the field of audiology faces a growing shortage, with a 41 percent attrition rate– after factoring for retirement– between 1985 and 2012 (Windmill and Freeman, 2013). Compounding this problem, per survey data from the Council of Academic Programs in Communication Sciences and Disorders, the number of students matriculating into clinical audiology programs fell by nearly 40 percent between 1997 and 2012, simultaneous to a halving of the number of audiology programs in the U.S. (Windmill 2013). The net effect of these trends is a shrinking profession.

2.1.2.2 Health Policy and Audiologists' Scope of Practice

The availability and accessibility of audiologists in the U.S. is strongly affected by federal and state policies that regulate insurance coverage of audiologist services. Medicare and Medicaid, public U.S. federal programs, provide health insurance coverage of elderly (Medicare), and eligible disabled and low-income (Medicaid) persons (Arnold, Hyer, and Chisolm, 2017). Medicaid is administered at the state level, allowing states to decide eligibility requirements, benefits levels, and which 'optional' benefits to include. The Center for Medicare and Medicaid Services (CMS) classifies audiologists as "non-physician practitioners," and as such, their services are not covered by either program unless they are deemed "medically necessary" and coded as "other diagnostic tests" in support of a physician's diagnostic medical evaluation or to evaluate the appropriate medical or surgical intervention for a disorder of the auditory system (CMS, 2016).

Given these restrictive insurance regulations, patients' access to audiologists is partially contingent upon the availability and accessibility of primary care physicians who have a strong gatekeeper role (Arnold, Hyer, and Chisolm, 2017). A primary care physician must first designate audiologist services as medically necessary before a patient can request payment for services from Medicare or Medicaid. Moreover, audiologists' scope of practice is restricted by state laws that allow hearing and balance assessments that fall under “other diagnostic tests” to be performed by other types of health care providers such as physicians, nurse practitioners, or clinical nurse specialists (Elwood, 2013). This effectively limits audiologists’ scope of practice to evaluations and diagnostic tests if their revenue is based on reimbursements from Medicare and Medicaid. This can be an incentive for audiologists to locate in areas with higher household incomes, where patients can afford to pay out of pocket for audiologist services beyond hearing assessments and evaluations, such as hearing aid fittings and programming, which require regular follow-up appointments.

Currently, Medicaid only covers physician-ordered and referred audiologist services in 28 states, and the extent of coverage varies state-by-state (Arnold, Hyer, and Chisolm, 2017). Only four states (Arkansas, Connecticut, New Hampshire, Rhode Island) have laws requiring private health insurance companies to cover hearing aids for adults [**Figure 2.2**]. Figure 2.2 shows the presence of state-level legislation requiring private health insurance plans to cover audiology services. Seventeen states have legislation requiring insurance coverage of audiologist services for minors and dependents only. The remaining 29 do not have any such legislation.

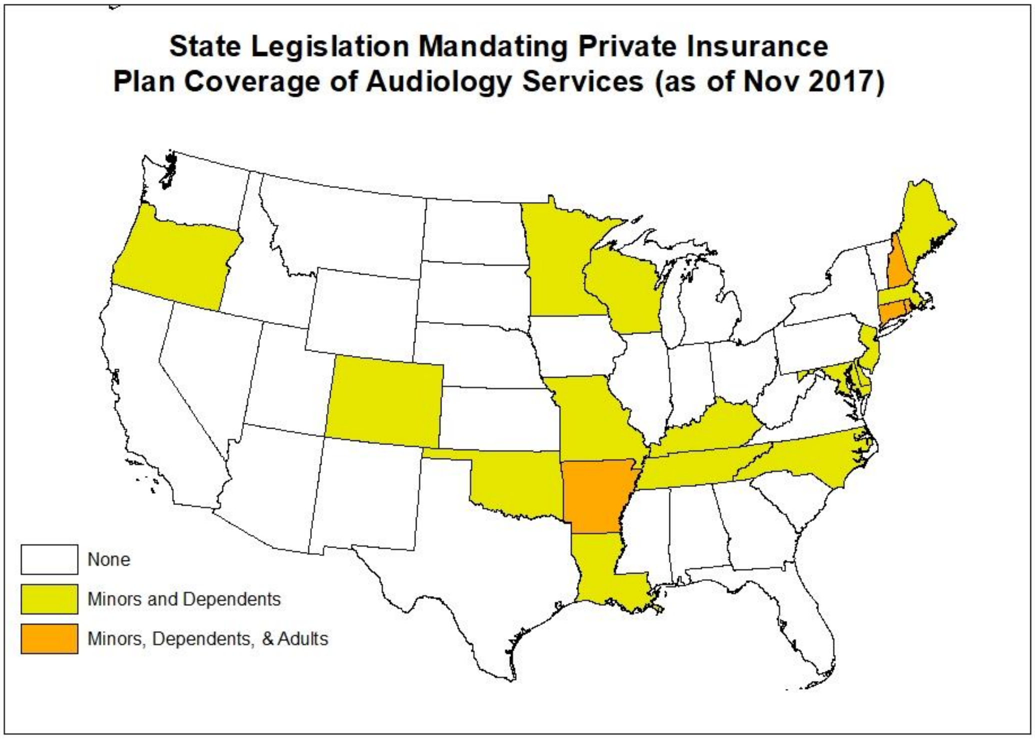


Figure 2-2 - *Status of Legislation Requiring Insurance Coverage of Audiology Services*

Twenty-one states have laws that mandate private health insurance coverage of hearing aids for minors and enrolled students, in part to comply with the Individuals with Disabilities Education Act (IDEA), with upper age limits ranging from 12 (New Mexico) to 25 (Oregon). Thus, based on geographic location, most self-referring patients would have to bear the costs of a visit to an audiologist themselves, as most private health insurance plans do not cover audiologist services.

Moreover, because hearing aids are not classified by the Center for Medicare and Medicaid Services (CMS) as "durable medical devices," they are not covered under Medicare except if the beneficiary has a supplementary Medicare Advantage Plan (Glantz, 2017). As with other insurance regulations, this restriction means that audiologist services are most affordable to those with the means to pay the out-of-pocket costs for hearing aids and devices (Blustein and Weinstein 2016; CMS, 2007).

Among adults with hearing loss, hearing aid ownership and use is low. Chien and Lin (2012) found that only about 20 percent of adults above age 50 who could benefit from amplification owned and used hearing aids. In recent years, the highest growth in hearing aid prevalence was seen among elderly retired persons (65 or older) and persons whose household income was over $60,000 (Kochkin, 2007; MarkeTrak, 2009). The average cost of a hearing aid was $4,700 in 2013, which comprises nearly 10 percent of the inflation-adjusted (pre-tax) median household income in the U.S. that year ($51,939) (MarkeTrak, 2009; U.S. Census Bureau, 2013). Certainly, in the absence of third-party payments for audiologist services beyond physician-ordered assessments, cost relative to household income is a serious consideration for consumers, especially in a context where persons with diagnosed hearing loss have lower employment rates and lower incomes on average compared to those without hearing loss (Jung and Bhattacharyya, 2012). Considering the relatively low utilization rates for hearing aids and hearing healthcare services, research is urgently needed on factors shaping geographical availability and accessibility of audiology services.

2.2 Data and Methods

Data on audiologists were extracted from the American Speech-Language Hearing Association (ASHA) membership dataset as of September 2015, which listed the number of audiologists in each city in the United States. These data were used to produce county-level counts of audiologists in the United States. These count variables serve as the dependent variable in the estimated regression models (**Table 2.1** summarizes the variables for all models). The normalized count or population-weighted ratio of providers was ruled out as an outcome variable due to collinearity with population density, an important predictor variable. Moreover, the proportion of county population age <18 was ruled out as a covariate due to its collinearity with median age, and the lower risk of hearing loss among minors.

Explanatory variables represent state policies and socio-demographic factors that are hypothesized to affect the supply of audiologists. The variables include: (a) state legislation requiring health insurance plans to cover audiologist services for minors, dependents, and adults, (b) number of clinical audiology (Au.D) programs, (c) median household income, (d) percent uninsured, (e) population density, (f) median age of the population, (g) estimated percent of older adults ages 65 and over reporting hearing difficulty, (h) whether the state's Medicaid program covers audiologist services and treatment, and (i) the NCHS urban-rural county classification values.

The categorical variables "state legislation requiring health insurance plans to cover audiologist services" and "Medicaid coverage of audiologist services and treatment" are state-level health policies that are likely to increase residents' access to audiology services. These categorical variables were coded as binary variables to represent the presence or absence of policy coverage requirements in a state. Additionally, to assess the geographic pattern of audiologist locations, the National Center for Health Statistics (NCHS)'s 2013 urban-rural classification scheme for counties is included as in indicator variable.

The number of clinical audiology programs (Au.D) is expected to influence audiologist supply given prior research indicating that health care providers tend to choose practice location near the place where they received clinical training (Baer, Gesler and Konrad, 2000). The other demographic variables– percent uninsured, median age, and median household income– are included as measures of demand for services. And given the importance of distinguishing between *demand* (realized outcomes of help-seeking behaviors, including utilization) and *need* (sometimes called 'latent demand'; Mayer, 1982, 224), the share of older adults (65+) reporting hearing difficulty at the county level is included as a measure of population need for audiology services. Population density is included as a proxy for urbanicity, as literature has found a strong urban bias in availability of healthcare workers (Peterson et al., 2011). These county-level demographic data came from the American Community Survey (ACS) 5-Year Estimates (2011-2015) to match, as best possible, the ASHA dataset.

Prior to model fitting, a global univariate Moran's I test was applied to the outcome variable (count of audiologists), and significant positive spatial autocorrelation was identified in 544 (17.3 percent) counties for the outcome variable. Moreover, negative spatial autocorrelation was identified in 99 (3.2 percent) counties. The remaining 2,499 (or 79.5 percent) U.S. counties did not have significant clustering or dispersal of values for the outcome variable. This, coupled with the high proportion of counties without audiologists (56.6 percent), supports a hierarchical mixed effects hurdle model as an appropriate approach for assessing the association between socio-demographic and policy predictor variables and audiologist availability and supply at the county level.

At the county level, overdispersion is acute due to the large number of counties with zero values. To address this issue, I estimate a hurdle model in STATA 15 (StataCorp, 2017). The hurdle model approach entails two steps: first a logistic regression model is estimated with presence or absence of audiologists by county as the outcome variable; and second, a regression model appropriate for count data is estimated to analyze predictors of the number of audiologists per county for counties where audiologists are present. The first step addresses the probability of a zero-count, while the second step considers variation in the count among counties where the phenomenon is present (Cameron and Trivedi, 1998; Mullahy, 1986).

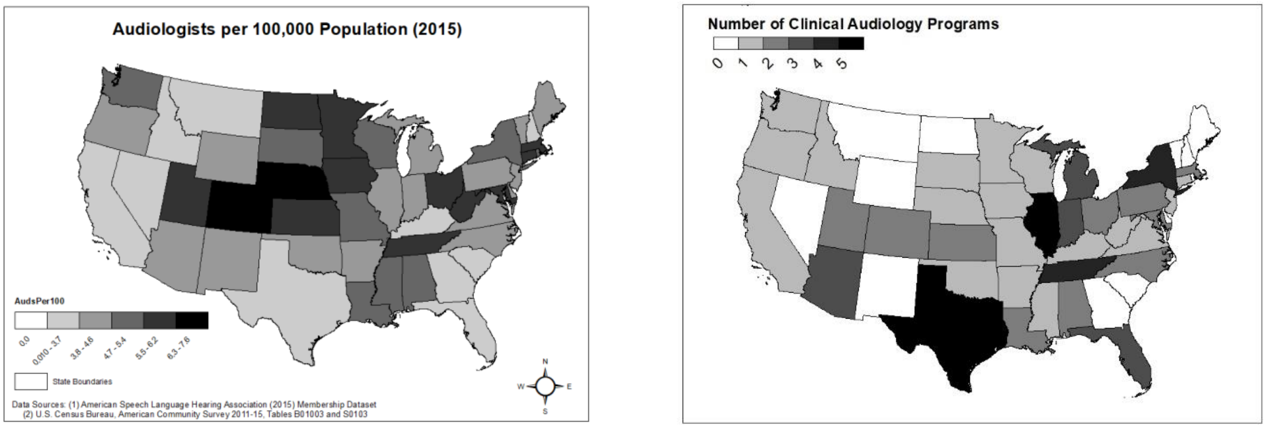
The county-level data also have a hierarchical structure with counties (level 1) nested within states (level 2). Therefore, each model is formulated as a multilevel model, and the models are estimated in two steps, adapting Tarling (2009)'s method: (i) level 1 explanatory variables, and (ii) again with level 2 explanatory variables added. Using STATA 15, I estimated a logistic mixed effects regression model, followed by a negative binomial mixed effects regression model to examine the uneven availability of audiologists among counties within the United States. This model is appropriate because it allows for two levels– state and county– while analyzing the predictors of audiologist availability and supply. The negative binomial regression model, a generalized Poisson model (also known as the Poisson gamma-mixture model) is also advantageous because it is appropriate for both categorical and continuous independent variables.

Table 2-1 - *Summary Table of Variables - means and standard deviations reported for continuous variables, and proportions (or relative frequency) reported for categorical variables*

Variable	**Counties with Audiologists (n = 1,365)**	**Counties without Audiologists (n = 1,777)**
Medicaid Coverage of audiology services (2017)	51.6%	55.2%
State legislation requiring insurance coverage of audiology services (2017)	34.2%	30.9%
NCHS 2013 Rural-Urban County Classification		
(1) Large central metro	4.54%	0.34%
(2) Large fringe metro	19.1%	6.08%
(3) Medium metro	18.9%	6.42%
(4) Small metro	17.0%	7.09%
(5) Micropolitan	26.1%	16.05%
(6) Noncore	14.4%	64.02%
Median Household Income (2011-15)	$51,414(18,045.90)	$43,317(8,148.31)
Median Age (2011-15)	39.5(4.98)	41.9(5.3)
% Uninsured (2011-15)	15.7(5.7)	17.1(7.4)
Population Density (per sq/mi) (2011-15)	441.9(2280.6)	123.4(1163.4)
% Adults Age 65+ Reporting Hearing Difficulty	16.4(3.38)	18.7(4.9)
Number of Au.D Programs (2017)	.051(.226)	0.002(0.047)

2.3 Results & Discussion

The supply of audiologists in relation to population is highly uneven across states (**Figure 2.3**). The range for all 50 states is 2.1 to 7.62 audiologists per 100,000 population. Overall, western and southern states have low audiologist supply per population compared with states in the Midwest and northeast. States such as Nebraska, Colorado, North Dakota, and West Virginia have the highest per capita supply of audiologists while more populous states such as New York, Texas, California, and Florida have the highest counts of audiologists and lower numbers of audiologists per 100,000 population.



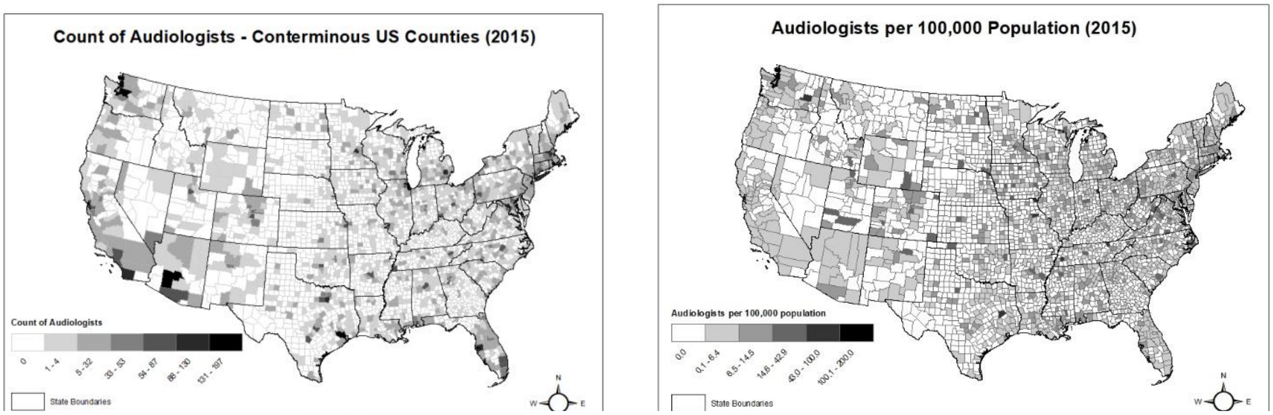
Data Sources: (1) American Speech Language Hearing Association (2015) Membership Dataset
(2) U.S. Census Bureau, American Community Survey 2011-15, Tables B01003 and S0103

Figure 2-3 *- (l) Audiologists per 100,000 population (conterminous US states) and (r) Count of Clinical Audiology Programs at State Level*

The number of clinical audiology (Au.D) programs varies greatly among states (**Figure 2,** right). Notably, all Midwestern states have clinical audiology programs, while there are clusters of states with clinical audiology programs in the northeast. Degree programs are scarcer in Western states, notably California which lacks programs relative to its large population. Both the training and policy landscapes for audiologists are highly uneven. Notably some states lack both audiology degree programs and mandated insurance coverage of audiology services, providing few incentives for audiologists to practice within the states.

States are large and heterogeneous spatial units for analyzing geographic disparities in audiologist supply, so I mapped and analyzed the spatial distribution of audiologists at the fine-grained county scale (**Figure 2.4**). In 2015, there were 13,479 registered audiologists in 1,365 counties– or 43.4 percent of counties, meaning that fewer than half of U.S. counties (56.6 percent) had an audiologist. The range was 0 to 197, with a mean of approximately 4 audiologists per county, which exceeded the median value of approximately 2 audiologists per county. Overall, both the county-level count of audiologists and the number of audiologists per population had a left skewed distribution. Counties containing and surrounding large metropolitan areas typically had higher audiologist supply. **Figures 2.4** shows the number of audiologists per 100,000 population and the unadjusted count of audiologists at the county scale respectively.

Counties that have, or do not have, audiologists differ in their socioeconomic, policy, and geographic characteristics (**Table 2.1**). Counties with audiologists are more prevalent in states that have legislation requiring insurance coverage of audiology services. There are wide inequalities in availability of audiologists along the urban-rural continuum. Counties with audiologists are more likely to be categorized as large central metro, large fringe metro, or medium metro areas compared to counties without audiologists. (**Table 2.1**). The mean values of socioeconomic and demographic variables such as age and income also differ between counties with and without audiologists. Counties with audiologists tend to have younger populations and higher median income levels than those without. Interestingly, a greater share of counties without audiologists were in states whose Medicaid programs cover audiology services for adult beneficiaries (55.2% vs. 51.6%).



Count of Audiologists - Conterminous US Counties (2015)

Audiologists per 100,000 Population (2015)

Figure 2-4 - *(l) Count of Audiologists at County Level (2015), (r) Audiologists Per 100,000 Population at County Level (2015)*

2.3.1 Hurdle Model Results

The first portion of the 2-step hurdle model was the logistic model assessing predictors of audiologist availability (presence or absence) at the county level. The logistic mixed effects model shows that median age and the share of older adults age ≥65 reporting difficulty hearing are significantly (*p*<.001) and negatively associated with audiologist availability at the county level [**Table 2.2**]. Put another way, the findings indicate that counties with younger populations are more likely to have audiologists present. Other statistically significant predictors include median income and presence of audiology degree programs, both of which are positively associated with audiologist availability. Moreover, audiologists have an urban bias. Across the urban-rural continuum, relative to counties classified as “large central metros”, “non-core” counties were over three times less likely to have audiologists (*p*<.001).

The remaining variables (state legislation requiring private plan coverage of audiology services, Medicaid program coverage of audiology services for adult beneficiaries, and the rate of uninsurance) were not statistically significant predictors of audiologist availability at the county level. These results show that the presence of audiologists by county is largely associated with presence of audiology degree programs, along with socioeconomic and demographic characteristics of county populations, especially high income, young age, and insurance coverage. Ironically, audiologists are less available in counties with older populations and higher shares of older adults reporting hearing difficulty, an inverse-care association given the high need for audiology services among older adults.

Table 2-2 *- Hierarchical Regression Analysis of Predictors of Audiologist Supply at the County Level*

Hurdle Model of Predictors of Audiologist Availability and Supply at the County Level				
	Logistic Mixed Effects Model (n = 3,141)		*Negative Binomial Mixed Effects Model (n = 1,365)*	
Outcome Variable	*Availability of Audiologists at County Scale*		*Supply of Audiologists at County Scale*	
Predictor Variables	*Model 1*	*Model 2*	*Model 1*	*Model 2*
Audiology (Au.D) Program Count	1.6818**	1.68022**	0.9059***	0.9147***
Percent Uninsured	-0.01055	-0.01044	0.008166	0.010588
Median Age	-0.05606***	-0.05633***	-0.0448941***	-0.04488***
Population Density	-0.00001*	-0.0001*	0.00011	0.0000
Household Income (log transformed)	0.45881***	0.4725***	-.023922	-0.0273
Percent of Adults ≥65 Reporting Hearing Difficulty	-0.0709***	-0.07105***	-.0957***	-0.0949 ***
NCHS 2013 Rural-Urban County Classification				
1 – Large central metro	(reference)	(reference)	(reference)	(reference)
2 – Large fringe metro	-1.1964*	-1.2082*	-0.8422***	-0.8358***
3 – Medium metro	-1.18811	-1.19444*	-1.00844***	-0.99888***
4 – Small metro	-1.20499*	-1.1972*	-1.53944***	-1.5289***
5 – Micropolitan	-1.42399**	-1.41466**	-2.14777***	-2.1462***
6 – Noncore	-3.09522***	-3.0795***	-2.1912***	-2.18566***
State-level legislation				
0 – none	-	(reference)	-	(reference)
1 – Minors and dependents	-	0.36611	-	0.1053
2 – adults, minors and dependents	-	0.94166	-	0.1653
Medicaid Coverage of Audiology Services	-	-0.1877	-	0.1687
(AIC)	3168.271	3168.283	7560.23	7561.992
(BIC)	3246.951	3265.12	7633.295	7650.713
	***p<.05; **p<.01; ***p<.001**			

The results of the second-stage, negative binomial mixed effects model, which analyzes predictors of the count of audiologists in counties where audiologists are present, are shown in **Table 2.2**. The model confirms results of the first-stage, logistic mixed effects analysis, showing positive, significant associations between audiologist supply and the number of Au.D programs. Among counties with audiologists, both median age and the proportion of adults ≥65 reporting hearing difficulty are negatively associated with audiologist supply (*p*<.001). In other words, among counties with non-zero values of audiologists, counties with younger populations, lower proportions of older adults reporting hearing difficulty had a larger supply of audiologists. Interestingly, median household income ceased to be a significant predictor of audiologist supply among counties with audiologists.

Moreover, the results of the second step of the hurdle model indicate an urban bias in audiologist supply. Among counties that have one or more audiologists, "non-core" or rural counties being over two times less likely to have audiologists compared to the reference category– "large central metro" counties (*p*<.001). The strongest predictor of audiologist supply is the presence of a clinical audiology (Au.D) program in the county (*p*<.001), as is true in the first-stage model of audiologist availability. Finally, state Medicaid program coverage of hearing aids for eligible adults was not significantly associated with audiologist supply at the county level.

2.3.2 Discussion

This study demonstrates that, in the context of current health policies and the clinical training landscape, the availability and supply of audiologists in the United States is highly uneven and inequitable. Approximately 56.6 percent of U.S. counties do not have audiologists, and counties with lower household incomes and older populations are at a disadvantage, which suggests stark inequities in audiologist service accessibility that may worsen, given the trends of attrition among practicing audiologists and falling enrollment in clinical audiology programs (Windmill, 2013; Windmill and Bush, 2008).

Moreover, at the state level, the ratio of audiologists per 100,000 population varies significantly. Audiologists are notably lacking in some southern and western states, such as Alabama, Georgia, Nevada, and Montana, which do not have any clinical audiology (Au.D) programs, nor do their Medicaid programs cover audiology services for adults (Arnold, Hyer, and Chisholm, 2017). This finding adds context to Mahmoudi and colleagues' (2018) finding that residents in southern states were less likely to own hearing aids. Although some of these states have young populations whose need for hearing services is less, as those populations age, many more audiologists will be needed to address the growing burden of hearing loss.

The results of the hurdle model show that audiologist supply is negatively associated with median age and the share of older adults reporting hearing difficulty, both of which are key demand variables. This reflects Tudor Hart's (1971) inverse care law, wherein "*the availability of good medical care tends to vary inversely with the need for it in the population served . . . [especially] where medical care is most exposed to market forces*." Taken together, these findings suggest that audiologists are attracted to metropolitan counties with higher median household incomes, and younger populations, that are located in states with higher numbers of clinical audiology (Au.D) programs. Put another way, among counties with providers, older people in less densely populated or more rural counties are at a disadvantage in terms of the availability and supply of audiologists. The spatial concentration of U.S. health care providers in affluent places or service areas is not new, however. In a 1967 report, the U.S. National Advisory Commission on Health Manpower noted a "maldistribution of healthcare professionals" stemming from their tendency to locate in affluent neighborhoods (quoted in Guagliardo, 2004).

These findings show that Medicaid coverage of hearing aids for adults is not significantly associated with audiologist availability or supply among counties with audiologists. This may be due to factors not captured in the models, such as a downward trend in Medicaid reimbursements for audiology services (McManus et al, 2010). Understanding the dynamic relationships between contextual factors distinctive to each state and state-level health policy decisions requires dynamic analysis of relationships over time, an important topic for future research.

Relatedly, the presence or absence of state legislation requiring insurance plans to cover audiology services for any subset of the population is not a statistically significant predictor of audiologist availability or supply at the county level. Heterogeneity in the mandated coverage, as well as potential differences in enforcement may explain these results. For example, among the 17 states whose laws mandate insurance plan coverage of audiology services for minors and dependents only, the upper age limit is 25 (Oregon), and the lower age limit is 12 (New Mexico). It is important to keep in mind that both policy enforcement and eligibility requirements may vary among states that have insurance coverage requirements (Arnold, Hyer, and Chisolm, 2017).

The county-level analysis captures demographic and socio-economic heterogeneity within states– differences which intersect with state policy factors. Provider availability is assessed at the county level in a nested model, which addresses both (i) state-level policy variables and (ii) local variation at the county scale, including the distribution of providers and socio-demographic heterogeneity. As such, this study accounts for the counties as nested administrative and areal units within states by using mixed effects models of provider availability and supply. This is important, considering that scale is important as both a level and a *relation*, given the relationship between counties and states (Howitt, 1998, quoted in

Wiles & Rosenberg, 2009). Taken together, these findings suggest that scale matters a great deal when assessing the effects of health policy and demographic factors on healthcare provider availability in the United States, given the role of both state-level governance and contextual heterogeneity among counties nested within states.

2.4 Conclusion

These findings suggest that there are material consequences for the classification of audiologists as 'non-medical' health care providers, and the subsequent lack of coverage under private insurance, Medicare, and Medicaid for their services beyond physician-referred assessments. States have responded to the lack of audiologists through legislation requiring insurance plan coverage of audiology services and the inclusion of audiology services as essential benefits under Medicaid. While state legislation requiring private health plan coverage of audiologists is not predictive of audiologist supply, they still in effect expand coverage for residents. Moreover, given that the strongest predictor of provider supply is the count of audiology programs, states have the opportunity to address the shortage of providers, thus targeting the clinical training pipeline to address falling enrollment in clinical audiology programs. Additionally, provision of incentives for providers to locate in underserved areas may potentially address attrition among practicing audiologists (Windmill, 2013; Windmill and Bush, 2008). In conclusion, more policies should address both the supply and equitable distribution of audiologists.

In a sense, this paper is a response to Connell and Walton-Roberts' (2016) call for more attention to the political economy of health care, including health policy and the healthcare workforce. This study also follows Curtis and Riva's (2010) recommendation to incorporate multilevel models to capture interactions between multi-scale variables that shape health care provider availability in geographic space.

Future work could address the five A's of access (affordability, availability, accessibility, accommodation, and acceptability) and the added concept of "awareness" of specific healthcare services (Cromley and McLafferty, 2012, 304; Penchansky and Thomas, 1981; Saurman, 2016). With the passage of the Over-the-Counter Hearing Aid Act (attached to the FDA Reauthorization Act) in August 2017, there is fertile ground for future studies of hearing health care accessibility as hearing aids for the treatment of mild and mild-to-moderate hearing loss become more widely available at a slightly lower price points without the requisite medical clearance requirements. This opens the door for labor substitution, which means that hearing healthcare will be dispensed more widely in both wholesale and retail settings, further beyond the purview of the audiologist's office. However, as most people with hearing loss will still need the standard hearing aids dispensed by audiologists, the availability and supply of audiologists will remain a key determinant of hearing health care access (Arnold, Hyer, and Chisholm, 2017). The affordability of hearing loss treatments remains an issue, as most people with hearing loss will still incur large out-of-pocket costs at these lower hearing aid price points (Donahue, Dubno, and Beck, 2010; Mahmoudi et al, 2018).

This paper addressed the availability and supply of audiologist service access, and to a limited extent, the affordability of audiologist services. Future work can build on these findings to study spatial accessibility— that is, jointly assessing the availability (number of providers from which a patient can choose within a defined area) and accessibility (travel impedance to provider locations). Moreover, there is much potential for qualitative research on the accommodation and acceptability of these services. Future qualitative or mixed methods research would complement spatial analyses of audiologist service access. Furthermore, a spatial analysis of audiologists' practice locations relative to the location of the clinical audiology (Au.D) programs from which they graduated may confirm Baer, Gesler and Konrad's (2000) Wineglass Model, mirroring a pattern seen among medical school graduates and adding to an important body of work explicitly linking health care workforce and health care service accessibility.

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3 HEALTH CARE PROVIDER CO-LOCATION & RESULTING ACCESS DISPARITIES BY RACE AND CLASS: THE CASE OF PRIMARY CARE PHYSICIANS AND AUDIOLOGISTS IN CHICAGOLAND[10]

Abstract: In primary-care centric models of care provision, specialist co-location with primary care physicians can potentially improve care coordination and continuity. This study asks whether the co-location of specialists with referring primary care physicians can reinforce racial, ethnic, and class inequities in spatial access to care. Given a U.S. health policy context wherein audiologist services are only reimbursed if they are medical practitioner-referred, audiologists are hypothesized to co-locate with primary care providers (PCPs). Using spatial cluster analysis and spatial regression approaches, this study quantifies the tendency for PCPs and audiologists' to co-locate and analyzes the consequences for spatial access disparities in the Chicago, Illinois metropolitan region. Audiologists and PCPs co-cluster significantly across Chicagoland. The spatial lag model confirms racial, ethnic, and class disparities in network travel distance to audiology services in the core counties of the region. The results suggest that, for audiology services, health policies and the resultant interdependence across the hierarchy of care manifest spatially, possibly reinforcing service access disparities within segregated city-regions.

Keywords: audiologists, primary care providers, health care access, hierarchy of care, spatial analysis, K-function, exploratory spatial data analysis, spatial regression

Highlights:

- Health care policies governing interprofessional practice have a spatial dimension
- Provider co-location across the hierarchy of care can reinforce access disparities
- Racial, ethnic, and class disparities in access to hearing care shape service use

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[10] This chapter will be submitted to *Health and Place* as a co-authored paper with Dr. Sara L. McLafferty, to give due credit for her indispensable advice in formulating the methods for this study.

3.1 Introduction

Health care policies are often built on referral linkages between specialist and primary care (PCP) providers that can have place-based implications for access to care. Many national health systems require a PCP referral for patients to obtain specialized services and treatments. In the U.S., public and private health insurers often mandate an approved PCP referral as a prerequisite for reimbursement of specialist care. These referral linkages, which extend across the hierarchy of care (Wiles & Rosenberg, 2009), have spatialized effects that can shape inequities in access to services across axes of social difference such as race, ethnicity, and class. I argue that referral linkages embedded in health policies can promote the co-clustering (nearby location) of PCPs and linked specialist providers, resulting in uneven provider locations that affect spatial access to care. Further, this study extends prior inquiry into the interaction between racial segregation and disparities in healthcare access by asking how co-clustering of services impacts these disparities (White, Haas, & Williams, 2012). This paper examines the spatial dimensions of referral linkages and the implications for inequalities in access via a case study of audiology (hearing and balance specialist) services in the Chicago metropolitan region.

Co-location of health care has both positive and negative implications for spatial access to care. Post-Alma Ata, there is a growing body of work on the benefits of co-location of primary care and specialists for care coordination amid the rising prevalence of chronic conditions and multi-morbidity (McDonald et al, 2017). Notably, some evidence indicates that co-location improves continuity and coordination in the management of chronic conditions (e.g. Rumball-Smith et al, 2014); however, this research has largely been undertaken in countries like the United Kingdom, Canada, and New Zealand which have national health systems that allow for more central planning toward coordination and continuity across the hierarchy of care. Moreover, a study of general practitioners and patients in 34 European countries showed that the benefits of co-location are contingent upon the quality of the primary care infrastructure (Bonciani et al, 2018). For example, the polyclinics of Lithuania are a fundamentally different model from the ‘medical home’ model central to New Zealand and Australia’s health systems, which differ from the United Kingdom’s national health system model (Bonciani et al, 2018).

Arguably, the place-specificity of health care policies limits the generalizability of these studies to care provision in the United States, whose highly marketized health care ‘system’ is anomalous among states with similar national incomes. Indeed, as Wiles and Rosenberg (2009) wrote, “Structurally, primary health care (PHC) is organized through a series of decisions, rules and policies embedded within the economic and political systems of the places in which people live” (79). This suggests a need to analyze the co-location of specialists with primary care providers while attending to both (i) local and multi-scalar policy considerations that shape the distribution of health care providers in space and (ii) the particularities of spatial data. To date, many studies of provider co-location employ non-spatial regression approaches that do not account for spatial dependence or autocorrelation.

Moreover, few studies have examined the co-location of allied health care providers, such as audiologists, with referring primary care providers. Notable examples include Jesson and Wilson’s (2003) study of pharmacy co-location with medical centers in the United Kingdom and Miller and colleagues’ (2014) study of behavioral health practitioner co-location with primary care physicians (PCPs) in the United States. Jesson and Wilson (2003) found that there were tensions between the U.K. National Health Service’s (NHS) push for pharmacist co-location with primary care to improve patient medication adherence, but pharmacists found themselves pulled between the universalism of the NHS and the pharmacies’ profit-centered ownership models, which fueled tendency to locate in areas where patients can pay more. In the U.S. context, Miller et al (2014) conceptualized co-location between PCPs and behavioral health practitioners as a measure of integration, finding rural-urban gradients in the degree of co-location whereby the two sets of practitioners were more likely to be co-located in rural ‘frontier areas’ after adjusting for PCP supply. Aside from these examples, most studies of health care provider locations and accessibility focus on one set of providers, such as primary care physicians (Crooks & Schuurman, 2012; Cutchin, 1997; Kazanjian and Pagliccia, 1996; Laditka, 2004), pediatricians (Guagliardo et al., 2004), residential nursing care providers (Andrews & Phillips, 2002), optometrists (Gibson, 2015), or urologists (Yao et al., 2015). Drawing from a body of work in health and medical geography that considers health policy effects on provider availability and supply in geographic and social space (e.g. Norris (1997) comparative study of state licensing regulations and pharmacy locations), this study assesses the spatialized arrangements of care under health care policies that require primary care practitioner referral as a prerequisite for reimbursement of audiology services.

Audiologists, or specialists who treat hearing and balance disorders, are non-physician providers whose services are not covered under most public or private health insurance plans unless their services are referred by a medical practitioner and deemed “medically necessary” (Arnold, Hyer, and Chisolm, 2017; CMS, 2016; Glantz, 2017). Conceptually, within this health policy context, access to audiologist services is contingent upon access to primary care providers (Pessis, 2009). As such, I hypothesize that audiologists will tend to co-locate or cluster spatially with general practitioners or primary care providers (PCPs), so that referral networks between the two will be seamless. The research questions are as follows: (i) *Given the necessity of medical practitioner referral for payment of audiologist services, do audiologists co-locate with primary care providers?* (ii) *Does the co-location of audiologists and primary care providers reinforce socioeconomic, racial, and ethnic inequalities in spatial access to care?*

In the U.S., audiologists illustrate well the importance of referral linkages. As a prerequisite for reimbursement of audiology services, the Centers for Medicare and Medicaid Services (CMS), the *de facto* regulator of health care in the U.S., requires physician referrals (CMS 2016; Givan, 2016), in part due to the classification of audiologists as ‘non-physician providers’ (Pessis, 2009). Further, given that hospitals and physician practices employ the majority of audiologists (Bureau of Labor Statistics, 2016), I expect that PCPs and audiologists will co-cluster – i.e. locate nearby each other – to facilitate referrals and enhance care coordination and continuity. Using a case study of Medicare-enrolled audiologists and the pool of primary care providers who can potentially refer patients, I combine exploratory spatial data analysis (ESDA) and spatial regression approaches to examine and map the spatial interdependencies between primary care providers and audiologists. In addition, spatial regression approaches are used to assess associations between network travel distance to audiologists and socio-demographic variables to address the question of whether the observed spatial arrangement of providers reinforces racial, ethnic, and socio-economic disparities in access. As the United States’ population ages and hearing loss prevalence increases, hearing healthcare accessibility is becoming a key issue.

The findings of this study will contribute to understandings of health provider locations and the interdependencies among providers across hierarchies of care. This bridges a gap in the literature, as most previous work focuses on single types of providers, ignoring their locational interdependencies within health policy contexts. Moreover, given the demonstrated lack of providers in areas with lower incomes and higher proportions of Black residents (Elesh and Schollaert, 1972), this study assesses how inequitable distributions of specialist providers may be reinforced via their co-clustering with referring primary care providers.

3.2 Background

3.2.1 Health Policy as Context

The health policy context strongly affects unequal access to all types of health services including services for people with hearing loss. As Stimson (1972) notes, “provision and use of health care services in a given geographical area needs to be studied within the context of the organizational structure of the system.” These contexts include Medicare and private insurance regulations requiring a primary physician referral for coverage of audiology services, and lack of insurance coverage of audiology services beyond assessments in support of a medical diagnosis (CMS, 2016).

The lack of insurance coverage for audiologist services and hearing aids can be traced to the 1935 Social Security Act, section 1862(a), which specifically excluded coverage of hearing aids (Glantz, 2017; McNeal, 2016). This, coupled with the language in the 1965 Social Security Amendments which classified audiologists as “non-physician” providers, precluded coverage of audiological services and treatment beyond physician-referred and ordered assessments. The persistence of the category ‘non-physician provider’ and its attendant limitations is an example of what Hanlon (2009) identified as path dependence in health care policy, wherein, “institutional arrangements are the outcomes of historically-situated negotiations amongst asymmetrically related networks of actors and groups” (51). Further, there is a shortage of audiologists due to attrition, clinical program closures, and falling enrollment (Windmill, 2013; Windmill and Freeman, 2013), and that shortage is exacerbated by a strong urban bias among audiologists at the county level, which also disadvantages residents in areas with older populations and higher proportions of older adults reporting difficulty hearing (Planey, 2019). Exacerbating this pattern of urban bias, is a strong tendency for audiologists to locate near clinical audiology (Au.D) programs, similar to the observed tendency of medical doctors to practice near where they completed their clinical training (Konrad, Baer, & Gesler, 2000). Overall, these programs are located in urban areas, near academic medical centers. The urban bias among audiologists possibly arises from the fact that Au.D programs place their graduates in 3rd or 4th year practicum rotations with nearby facilities.

Both public and private insurance plans require referral from a medical practitioner as a condition for reimbursement of audiologist services. Given that audiology services are not typically covered by private health insurance beyond physician-referred assessments, there may be a gap between insured status and actual, realized access to diagnosis and treatment of hearing loss (Glantz, 2017; Whitson & Lin, 2014). Moreover, a downward trend in Medicaid reimbursements for audiology services may exacerbate the inaccessibility of services for low-income patients (McManus et al, 2010). A prior study found that Medicaid coverage of audiology services did not necessarily predict higher provider availability at the county scale (Planey, 2019).

3.2.2 Conceptualizing Access to Audiologists

In this study, access is defined as a process in space and time whereby a person seeks and uses health care services. Specifically situated within political economic contexts, such as health care policy and the spatial distribution of providers under market conditions, this study considers access in a context where a primary care provider referral is a prerequisite to specialist care access.

We can understand health care access as the interaction between people, processes, and systems— all of which have spatial contexts— to produce service use. Building on Penchansky and Thomas' (1981) formulation of access, Levesque and colleagues (2013) argue that a comprehensive definition of "access" must account for both the demand-side and supply-side factors, including people (characteristics of clients), processes (how access is realized), and systems (e.g. location and provider availability and spatial distribution). The authors identify spatial and aspatial facets of access and their corollaries including: approachability (ability to perceive), acceptability (ability to seek), availability and accommodation (ability to reach), affordability (ability to pay), and appropriateness (ability to engage).

Given the lack of public and private insurance coverage of audiology services, affordability is an important dimension of hearing health care access. In their cross-sectional analysis of population-based surveys in the United States and Canada, Lasser, Himmelstein, and Woolhandler (2006) found that the cost of care was a primary barrier to access to audiological services. Relatedly, Barnett, Koul, and Coppola (2014) found, based on cross-sectional 2004 Medicare Current Beneficiary Survey (MCBS) data, that higher out-of-pocket costs were a predictor of dissatisfaction with health care accessibility among Medicare beneficiaries with hearing loss. In 2014, the average cost of one hearing aid was $2,400 (PCAST, 2015). As most people with hearing loss need two hearing aids, the out-of-pocket cost was approximately 11.2 percent of the median household income for that year (Census Bureau, Current Population Survey, 2014). From the supply-side perspective, audiologists have a strong incentive to locate in areas with high household incomes and high rates of insurance coverage, and this is reflected in their availability and supply at the county level (Planey, 2019).

Where physician referral is necessary for coverage of specialist services, it can be argued that awareness on the part of primary care providers is important for the management of chronic conditions that require coordinated care (referral to and partnership with secondary and tertiary providers). In the process of health care access, help-seeking begins with the recognition of need, and the determination that services are acceptable. Levesque and colleagues' (2013) corollary to approachability– "ability to perceive"– is a cognate to Saurman's (2016) concept of "awareness" as an added dimension of Penchansky and Thomas' (1981) multi-dimensional model of health care access.

It is instructive to extend this concept from the patients to providers– especially primary care providers who serve a gatekeeper role within the health care system. Treatment of hearing loss depends on primary care doctors' recognition of hearing loss as a 'problem' and their subsequent referral of patients to audiologists for assessment (Arnold, Hyer, and Chisolm, 2017; Center for Medicare and Medicaid Services, 2016). Studies suggest that primary care provider awareness of audiology services is low (Mahboubi, Lin, & Bhattacharyya, 2017; Wu et al, 2013). For example, a survey of primary care providers in two counties in southern California found that 26 percent were unaware that cochlear implants, surgically implanted neuro-auditory prosthetic devices that stimulate the auditory nerve, were a treatment for hearing loss, and 80 percent were unaware that all health insurance plans cover cochlear implants (Wu et al, 2013). In their analysis of 2014 National Health Interview Survey (NHIS) data, Mahboubi, Lin, and Bhattacharyya (2017) found that, among adults with self-reported hearing loss, approximately 20.6 percent saw a primary care physician in the previous 5 years about their hearing loss. Moreover, referral rates for hearing healthcare were low: 32.6 percent for Ear Nose Throat (Otolaryngologist) doctors, and 27.3 percent for audiologists.

Moreover, disparities in hearing health care access cut across race, ethnicity, and socio-economic status. Bainbridge and Ramachandran (2014) found that people with higher incomes had higher rates of hearing loss diagnosis, and that the proportion of non-Hispanic whites who used hearing aids was over twice that of non-Hispanic Blacks, Hispanics, and multi-racial people (35.4 percent compared with 17.1 percent, p <.05). More recently, Nieman and colleagues (2016) found that, after adjusting for hearing loss severity, Black respondents were more likely than white respondents to report recent hearing testing (odds ratio [OR] = 1.68), but they were less likely to regularly use hearing aids (OR = 0.42). The authors also found that, among African American patients, status as a Medicaid beneficiary was negatively associated with receiving a hearing test, pointing toward the uneven coverage of audiology services among state Medicaid programs (Arnold, Hyer, and Chisholm, 2017). Further, even among older patients (age 66 and over) with private insurance coverage, Black and Hispanic patients have lower rates of hearing aid ownership (9.8% and 6.5% respectively) compared with 13.6% of white patients) (Mahmoudi et al, 2019).

Spatial access to health care in the U.S. is unevenly patterned at the axes of race and class. For example, per the U.S. Department of Transportation's National Household Travel Survey data, over half of Black patients' travel times for medical and dental care exceeded 30 minutes, compared with 25 percent of white respondents, suggesting racial disparities in travel impedance to medical care (Probst et al, 2007). The chilling effect of travel impedance to care on health care service use at the axes of race and ethnicity is apparent in disparities in preventative care utilization such as pap smears (Coronado et al, 2004) and childhood immunizations (Thomas, Kohli, & King, 2004). Moreover, travel impedance to specialist care, such as oncology care is associated with later diagnosis and delayed treatment after diagnosis- as observed among Black colon cancer patients in the city of Chicago (Jones et al, 2017). Therefore, this study builds on what is known about health care utilization and how heath care access is conceptualized as a process with spatial and aspatial facets. I argue that the co-clustering of primary care providers and tertiary care providers, such as audiologists, can be understood as a determinant of access in the treatment and management of chronic conditions.

The research question asks whether specialist co-location with primary care physicians reinforces disparities in spatial access to care at the axes of race, ethnicity, and class. First, I hypothesize that Medicare-enrolled audiologists co-locate with PCPs because the Centers for Medicare and Medicaid Services (CMS) regulations stipulate that physician referral is a precondition for coverage of audiologist services. Given the importance of proximity to physician referral networks, as well as audiologists' tendency to work in hospitals and medical centers, I hypothesize that audiologists will tend to co-locate with primary care physicians.

Second, given the phenomenon of "distance decay", wherein health care service utilization decreases with distance to a degree partially contingent upon where the provider falls within the health care service hierarchy (Gesler and Cromartie, 1985) and the lower availability of PCPs in concentrated low-income areas, I hypothesize that audiologists' co-location with primary care providers will actually reinforce racial, ethnic, and class-based inequities in spatial access to care, given known disparities in spatial access to primary care (Elesh et al, 1973). Arguably, spatial proximity between audiologists (tertiary providers) and referring primary care physicians is an important facet of hearing healthcare access, which has consequences for access and care utilization. I also expect more travel impedance in areas with lower population density within Chicagoland, given prior research documenting poorer PCP accessibility in these areas (Iezzoni et al., 2006; Mobley et al., 2006). In a previous study, I found that audiologist availability and supply were inversely related to both the median age of the population and the share of older adults self-reporting hearing difficulty at the county level– key measures of demand for audiologist services (Planey, 2019). Moreover, I found that audiologist availability and supply was positively associated with household income, which corroborated earlier findings of unmet need among lower income older adults (Agrawal, Platz, and Niparko, 2009; Nash et al., 2013; Van Eyken et al., 2007). In sum, these findings suggest an inverse care relationship (Tudor-Hart, 1971) between audiologist availability and accessibility and population-level need.

3.3 Data and Methods

The study area is the Chicago metropolitan region, designated as the Consolidated Metropolitan Statistical Area (CMSA) which includes Cook County and nine surrounding counties (Lake, DuPage, Will, McHenry, Kane, DeKalb, Kendall, Grundy, and Kankakee counties), consistent with prior studies of the region (Luo & Wang, 2003). The census tract-level demographic and socio-economic data for this study are derived from the U.S. Census Bureau's American Community Survey 5-year estimates (2013-2017).

The provider location data for this study come from the Center for Medicare and Medicaid Services' (CMS) Physicians Compare dataset, which lists the office locations of Medicare- and Medicaid-enrolled health care providers- or providers who accept payment from the U.S.'s public insurance programs. These addresses were geocoded to produce point data for both audiologists and primary care physicians. Consistent with previous studies, family practice doctors, general practitioners, and internists were counted as primary care providers (PCPs) (Luo & Wang, 2003; Cooper, 1994). The CMS dataset excludes healthcare providers within the Veterans Administration (VA) health system, which means that it undercounts the actual supply of audiologists. However, this is advantageous for our analysis, which looks at market-based location decisions among Medicare-enrolled audiologists given Medicare regulations governing reimbursement of their services. Thus, this analysis necessarily excludes providers at federally-planned Veterans Health Administration locations.

3.3.1 Spatial Cluster Analysis

To assess the spatial dependence, or degree of co-clustering or dispersion between primary care providers and audiologists in the study area, I estimate a cross-L function in R using the *SpatStat* and *Sparr* packages (Davies, Hazelton, and Marshall, 2011). The cross-L function is a commonly used summary function that visualizes the degree of spatial dependence between two sets of events (Ripley, 1976, 1977; Besag, 1977). Because K and L functions summarize spatial dependence between events, they are a formal way of assessing the first law of geography— "*All things are related, but near things are more related than far things*" (Tobler, 1970; Waller and Gotway, 2004).

The K-function calculates the number of events (*E*) within *d* distance of a randomly chosen event divided by the intensity π (number of events in study area *A*) (Waller and Gotway, 2004). The K-function is cumulative, calculated as a function of increasing distance between point locations, where n is the total number of events in study area A (Loosmore and Ford, 2006).

$$K(d) = \frac{1}{\lambda}\,\mathrm{E}(\#\text{ events within } d \text{ of an arbitrary point})$$

$$\hat{K}(d) = \frac{A}{n^2}\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij} I_d(i,j)$$

***Equation 3-1** - K-function Equation*

The null hypothesis (H_0) is complete spatial randomness (CSR), where the value of K(d) is proportional to the area of a circle with the radius d (πd^2). Moreover, under CSR, the L-function, the linear transformation of the K-function, takes the form L(d) = d. To analyze co-clustering between PCPs and audiologists, this study uses the cross L function, a variant of the L function that focuses on the distance between 'marked' point patterns – in this application, health care provider locations are marked as PCP or audiologist.

To visualize the overlap between audiologist and PCP locations, I overlay audiologist point locations over the edge-corrected kernel density estimates of PCP locations in Chicago. The fixed bandwidth parameter for the kernel density map is determined based on Bailey and Gatrell (1995) formula (below), where the bandwidth (τ) is a function of the area size (A) and the number of events or locations (n):

$$\tau = 0.68 * n^{-0.02} * \sqrt{A}$$

3.3.2 Network Analysis and Spatial Regression Modeling

The second portion of the analysis begins with estimating the minimum network distance to an audiologist from the population-weighted centroid of each census tract as a measure of accessibility of audiology services within the Chicago metropolitan region (Cromley and McLafferty, 2012). This approach has been used in previous studies of facility accessibility (Shannon et al, 2018).

To account for edge effects, I estimate the nearest travel distances based on all audiologist point locations, rather than only audiologist locations within the study area. Similar approaches have been found to reduce errors in estimations of travel distance (Berke and Shi, 2009).

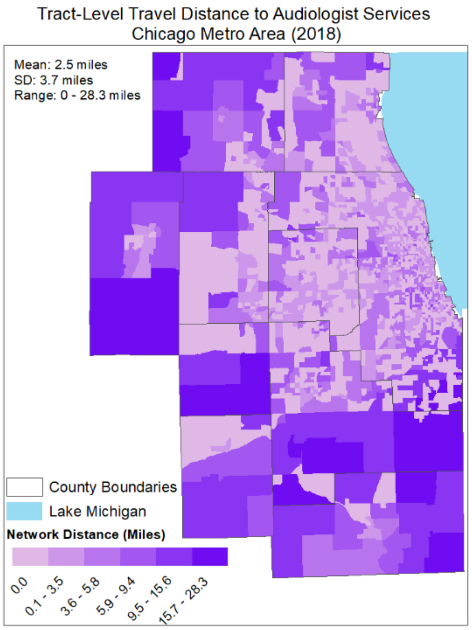

Figure 3-1 - *Network distance to audiology services from the population-weighted centroid of each census tract in the study area*

Thereafter, I estimate a spatial regression model to assess the associations between network distance to the nearest audiologist and socio-demographic variables at the census tract level. The predictor variables represent measures of race, class, and need for hearing health services: proportion of Black population, median household income, percent insured, population density, and the proportion of adults age ≥65 reporting difficulty hearing. The outcome variable is the travel distance to the nearest audiologist from the population-weighted tract centroid. **Table 3.1** summarizes the variables for the models.

Moreover, to model the association between audiologist accessibility and primary care provider availability, I included the tract-level density of PCPs per square mile in the study area as a predictor. To produce this variable, I estimated the kernel density of PCP locations within the study area, as discussed earlier and assigned the local density values to each population-weighted census tract centroid.

The study area includes diverse place environments, from the densely populated city of Chicago to suburban and exurban areas on the area's fringe. To account for this heterogeneity, the spatial regression analysis was split between the more densely populated urban counties (Cook, Lake, DuPage) and predominately suburban (and to a lesser extent, rural) counties (McHenry, Kankakee, DeKalb, Kane, Grundy, Will, and Kendall). This split, based primarily on population density, mirrors the National Center for Health Statistics (NCHS) 2013 rural-urban classification scheme for counties. The model for the core counties comprised 3 counties (Cook, Lake, and DuPage) encompassing 1,656 census tracts, while the non-core county model encompassed 7 counties (McHenry, Kankakee, DeKalb, Kane, Grundy, Will, and Kendall) containing 356 census tracts.

Table 3-1 - *Summary of Spatial Regression Model Variables*

Summary Table of Spatial Regression Model Variables				
	Chicagoland Non-Core Counties Census Tracts (n = 356)		**Chicagoland Core Counties Census Tracts** (n = 1,656)	
VARIABLES	Median	Range	Median	Range
Shortest network distance to audiologist (miles)	2.98	2.9 - 28.3	0.37	0.0 - 21.1
Share of Black Population (%)	4.0	0 - 91.0	5.0	0.0 – 99.0
Share of Latinx population (%)	12.5	0.6 – 92.4	11.2	0.6 – 93.9
Share of white population (%)	86.6	5.3 - 99.3	69.0	1.0 – 98.5
Share of older adults reporting difficulty hearing (%)	2.4	0 - 9.1	2.2	0.5 – 9.6
Median age (years)	37.9	22.6 – 61.4	36.9	22.8 - 71
Share of population with insurance (%)	93.15	71.7 – 99.4	89.3	67.1 – 99.7
Household income (US, 2016)	$69497.50	$15242 – $160318	$59643	$13536 - $240000
Share of households without a car (%)	3.4	0 – 59.2	0.9	0.0 – 11.5
Population density (population per square mile)	720.9	10.68 – 6,734.1	2642.1	175.4 – 189424.8

3.4 Results

The availability of providers reflects the hierarchy of health services, with more PCPs and fewer specialized providers (audiologists). Specifically, the number of Medicare- and Medicaid-enrolled PCPs in the Chicago metropolitan area totaled 1,888, compared with 258 Medicare-enrolled audiologists. Further, their locations reflect a strong bias, with greater availability in the central business district within the city of Chicagoand the Medical Corridor to the southwest. Physician and audiologist locations also reflect a general tendency toward locating in areas with higher incomes, such as Chicago's Northside neighborhoods (**Figure 3.2**).

Census tracts in the urban, 'core' counties also have overall shorter network distance to the nearest audiologist, compared with the non-core counties (**Table 3.1**). Core counties generally had higher population densities, lower household incomes, younger populations, higher uninsured rates, and slightly lower shares of older adults self-reporting hearing difficulty compared with suburban, 'non-core' counties (**Table 3.1**). Tracts in the region's urban core had an overall higher share of Black residents than their suburban counterparts.

3.4.1 Cross-L Function Findings

The first step of the analysis was the cross-L function, summarizing the spatial dependence between primary care providers and audiologists in the study area. Below, in **Figure 3.2**, the graphical results of the cross-L function are shown, along with a confidence interval based on 99 Monte Carlo simulations. The results show that audiologists and primary care providers significantly co-cluster across the study area, a pattern also evident in **Figure 3.2**.

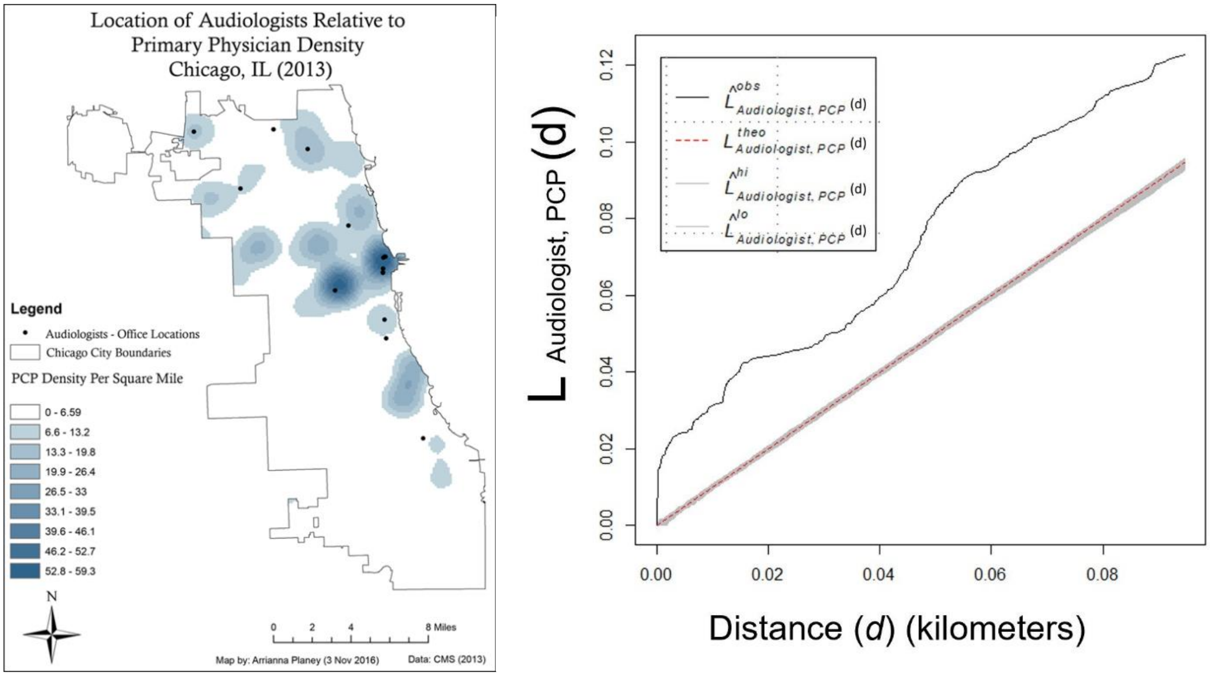

***Figure 3-2** – (L) Kernel Density Estimates of PCPs with Audiologist Locations Overlaid (R) Cross-L Function - Audiologists and PCPs in Chicago. Indicates co-clustering across the study area*

The graphical results of the cross-L function show that audiologists and primary care providers significantly co-cluster across the study area. The accompanying kernel density map of PCPs with overlaid audiologist locations illustrates this co-clustering (Fig. 3.2). It also shows that primary care providers have the highest density in the central business district (colloquially known as “the Loop”) and in the medical corridor slightly southwest. The medical corridor consists of a concentration of large hospitals, all clustered within 1-2 miles of each other, and one of these hospitals, Rush University Medical Center, has a clinical audiology practicum site This medical corridor is also where audiologist density is highest, which fits with the findings of my previous multilevel analysis of audiologist availability at the county level, which showed that proximity to clinical audiology programs was the strongest predictor of audiology supply at the county level (Planey, 2019). Also, from **Fig. 3.3**, it is apparent that Chicago’s majority-Black and Latinx south and west side neighborhoods lack providers.

3.4.2 Spatial Regression Model

The diagnostics for the initial ordinary least squares (OLS) models predicting distance to the nearest audiologist showed significant spatial autocorrelation, so I estimated spatial lag regression models in GeoDa for both subsets of the study area. For the spatial weights, I used rook weights.

Table 3-2 *- Spatial Lag Regression Model assessing associations between travel impedance to audiology services and tract-level socio-demographic characteristics among non-core counties in Chicagoland*

Chicagoland Non-Core Counties (n = 356 census tracts)			
Variables	Coef (β)	Standard Error	*p*>z
Share of Black Population (%)	-0.362935	1.81919	0.84187
Share of Hispanic Population (%)	-0.283073	1.94329	0.88418
Density of Primary Care Physicians per Sq/Mi	-5.00409	2.0919	0.01675
Share of Older Adults Reporting Difficulty Hearing (%)	-0.0646897	0.209271	0.75723
Median Age (years)	0.103763	0.0513545	0.04333
Share of population with insurance (%)	-0.0990129	0.0429696	0.02121
Median Household Income (US, 2016)	4.52324e-006	1.41021e-005	0.74840
Population Density (population per square mile)	0.0227465	0.00442043	0.00000
AIC: 2067			

The spatial regression results show varying associations of socioeconomic and health care factors with distance to audiologist between the region's non-core and core counties. In Chicagoland's non-core counties, there was an inverse association between tract-level network distance to audiology services and density of PCPs (*p*<.05), reflective of the broader pattern of audiologist co-location with referring PCPs. Moreover, tracts with older populations, higher median ages, had longer travel distances to care. Finally, in these suburban areas, there was a positive association between travel distance to audiologist services and population density [**Table 3.2**].

Table 3-3 - *Spatial Lag Regression Model assessing associations between travel impedance to audiology services and tract-level socio-demographic characteristics among core counties in Chicagoland*

Metro Chicagoland Core Counties (Cook, DuPage, and Lake Counties) (n = 1,656 census tracts)			
Variables	Coef (β)	Standard Error	*p*>z
Share of Black Population (%)	1.23562	0.30739	0.00006
Share of Hispanic Population (%)	1.56086	0.41567	0.00017
Density of Primary Care Physicians per Sq/Mi	-0.332282	0.0913434	0.00028
Share of Older Adults Reporting Difficulty Hearing (%)	-0.00302155	0.0599156	0.95978
Median Age (years)	0.00941004	0.0140035	0.50160
Share of population with insurance (%)	0.00376367	0.0115372	0.74426
Median Household Income (US, 2016)	-5.54637e-006	3.41045e-006	0.10389
Population Density (population per square mile)	0.0748886	0.016132	0.00000
AIC: 8224.56			

In contrast, the results for the densely populated core counties (Table 3.3) show somewhat different associations. Tracts with a higher proportion of Black residents had poor spatial access to audiology services, as did tracts with higher proportions of Hispanic residents (**Table 3.3**). Moreover, within core counties in Chicagoland, tracts with higher PCP density per square mile had shorter distances to audiologist services. This is consistent with the cross-L function findings, which show that audiologists co-locate with PCPs in the study area (**Figure 3.3**).

Cumulatively, these findings confirm the hypotheses that audiologists tend to co-cluster with primary care providers, and that this co-location can exacerbate spatial access across the axes of race, ethnicity, and class. There is strong evidence of co-location, confirming my hypothesis that their location decisions and spatial proximity reflect the hierarchy of care between primary and tertiary providers which is mandated by referral requirements. Further, the spatial regression model findings verify that network travel distance to audiologist services is *inversely* associated with PCP density at the tract level, providing further support for co-location. Beyond co-location, the spatial regression models for non-core counties and core counties revealed heterogeneity and demographic and race/ethnic disparities in access to audiologists within the study area.

3.5 Discussion

Coupling exploratory spatial data analysis (ESDA) and spatial regression modeling approaches, this study assesses whether audiologists co-locate with referring primary care physicians, and whether this co-location results in racial, ethnic, and class disparities in spatial access to hearing health care. The results show a strong tendency for audiologists and PCPs to co-cluster geographically in a pattern that both reflects and facilitates referral links mandated in health policies associated with reimbursement. Although a spatial analysis like this cannot identify the reasons for co-clustering, the observed proximity between providers is consistent with a behavioral process in which audiologists locate near PCPs in order to streamline mandated referral processes. In addition, co-clustering is observed in and around major hospitals and audiology training programs that employ both types of health care providers. This is consistent with Bureau of Labor Statistics data, which show that audiologists are primarily employed in physicians' offices, private practices ("officers of other health practitioners"), and general medical and surgical hospitals (Bureau of Labor Statistics, 2019).

These findings confirm my hypothesis that the clustering of primary and specialist care providers reinforces racial and ethnic disparities in spatial access to care within the Chicagoland's more urbanized areas, while affirming demographic differentials in the spatial accessibility of audiology services within the outer ring suburban areas of Chicagoland. In the non-core counties, there is evidence of an inverse care-type association in which places with a higher percentage of elderly population and lower median incomes have longer travel distance to audiology services. This finding mirrors earlier findings at the national scale (Planey 2019). In the core counties, inequalities by race and ethnicity are evident: Tracts with a higher concentration of Black and Latinx residents have longer travel distances to audiology services. Thus, the findings confirmed my second hypothesis, which posited inequities in spatial access to co-located specialist care across the axes of race, ethnicity, and class in the study area.

Effectively, there is an inverse care association (Tudor Hart, 1971) between both availability and accessibility of audiology services. Prior work on utilization of hearing health services supports these findings, including lower rates of hearing loss diagnosis among people with low incomes and higher likelihoods (nearly twice as high) of hearing aid ownership and use among whites compared with Black and Latinx people (Bainbridge & Ramachandran, 2014; Nieman et al, 2016).

To date, most geographic studies of health care service accessibility focus on one set of providers. Moreover, this study answers the call to bring policy into studies of health care geographies by considering the co-location of specialists and referring primary care physicians within a context where PCP referral is a prerequisite for Medicare reimbursement . As such, it is fitting that this study is based on practice locations of Medicare enrolled providers (Centers for Medicare and Medicaid Services (CMS) Physicians Compare dataset, 2018). Moreover, Medicare's status as the "*de facto* regulator of the health care system" in the United States (Givan, 2016, 105) affirms the importance of focusing on Medicare- and Medicaid-enrolled providers.

This study is novel in its application of spatial analytic approaches to assess specialist co-location with primary physicians and the effect of primary care provider and specialist co-location on disparities on spatial accessibility of care. Further, defining the outcome variable for the spatial regression model as the network travel distance to audiology services from the population-weighted tract centroids is advantageous on two counts: this approach reduces estimation errors, in comparison to distance calculations based on geometric/areal centroids (Berk and Shi, 2009), and network distance measures are more accurate than estimates based on Euclidian distance. Further, this approach partially addresses what Guagliardo (2004) identified as a tendency for average distances to over-emphasize providers who are inconvenient based on network distance.

3.5.1 Limitations

This study is limited by its focus on a single metropolitan area, so the generalizability of findings to other urban and rural regions and to other countries, is unclear. Other countries may lack the referral mandates that encourage the co-location process. Future studies are needed to   assess the spatial dependence between audiologists (or other specialists) and primary care physicians in diverse study areas. Moreover, the current study excludes Illinois' rural areas, which have lower levels of access to primary care providers and specialists (Ricketts 1999).

It should also be noted that the K-function and cross-L functions, and kernel density estimation are based on Euclidean distance. Future directions include K-functions based on network distance, such as constrained kernels, or the split kernel method (Okabe, Satoh, and Sugihara, 2009; Sugihara, Satoh, and Okabe, 2010). These approaches, no doubt, would be computationally intensive and contingent upon characteristics of the network itself (density, angles), but they could be a more meaningful measure of clustering or dispersion of healthcare providers in an urban area.

There is a need for more studies of provider co-location that are attentive to (in)equity in spatial access to care among marginalized communities, who typically have heavier burdens of non-communicable or chronic conditions and a greater need for continuity and coordination in the management of these conditions. The spatial and social inequalities observed here may be representative of many types of specialist health care services in the U.S. in which providers gravitate, both individually and collectively, to places and neighborhoods perceived as profitable.

3.6 Conclusion

Set in the context of the United States' highly marketized health care system, this study begins with the proposition that health care policies governing interprofessional practice are reflected in the spatial arrangement of health care services. Taken together, the findings from both the exploratory cluster analyses and spatial regression models assessing tract-level travel impedance to care for core and non-core counties in Chicagoland show that the clustering of providers- audiologists and referring primary care providers- reinforces racial, ethnic, and class disparities in spatial access to care. Research shows that these disparities have consequences for population health. For example, Fishman, McLafferty, and Galanter (2018) found that poorer spatial access to primary care was associated with the use of the emergency department for non-emergent conditions among patients in the city of Chicago, corroborating earlier findings across a 31-state study area among older adults (Laditka, 2004). Moreover, hospitalizations for ambulatory care sensitive conditions (ACSC) are higher in low-income areas and among uninsured residents (Pappas et al, 1997).

Given that untreated hearing and balance disorders are associated with a threefold risk of falls among older adults (Lin et al, 2013), the accessibility of audiology services is of great importance as the U.S. population ages. These effects will likely be spatially uneven, given that suburban and rural counties are aging faster than urban counties, while urban counties have higher provider supply due to the advantageous combination of high population density and higher household incomes (Cagney and York Cornwell, 2018; Planey, 2019).

This study contributes to the literature on health care access by assessing the effects of specialist co-location with primary care providers on spatial access to care at the axes of social difference — that is, race, ethnicity, and class — in a highly segregated metropolitan region. First, by measuring area-level inequities in spatial access to healthcare services in the highly-segregated Chicago metro area, this study follows up on White and colleagues' (2012) call for greater attention to racial and ethnic segregation as a potential factor underlying place-based healthcare disparities. Second, in addressing the policy context of audiologist co-location with primary care physicians, this paper extends Bambra, Smith, and Pearce's (2019) invitation to apply political economic approaches to the study of health and place to assess *health care* in place. In doing so, this study raises questions about perceptions of primary care-centered models of health care as a given 'good': A key takeaway here is that specialist co-location with primary care providers as a policy solution is not equitable if the underlying distribution of primary care is inequitable. In this context, the findings of this study can inform health care policies addressing hearing health care accessibility and care coordination for an aging population with a growing burden of comorbid conditions amid a growing shortage of audiologists.

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4 INTRODUCING A CONCEPTUAL MODEL OF HELP-SEEKING AND ACCESS FOR THE MANAGEMENT OF CHRONIC CONDITIONS

Background: In the following chapter, I introduce the next phase of my work, which is a conceptual model of health care access for the management of chronic conditions, specifically hearing and balance disorders among patients in the United States. This model builds on Levesque, Harris, & Russell's (2013) conceptual framework of healthcare access to account for scale and context and to represent more explicitly access as the process of help-seeking and health care utilization, whereby patients navigate the environments in their activity spaces, the constraints and affordances of their health care systems, and the health care policies (state, federal) that shape health care delivery. The following sections address scalar and qualitative dimensions of health care access, beginning with the space of the clinic.

Methods: Synthesis of literature on help-seeking for, access to, and use of hearing healthcare, or audiologist services.

Results: Based on the existing frameworks and studies of access to hearing healthcare, I define access as the process of help-seeking and health care utilization, whereby patients navigate the environments in their activity spaces, the constraints and affordances of their health care systems, and the health care policies (state, federal) that shape health care delivery. This process begins with recognizing and identifying the need for healthcare services. Consistent with Levesque, Harris, & Russell (2013), access is conceptualized as the dynamic interaction between the 5 A's of access (1) Approachability and Awareness; 2) Acceptability; 3) Availability and accommodation; 4) Affordability; 5) Appropriateness) and corollary individual-level dimensions (1) Ability to perceive; 2) Ability to seek; 3) Ability to reach; 4) Ability to pay; and 5) Ability to engage). However, I revise the conceptual model to account for multi-scalar healthcare policies and health system characteristics that shape the accessibility of audiologist services in the United States

Conclusion: To capture the complexity of healthcare access, it is necessary to account for the scalar dimensions of healthcare policies, which shape the availability and provision of healthcare via financing and other structural incentives (such as requiring referral from primary care providers as a prerequisite for payment of allied healthcare provider services). Moreover, explicitly accounting for scale allows for analyses to capture regional variation in state and federal healthcare policy, and their consequences for care access. At the level of the patient, this model complicates behavioral models that neglect the constraints and affordances imposed by one's socio-ecological context, such as racial segregation, and rural-urban disparities in healthcare accessibility.

Keywords: access to healthcare, accessibility, conceptual model, hearing loss, care continuity, utilization of health services

4.1 Introduction

As the United States population ages, there is a growing need for chronic care. Hearing loss, in particular, affects a third of adults in the United States, and nearly two-thirds of adults in the fastest-growing age category — adults ages 75 and older. This demographic shift is spatially uneven, with residents in rural counties aging more rapidly than their urban counterparts (Cagney and York, 2018). Moreover, the number of adults with hearing loss is expected to double by 2060 (Goman, Reed, and Lin, 2017). Currently, older adults in the U.S. typically wait 5-10 years before seeking help after the initial recognition of their hearing loss (Davis, et al, 2007). Unfortunately, among older adults, the consequences of foregone treatment of hearing and balance disorders spill over into quality of life domains (heightened risk of dementia; social isolation; greater risk of adverse outcomes in clinical settings), leading to greater risk of injury-causing or mortal falls (Lin, Metter, O'Brien, Resnick, Zonderman, and Ferrucci, 2011; Mick, Foley, & Lin, 2014).

This paper builds on the Levesque, Harris, and Russell (2013) conceptual framework of access to healthcare (**Figure 4.1**) to forward a conceptual model of help-seeking and access to care for the management of one chronic condition: hearing loss. Levesque and colleagues' (2013) conceptual framework integrates Thomas and Penchansky (1981) five "A's" of access (affordability, availability, accessibility, accommodation, and acceptability) with Aday and Andersen's (1974) Behavioral Model of Health Services Use and its offshoot (Andersen, 1995) to conceptualize access in terms of the interaction of abilities of populations and the dimensions of access.

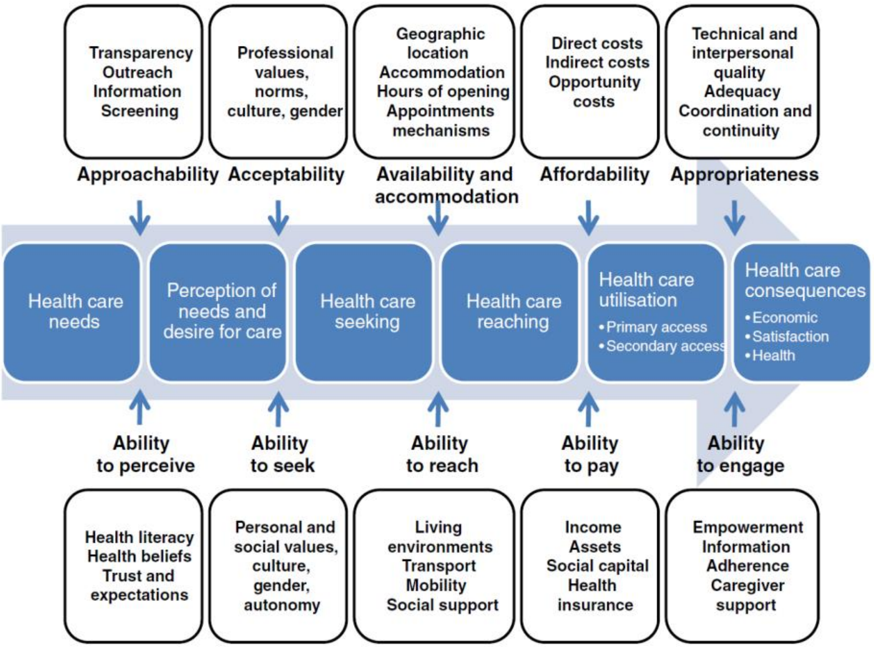

Figure 2 A conceptual framework of access to health care.

***Figure 4-1** - Levesque, Harris, & Russell (2013) Conceptual Framework of Access to Healthcare*

In the literature, health care access has been defined as a spatial, behavioral, and systemic characteristic, as well as an episode whereby a person enters a health care system (Hornbrook, Hurtado, and Johnson, 1985). Frenk (1992) defines access as the ability of a population to seek out and obtain care. Some researchers focus on realized or "revealed" access which can be defined in terms of the quantity of services consumed by the client (Joseph & Phillips 1984; Shengelia, Murray, and Adams 2003).

An influential paper by Penchansky and Thomas (1981) defines access as multi-dimensional, proposing 5 A's of access, which encompass spatial and aspatial facets: availability, accessibility, accommodation, affordability, and acceptability. *Availability* is defined as the adequacy of the supply of providers relative to need, including the spatial relationship between providers and patients (Guagliardo, 2004). *Accessibility* is characterized as the degree of friction between the patient and provider or health system, including distance to care and other system-level barriers to or facilitators of help-seeking and service use. *Accommodation* can be defined as the degree to which a healthcare system enables timely patient entry into a healthcare system, and this includes walk-in appointment hours, or appointment slots outside of working hours. *Affordability* refers to the ability of a patient to bear the costs of care, which are borne of complex healthcare financing arrangements (reimbursements, co-pays, deductibles) and patient-costs associated with help-seeking and service use (opportunity costs, such as foregone income from missing work and the travel time to access care, and other costs, such as parking and transit fares).

Affordability is a key variable in measures of distance tolerance and distance decay relationships (defined as the relationship between distance to care and propensity to use healthcare services (Arcury, et al., 2005; Khan, 1992)) for a given set of healthcare services. *Acceptability* is the degree of agreement between patient and provider expectations of and attitudes toward care. A later study extends the five A's of access to include a sixth: awareness (Saurman, 2015). "Awareness" is important for both patients and providers- especially in the context of managing chronic conditions through coordinated and continuous care within complex health care delivery systems.

Aday and Andersen's (1974) classic Behavioral Model of Health Services Use conceptualizes access primarily in terms of the process of entering the health care system, wherein the characteristics of the person (predisposing and enabling) interact with resources and perceived need to produce health care service utilization. In the Leveque et. al. (2013) model (Fig. 5.1), these are articulated as the pairing of structural or aggregate measures of access and individual-level characteristics that interact in the process of help-seeking and service use: (i) approachability / ability to perceive; (ii) acceptability / ability to perceive; (iii) availability and accommodation / ability to reach; (iv) affordability / ability to pay; and (v) appropriateness / ability to engage. In building on this framework, I aim to be attentive to additional dimensions, specifically scale, temporality, and the multi-level policy context of healthcare help-seeking and service use for the management of chronic conditions.

Nested within "scale" is the multi-scalar health care policy context (federal and state), as well as the ecological (neighborhood context) and health system-level factors that people navigate as they seek help. Conceptually, in the process of help-seeking and accessing care for the treatment and management of chronic conditions, scale, context, and time are folded into one another because the process is iterative, spanning the hierarchy of care (from primary care to referred specialist care). As such, this work expands on Levesque, Harris, and Russell's (2013) conceptual model of patient-centered access at the interface of health systems and population to more explicitly account for the spatial and policy facets of access throughout the help-seeking process.

This project is timely, as it follows intensified interest in hearing health care access among academics and policymakers (National Academies of Science, 2016). Following the Food and Drug Administration regulatory guideline changes regarding over-the-counter hearing aids and personal sound amplifier products (PSAPs) in December 2016, and the August 2017 passage of the Over-the-Counter Hearing Aid Act (attached to the FDA Reauthorization Act), there is clearly an urgent need for understandings of help-seeking for and access to hearing health care that address individual-level factors as well as structural- and health-system-level factors that enable or inhibit access to diagnosis and treatment of hearing and balance disorders. This conceptual framework fills that gap and contributes to a more integrative understanding of care and access for the management of hearing and balance disorders in the U.S..

4.2 Access to Audiologist Services

Few studies have addressed geographic dimensions of access to audiologist services. In the extant literature on help-seeking and service use for the management of hearing and balance disorders, researchers have taken a more behavioral approach to hearing health care help-seeking and service use, including the Prochaska and DiClemente (1983) Transtheoretical (or Stages of Change) Model (TM), the Health Belief Model (HBM), the Self-regulatory Model (SRM), and the Self-determination Model (SDM) (Ferguson et al, 2016). These models center the psychosocial dimensions of hearing loss and help-seeking behaviors, and they can be classified as “stage” models. These models posit health behaviors, such as healthcare help-seeking and service use as deliberative and iterative processes borne out by individuals. However, it is important to account for the contextual and system-level factors that shape help-seeking and service use. Individual patients to not make choices or engage in behaviors in a vacuum, and this missing context can enable a better understanding of patient help-seeking processes and outcomes.

A key context for audiologist service accessibility in the United States is the health care policies that define the conditions under which audiologist services are reimbursed. For example, in the U.S. the Centers for Medicare and Medicaid Services (CMS) requires referral from a medical practitioner as a prerequisite for reimbursement of audiologist services. Further, those services must be assessments “in support of a diagnosis” (CMS, 2016). Because Medicare is the *de facto* regulator of healthcare in the U.S. (Givan, 2016), private insurance typically follows, and access to audiology services is similarly constrained for those with private insurance. This imposes constraints on the scope of practice for audiologists whose service areas are primarily comprised of older adults for whom Medicare is a primary payor. Arguably, the referral requirement also incentivizes audiologists’ location in areas with higher household incomes- and ironically- younger populations (Planey, 2019).

This project expands on Levesque, Harris, and Russell’s (2013) conceptual framework of healthcare access to account for healthcare policies that shape multiple dimensions of access, including healthcare provider supply and availability, and healthcare delivery system characteristics (e.g. financing arrangements that reward interprofessional practice in specific instances). Specifically, this revised framework addresses hearing healthcare service access and utilization among Medicare beneficiaries in the United States. Moreover, building on prior work which conceptualizes healthcare access in terms of spatial and aspatial facets (Khan, 1992), this integrative conceptual framework of access aims to interlink the spatial and aspatial dimensions of access.

In the following sections, I synthesize the literature on audiologist service access, addressing in turns, (i) spatial accessibility (accessibility and availability), (ii) availability and accommodation (ability to reach), (iii) affordability (ability to pay), (iv) approachability and awareness (ability to perceive), and (v) appropriateness (ability to engage).

4.2.1 Availability and Accommodation (ability to reach)

In the U.S., the supply of audiologists- hearing and balance disorder specialists- declined between 1985 and 2012 due, in part, to (i) attrition, (ii) a halving in the number of clinical audiology (Au.D) programs, and (iii) falling enrollment in these programs (Windmill, 2013; Windmill & Freeman, 2013). These triplet trends have broader implications for the accessibility and affordability of hearing healthcare. In terms of the geographic distribution of audiologists, rural-urban differences exist. At the county level, audiologist availability and supply reflects an urban bias, with metropolitan counties being more than three times as likely to have audiologists, and among counties with audiologists, urban counties had over twice the supply of audiologists (Planey, 2019). In contrast, rural counties, which often have lower median incomes and higher median ages, have lower levels of audiologist supply (Planey, 2019).

Moreover, at a finer geographic scale, audiologists co-locate with primary care providers (Planey, Chapter 3). Within the Chicago metropolitan region, where the distribution of healthcare providers and facilities reflects historic patterns of segregation, this means that Black and low-income residents in the region's core have longer distances to primary care and audiologist services. Put another way, the co-location of audiologists with primary care providers potentially reinforces existing racial and class disparities in spatial access to care (Chapter 3).

4.2.2 Spatial Accessibility (Accessibility and Availability)

In geographic analyses of healthcare access, spatial accessibility is understood as a combination of availability (number of providers) and accessibility (travel distance or travel time to access healthcare services) (Guagliardo, 2004). This aggregate-level conception of access is helpful for apprehending inequities in access to care in space (Bose et al, 2016; Wright & Ricketts, 2010). As demonstrated in the third chapter of this dissertation, higher concentrations of Black and Latinx residents in Chicago's racially and ethnically segregated metro region were associated with longer travel distances to audiologists, adding to the body of work on racial segregation and healthcare access reviewed by White and colleagues (2012). Specifically, studies of healthcare service utilization have found that adult Black residents residing in segregated, majority-Black zip codes were less likely to use healthcare services compared with white counterparts in majority-white zip codes (Gaskin et al, 2011).

In the case of audiologists, the spatial distribution of providers reflects an inverse care relationship (Tudor Hart, 1971), whereby audiologists tend to locate in counties with younger populations, higher household incomes, and lower proportions of older adults (age ≥65) reporting hearing difficulty (Planey, 2019). Further, prior studies have found that rural residents have longer distances to audiology services and longer periods before they receive a diagnosis compared to urban residents (Chan et al, 2017). Further, the results in the fourth chapter showed that the association between county-level per-beneficiary Medicare expenditures on audiologist services among Medicare patients ages ≥65 with hearing and balance disorders and fall mortality among older adults varied by rurality.

This is consistent with other studies, which find that rural patients have poorer care access, and are less likely to have a physician as their usual source of care (Kirby & Yabroff, 2020). However, given 'scope of practice' regulations that allow nurses and physician's assistants to provide primary care services, this does not mean that rural patients are not receiving primary care (Holmes, Morrison, Pathman, & Fraher, 2013). However, it is important to note that the relationship between rurality or urban status and residents' primary care access is not so straightforward (Arcury, Preisser, Gesler, & Powers, 2005). Among Medicare Expenditure Panel Survey (MEPS) respondents, residents in counties classified as 'metropolitan counties' (per the USDA's Rural-Urban Continuum Codes) were less likely to have a "usual source of care", compared with their counterparts in non-metropolitan counties, despite there being a higher density of primary care providers in urban service areas (Kirby & Yabroff, 2020). This suggests that proximity is a necessary, but insufficient condition for healthcare accessibility.

Inequities in spatial access to audiologist services may be particularly acute for older adults and people with hearing loss and other disabilities (Chan, Hart, and Goodman, 2006; Iezzoni, Killeen, & O'Day, 2006; Lagu, Iezzoni, & Lindenauer, 2014). In the U.S., audiologist availability and supply are greatest in counties with younger populations and smaller proportions of older adults (age ≥65) reporting hearing difficulty (Planey, 2019). Moreover, Behavioral Risk Factor Surveillance System (BRFSS) data show that residents in southern U.S. states have the highest self-reported rates of disability prevalence and high uninsured rates among young and middle-aged adults (Okoro et al, 2018). Additionally, these states have the lowest per capita supply of audiologists (Planey, 2019), which may partly explain Mahmoudi and colleagues (2018) findings that adults with hearing loss in these states are less likely to own hearing aids than are adults in other regions.

4.2.3 Affordability (Ability to Pay)

In the United States, healthcare spending has historically reflected an overall upward distribution of social resources, whereby low-income patients are met with barriers to utilization, while high-income patients are met with a healthcare system that encourages their healthcare use. Before 1965, per capita healthcare spending was the lowest for the lowest-income patients in the U.S., despite their heavier burdens of illness and injury (Dickman, et al, 2016). This pattern was attenuated by the passage of the 1965 law that created Medicare and Medicaid, which expanded the federal government's role in healthcare provision, and increased spending on healthcare for the lowest-income and sickest patients in the U.S.

However, post-2009 recession healthcare spending on the wealthiest remains the highest despite global decreases in per capital healthcare spending. For example, per capita healthcare expenditures fell for the poorest quintile of Americans at a rate of $19.27 per year between 2004 and 2012 (a cumulative 3.7% decrease), while expenditures on the wealthiest quintile grew at a rate of 19.7 percent- or $106.04 per person per year (Dickman, et al (2016). This trend potentially exacerbates inequities borne of the health-wealth gradient, whereby people with lower socio-economic status (SES) have poorer health status compared with their high SES peers (Marmot, 2001), with cumulative effects across the life course. Christopher and colleagues (2018) found that, "*Medical outlays reduced the median income of the poorest decile by 47.6% versus 2.7% for the wealthiest decile and pushed 7.013 million individuals into poverty.*" Relatedly, Maskileyson (2014) found that the health-wealth gradient among older adults in the U.S. was more pronounced compared with their counterparts in other high-income countries, all of which have higher per capita public expenditures on healthcare provision (Sweden, the United Kingdom, Germany, the Czech Republic, Israel).

The question of affordability is complicated by the fact that the populations with the highest hearing loss prevalence are also populations whose mobility is typically limited – elderly and disabled people. Moreover, these populations are also statistically more likely to have lower workforce participation rates and lower household incomes, which exacerbates the question of hearing healthcare affordability in the absence of Medicare and Medicaid coverage of audiological services and devices (Forbes, Sturgeon, Hayward, Agwani, and Dobbins, 1992; Horner-Johnson, 2014; Jung and Bhattacharyya, 2012). While Medicare does not cover audiology services outside of physician-referred assessments in support of a medical diagnosis (CMS, 2016), 28 state Medicaid programs cover audiologist services for adult beneficiaries (Arnold, Hyer, and Chisolm, 2017).

The reasons for this pattern are complex, but they can be traced to Title XVIII and Title XIX of the Social Security Act in 1965 (Wallhagen & Reed, 2018); specifically, the statutory exclusion of hearing health care services from Medicare and Medicaid essential services (which centered on primary care and reducing hospitalizations) (Whitson and Lin, 2014), in addition to the classification of audiologists as ‘non-physician providers’ (Glantz, 2017). Given the status of the Centers for the Medicare and Medicaid Services (CMS) as the de facto regulator of the US health care system (Givan, 2016), private insurance plans largely follow suit, setting audiology services apart from “essential” services, and requiring primary physician or other medical professional referral as a prerequisite for reimbursement for audiology services (CMS, 2016). As of 2017, only 28 state Medicaid programs cover hearing aids for beneficiaries. As of January 2020, only 5 U.S. states (Maine, Arkansas, Illinois, New Hampshire and Rhode Island) require their state Medicaid programs to cover hearing aids for both adult and child beneficiaries (American Speech Language Association, 2020).

As a result, adults in the U.S. face significant barriers to hearing healthcare in terms of cost. Among Medicare beneficiaries with untreated hearing loss, expenditures on hospitalizations are higher (Mahmoudi et al, 2016). Conversely, among Medicare beneficiaries who own and use hearing aids, Medicare expenditures are lower, but out-of-pocket costs for care are higher (Mahmoudi et al., 2016). Among older adults with private insurance coverage, racial and ethnic disparities in hearing loss treatment and hearing aid ownership among older patients persist, wherein Black and Hispanic patients have lower rates of hearing aid ownership compared with white patients (Bainbridge and Ramachandran, 2014; Mahmoudi et al, 2019). This pattern is mirrored among middle-age adults (ages <55), where those with diagnosed hearing loss had higher out-of-pocket costs than their counterparts (Simpson, Simpson, & Dubno, 2016). In a 2006 survey of U.S. adults with hearing loss who were ‘non-adopters’ of hearing aids, 76 percent of respondents identified finances as a barrier to adoption, and 64 percent specifically cited the cost of hearing aids as a barrier (Kochkin, 2007).

Relatedly, the greatest growth in hearing aid adoption is occurring among high-income, and mostly white older adults (Kochkin, 2009). In a nationally-representative sample of older adults (age >70), the prevalence of hearing aid use was approximately 66 percent higher in the top quintile of the income-to-poverty distribution, compared with the lowest quintile (Bainbridge & Ramachandran, 2014).

4.2.4 Awareness & Acceptability (ability to seek)

More recent scholarship has proposed an extension of Thomas and Penchansky's (1981) 5 "A's" of access to include "awareness"- or the degree to which healthcare providers or systems foster awareness through "effective communication and information strategies with relevant users (clinicians, patients, the broader community), including consideration of context and health literacy" (Saurman, 2016, 37). It is instructive highlight the concept of "awareness" as a facet of access on the part of both patients (who cannot seek out services that they do not know of) and providers (who cannot refer patients to services or providers that they are unaware of). In the U.S., this is key in a context where primary care providers serve a gatekeeper role and determine access to specialist care within the health care systems. Treatment of hearing loss thus depends on primary care doctors' recognition of hearing loss as a 'problem' and their subsequent referral of patients to audiologists for assessment (Arnold, Hyer, and Chisolm, 2017; Center for Medicare and Medicaid Services, 2016). Studies suggest that primary care provider awareness of audiology services is low (Mahboubi, Lin, & Bhattacharyya, 2017; Wu et al, 2013). For example, a survey of primary care providers in two counties in southern California found that 26 percent were unaware that cochlear implants, surgically implanted neuro-auditory prosthetic devices that stimulate the auditory nerve, were a treatment for hearing loss, and 80 percent were unaware that all health insurance plans cover cochlear implants (Wu et al, 2013). In their analysis of 2014 National Health Interview Survey (NHIS) data, Mahboubi, Lin, and Bhattacharyya (2017) found that, among adults with self-reported hearing loss, approximately 20.6 percent saw a primary care physician in the previous 5 years about their hearing loss. Moreover, referral rates for hearing healthcare were low: 32.6 percent for ear nose throat (otolaryngologist) doctors, and 27.3 percent for audiologists, respectively.

In their review of health care access and disparities frameworks, Meade, Mahmoudi, and Lee (2014) critiqued the Aday and Andersen framework for its lack of attention to cultural and contextual factors shaping disabled persons' ability to access health care. These contextual and cultural factors include mismatches between a deaf or hard-of-hearing patient's preferred communication modality and their clinician's language abilities, particularly where language service provision (such as medical interpreters) can depend on location and hospital ownership type (Schiaffino, Nara, and Mao, 2016). Overall, fewer than two-thirds of hospitals in the United States provided language services in the year 2013, a potential social determinant of health for the approximately 24 million people who are not proficient in spoken English (Schiaffino, Al-Amin, and Schumacher, 2014; Ryan, 2013). For deaf and hearing-impaired patients, audiologists are potentially key mediators in the broader matrix of healthcare access- especially with regard to facilitating effective communication. Overall, adults with hearing loss generally rate their satisfaction with patient-physician communication lower than their counterparts without hearing loss (Mick, Foley, and Lin, 2014).

4.2.5 Approachability (ability to perceive)

Among older adults, one of the first steps to help-seeking for hearing loss is a recognition of their hearing loss (Barnett et al, 2017). In conjunction with family support and an individual sense of self-efficacy, recognition of hearing loss was a facilitator of help-seeking for audiologist services across studies published between 1990 and 2015 (Barnett et al, 2017). Conversely, comorbidity —or competing chronic conditions — was considered a barrier to help-seeking for hearing loss, perhaps due to limited resources- borne of trade-offs due to competing needs- on the part of older adults and their families. Further, more severe hearing loss was associated with a greater propensity for help-seeking and audiologist services use (Kochkin, 2007; Van den brink, Wit, Kempen, & Van heuvelen, 1996; Duijvestijn, et al, 2003; Popelka, Cruickshanks, Wiley, Tweed, Klein, Klein, 1998; Meister et al, 2008; Mulrow, Tuley, & Aguilar, 1992).

Screening is a key facilitator of problem recognition, help-seeking and subsequent hearing health care service use. However, from a life course perspective, disparities in the detection, recognition, and treatment of hearing loss begin early. Evidence shows racial and ethnic disparities resulting from states' non-compliance with the Early and Periodic Screening Diagnosis and Treatment (EPSDT) program (Medicaid.gov, 2017), which is administered through state Medicaid programs to detect and treat hearing loss among minors in the U.S.. In 2018, fewer than 50 percent of children in California, North Dakota, South Dakota, and Mississippi were screened (GAO, 2019). These are all states with sizeable or concentrated Black, Hispanic, and Native American populations. Further, the county-level mean share of minors (ages 5-17) reporting difficulty hearing is 0.7 percent, compared with 17.7 percent among older adults age ≥65 (US Census Bureau, ACS 5-year estimates, 2013-17, Table S1810; Planey, 2019). However, despite the greater need for hearing loss treatment among older adults, there is not an analogous hearing loss screening and referral program for adults. As a consequence, hearing health services are underutilized among older adults, with low rates of screening, diagnosis, and treatment for hearing loss among adults (Crowson, Schultz, & Tucci, 2016; Nash et al, 2013

4.2.6 Appropriateness (ability to engage)

For deaf and hard of hearing patients, access by necessity goes beyond physical access to sites of health care provision, as required by the Americans with Disabilities Act, and Section 504 of the Rehabilitation Act of 1973. For example, studies examining satisfaction with health care services among deaf and hard-of-hearing patients have found that satisfaction is lowest among patients with more severe communication disabilities (Barnett, Koul, and Coppola, 2014, Manchaiah, Stephens, and Meredith, 2011; Iezzoni, O'Day, Killeen, Harker, 2004). Moreover, Meade, Mahmoudi, and Lee (2014)'s review of health care access and disparities frameworks rightly critiques the Aday and Andersen (1974) framework for its lack of attention to cultural and contextual factors shaping disabled persons' ability to access health care. Contextual and cultural factors include mismatches between a deaf or hard-of-hearing patient's preferred communication modality and their clinician's language abilities, particularly where language service provision (such as medical interpreters) can depend on location and hospital ownership type (Schiaffino, Nara, and Mao, 2016). Currently, fewer than two-thirds of hospitals in the U.S. provide language services, and among those, a minority provide interpretation services for American Sign Language users.

Further, it is well-established that miscommunications between deaf or hard-of-hearing patients and clinicians lead to errors in diagnosis and treatment, with increased risk of preventable adverse events in acute care settings (Bartlett et al, 2008; Scheier, 2009). One study found that physicians reported more difficulty in communicating with deaf patients and subsequently, lower levels of trust or understanding of their diagnoses and treatments among deaf patients (Ralson, Zazove, and Gorenflo, 1996). This disparity persists even among deaf or hard-of-hearing patients who are familiar with spoken English, but rely on speech/lip-reading, because they only receive about 30-45 percent of what is said (Lieu, Sadler, Fullerton, & Stohlmann, 2007). It is for this reason that Drainoni, Lee-Hood, and Tobias (2006) identified the lack of alternative communication modalities in clinical settings as a barrier to accessibility. Compounding this is the fact that deaf and hard-of-hearing persons may not have access to incidentally occurring health information (such as mass media campaigns on the radio or television), which may explain why even highly educated deaf persons have lower levels of health literacy than their hearing peers (Pollard, Dean, O'Hearn, and Haynes, 2009; Pollard and Barnett, 2009).

Moreover, patients with hearing loss may require more time to communicate effectively with their healthcare providers. In focus group studies assessing deaf and hard-of-hearing patients' perspectives on clinician-patient communication, a common request is more time for appointments to allow for effective communication with their provider, such as time to ask questions and clarify the information they received (Iezzoni, O'Day, Killeen, and Harker, 2004). As most hearing loss is chronic (permanent with the potential to progress), the cumulative effectiveness of provider-patient communication has implications for the suitability of the long-term management of the condition (Street et al, 2009).

Moreover, stigma and problem recognition may interact to shape the help-seeking process for older adults. Even in the absence of financial barriers to care, stigma figures importantly in older adults' use of hearing healthcare and acceptance of treatment. In the United Kingdom, where the National Health Service (NHS) provides hearing loss treatment free at point of use, adult hearing aid users report that their adjustment to hearing aid use was a process of adjusting to new sensory inputs, learning to maintain their new devices, and, most pertinently, accepting a new self-image as a hearing aid user (Dawes, Maslin, and Munro, 2014). Prior studies show that older adults perceive hearing aid use to be a public admission of one's status as an aging person (Hetu, 1996). In the U.S., where Medicare, the public health insurance program for older adults, statutorily excludes hearing loss treatment (Glantz, 2017; Fifer, 2020), lack of affordability may interact with stigma to prevent help-seeking to address hearing loss.

4.3 Conceptual Model

Models of healthcare access depict complex political, social, and economic processes that constrain and influence healthcare workers' location and practice decisions, and the use (or non- use) of those services by people in need. Prior studies of audiology service accessibility and utilization have used behavioral models, such as the Health Belief Model, the Theory of Reasoned Action, and the Transtheoretical Stages of Change Models (Saunders, Chisholm, and Wallhagen, 2012). These models conceive of access as a process, but do not explicitly account for the spatial or socio-environmental context of health care help-seeking and hearing healthcare utilization, nor do they account for health policy or the health systems shaped by the former. While Aday and Anderson's (1995) framework for health care access incorporates contextual characteristics, including health policy and the health system (in the form of financing and organizational structure), applications of this model still largely treat space as a covariate, rather than as a context. Frequently, these are based on statistical analyses of patient survey responses, with utilization as a dichotomized outcome. Conceptually, this methodological approach presumes that realized access or utilization is an endpoint, rather than a process.

Below [**Figure 4.2**] I propose an expanded conceptual model of multi-level characteristics shaping health care help-seeking and utilization for hearing loss among adults in the United States, which builds on Levesque et al (2013) patient-centered access to health care model. Like Levesque and colleagues (2013), I define utilization as realized access, but the iterative nature of healthcare help-seeking for the management of chronic conditions necessitates understanding that barriers in the help-seeking process can be cumulative in nature as patients age and their health states change. Importantly, access is understood as the product of a dynamic relation between the accessibility of health care organizations, providers, and systems and the ability of patients, households, and populations (Levesque, Harris, & Russell, 2013), and the accessibility of providers and ability of patients are mediated by the socio-spatial arrangement of populations and healthcare resources. In other words, what health geographers call "spatial accessibility" (Guagliardo, 2004) bridges the conceptual divide between patients and healthcare providers, because social and geographic space and *place* are the contexts for illness and disability *and* healthcare provision.

Further, the below conceptual model [**Figure 4.2**] brings healthcare policy back into the model. Notably, the Levesque, Harris, and Russell (2013) model omits “health policy” (defined by Aday and Andersen (1974) as including healthcare financing, healthcare workforce education and supply (“manpower”), and healthcare organization). At the top are macro-level factors such as state and federal level health policy. Overall, the model suggests that health care help-seeking and utilization comprise a process borne of the interaction of multi-level factors, ranging from individual and network-level factors (social support, health literacy, and perceived impairment), to health-system characteristics, including provider availability and the degree of coordination and continuity of care.

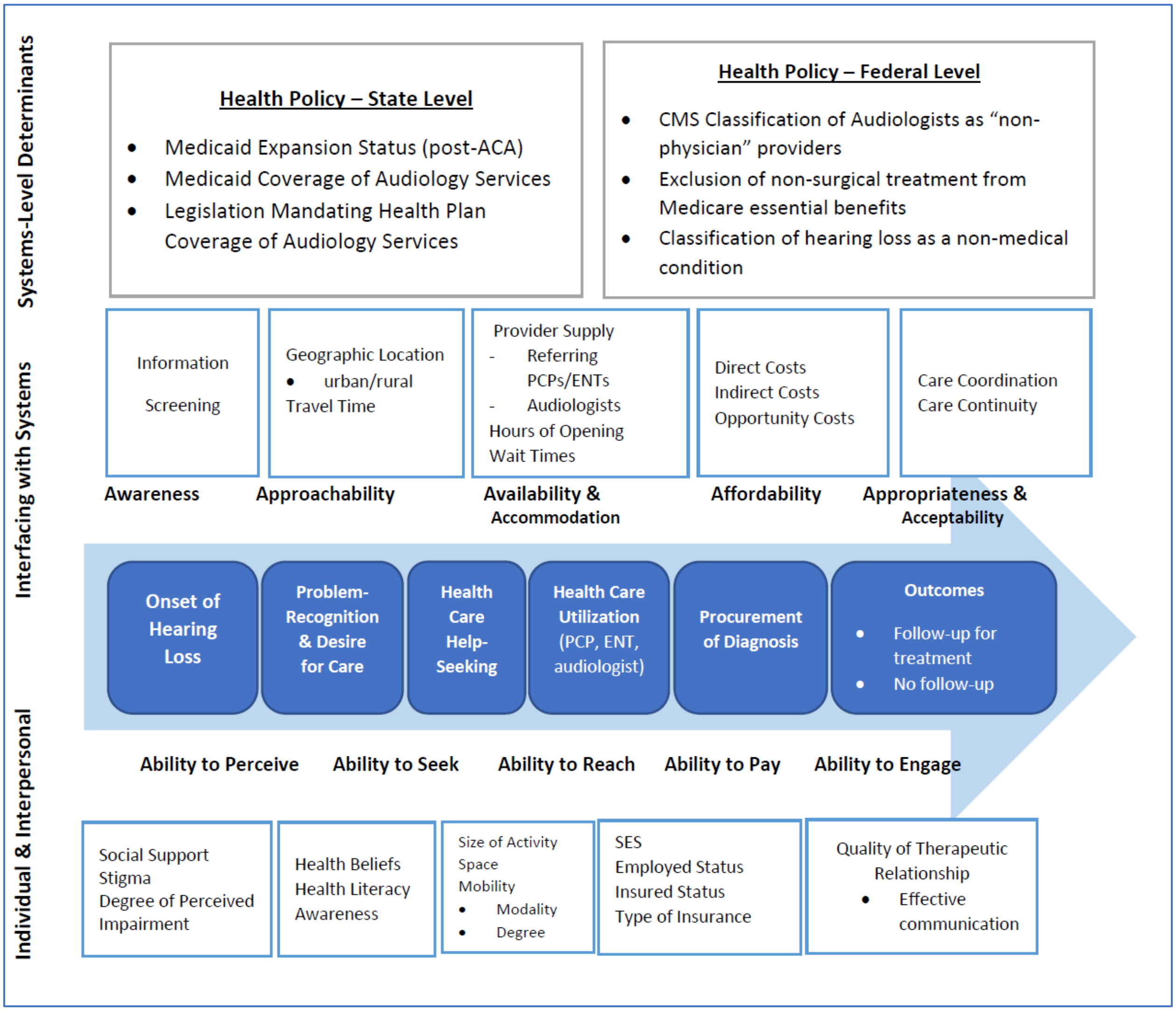

Figure 4-2 *- Conceptual Model of Help-Seeking and Service Use for the Management of Hearing Loss*

In this model [**Figure 4.2**], I intersect the dimensions of access (the 5-6 As) with the multi-scalar facets of access (ranging from individual-level characteristics to health care policies that shape the distribution and delivery of care. Along the horizontal axis is time. As you follow the arrow, you can see that the process begins with the onset of hearing loss, and the catalyst for the help-seeking process is the recognition of hearing loss. For simplicity, time is represented as an arrow, but the progressive nature of hearing loss and other, frequently comorbid chronic conditions means that help-seeking and service use for the management of chronic conditions may be an iterative process. This is particularly true in the case of older patients in the U.S., who must procure a physician referral in order for Medicare to pay for their hearing assessment, "in support of a medical diagnosis" (Fifer, 2020; CMS, 2016). It follows that older adults who suspect that they have hearing loss may seek out their primary care provider or other usual source of care prior to seeing an audiologist or Otolaryngologist (Ear Nose Throat doctor).

Vertically, I represent the multi-scalar context of access as a process. That ranges from individual, interpersonal characteristics, to ecological (neighborhood, family) characteristics and contexts, to system-level characteristics (supplier-side dimensions of access). On the top, I specify the key healthcare policies that shape both the supply of healthcare workers (audiologists), the financing of hearing healthcare services, and the provision of these services. These include federal (Medicare, Medicaid) and state (state Medicaid programs, and state legislation regarding the licensing of audiologists, their scope of practice, and mandates for commercial insurance plans to cover hearing and balance disorder treatments (Arnold, Hyer, & Chisolm, 2017)) policies.

These system-level factors shape both healthcare provision and patient help-seeking in myriad ways. First, healthcare policies that define reimbursement for healthcare services on the basis of the provider's status as a "physician" or "non-physician provider" privilege diagnostic services and treatments by medical practitioners over audiologists. This means that, cost-conscious patients may seek out care first from a physician, who may or may not refer them to an audiologist for diagnostic assessments "in support of a medical diagnosis (CMS, 2016). The category "non-physician provider" precludes reimbursement of audiologist services under Medicare, and many state-administered Medicaid programs (Arnold, Hyer, & Chisolm, 2017; Fifer, 2020). This is a disincentive for audiologists, who increasingly practice within private practices, and rely on a pool of self-paying patients who can cover what Medicare, Medicaid, and commercial insurance plans will not.

Second, state legislation requiring commercial plans to cover audiology services- passed and enacted in 17 states- do not necessarily incentivize a higher supply of audiologists at the county level (Planey, 2019), in part because state legislatures cannot regulate large employers' self-insured plans, which covered about 61 percent of the U.S. population as of 2019 (Kaiser Family Foundation, 2019). This is due to a carve-out in the 1974 Employee Retirement Income Security Act of 1974 (ERISA), which placed large, self-insuring employers under the jurisdiction of the federal Department of Labor (29 U.S. Code § 1144). Taken together, the classification of audiologists as "non-physician providers", the subsequent lower reimbursements, and the limits of state legislation requiring commercial plan coverage of audiologist services strongly suggest that audiologists benefit from selecting service areas where patients can pay out of pocket for care. This is evident at the county level across the U.S., where high-income and urban counties are more likely to have audiologists than their rural counterparts (Planey, 2019). Arguably, the incentives wrought by the low or absent reimbursement of audiologist services under public and commercial plans are manifest in the negative association between the county-level supply of audiologists and the share of older adults reporting hearing difficulty (Planey, 2019).

Therefore, federal and state healthcare policies inextricably affect the supply and spatial distribution of healthcare workers, in addition to shaping how healthcare is provided. Prior to December 2016, the process of help-seeking for hearing loss among older adults in the U.S. was different, because the Food and Drug Administration (FDA) required medical clearance from a physician before Medicare beneficiaries could purchase hearing aids (FDA, 2009). This meant that access to hearing aids was contingent upon (i) having a usual source of care, (ii) and physician awareness of hearing losses and their treatments. However, this was changed in August 2017, with the passage of the Over-the-Counter Hearing Aid Act (attached to the FDA Reauthorization Act). However, for older adults with more severe hearing losses, the hearing aid models available over-the-counter (OTC) are not adequate to address their needs, and their access to effective treatment is still contingent upon receipt of a medical diagnosis of their hearing loss.

4.4 Conclusion

Focusing on the diagnosis and management of hearing loss among older adults in the U.S., this proposed conceptual model for help-seeking and service use for the management of hearing loss extends Levesque, Harris, and Russell (2013) conceptual model to define access as an iterative process in space-time. Further, it brings back the healthcare policy context that shapes the spatial arrangement of healthcare provision through financing and workforce training (and subsequent effects on availability). This matters because behavioral models of healthcare access tend to define access as a product of the interaction between individual patient characteristics and resources and health system or provider characteristic. This formulation neglects the ubiquitous spatialization of healthcare and healthcare policy-key contextual factors in healthcare provision. In the case of audiologist availability, a strong urban bias is apparent in their practice locations, with greater availability in high-income areas with younger populations and fewer older adults self-reporting hearing difficulty (Planey, 2019). This inverse care association is also reflected in utilization patterns among Medicare beneficiaries, where, in the absence of coverage for non-surgical treatments of hearing loss, hearing aid owners are generally more likely to be white and high-income (Bainbridge and Ramachandran, 2014; Mahmoudi et al, 2019). Further, for low-income older adults who are dually eligible for Medicare and Medicaid, the affordability of hearing healthcare is contingent, in part, upon one's state of residence (Arnold, Hyer, & Chisholm, 2017). To the degree that policies are implemented, it is, thus, difficult to separate healthcare policy from the spatial arrangement and accessibility of healthcare services.

This revised model of help-seeking and service use accounts for the multi-scalar context of the process of access, while attending to the ways that the process can unfold in time. In other words, it accounts for access as a process in space-time, with attention to scalar dimensions of healthcare systems and healthcare policies. This model is adaptable and can be used to guide an analysis of help-seeking and service use for the management of hearing loss among older adults in the United States, with attention to both federal and state healthcare policies that affect the financing and provision of healthcare, including the supply of healthcare workers, such as audiologists. In this sense, I bring policy back into the Levesque, Harris, and Russell (2013) "Conceptual Framework of Access to Healthcare". In doing so, I retain the temporal aspects of Levesque and colleagues' model, while bringing back Aday & Anderson's (1974) attention to healthcare policies and their influence on healthcare access. Finally, this specific focus on audiologist service access is an area of growing interest as the number of older adults with hearing loss and associated comorbidities is expected to double by 2060 (Goman, Reed, & Lin, 2017)..

Future studies of the accessibility of audiologist services should be attentive to both the spatial arrangement of healthcare relative to populations need and healthcare policies that shape healthcare delivery. In doing so, these studies of healthcare access for the diagnosis and management of chronic conditions can situate behavioral dimensions of healthcare help-seeking and service use in their multi-scalar contexts across the patient journey.

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5 CONCLUSION

5.1 Prologue

My motivation for conducting this research stems in part from my experience as a deaf clinician-in-training in the clinical audiology (Au.D) program. After studying in the program for a year, I was ultimately pushed out via the refusal to provide reasonable accommodations in the clinic. Transferring to the Geography department allowed me to translate the questions I asked myself in the course of my clinical training into actionable and applied approaches for understanding the myriad tensions shaping audiologists' decision-making as practitioners in a landscape marred by clinical program closures, a growing shortage of providers, and falling reimbursements for audiology services, all of which render hearing health care less accessible to a rapidly greying population.

This chapter outlines a potential future research direction, which is attentive to the accessibility of audiologist services at a finer spatial scale: the space of the clinic. My dissertation has largely focused on spatial accessibility of hearing healthcare, from the national scale to the metropolitan regional scale, finding inequities in access at all levels. The findings of this dissertation, particularly those in Chapter 3, which assessed the co-location of audiologists with referring primary care providers and subsequent effects on racial and class-based inequities in spatial access to care, point to the importance of hierarchies within healthcare practice and care coordination. These hierarchies— manifest in lower reimbursement rates for "non-physician providers" under Medicare, Medicaid, and commercial insurance plans, with consequences for the affordability of needed care— arguably have spatial effects. In my early work, shadowing audiologists across Illinois, I observed that audiologists subtly reinforced the hierarchy between themselves and patients using the spatial arrangement of their office and clinic.

5.2 The Space of the Clinic

There's a comic that makes me chuckle. It is fairly straightforward- in one panel, it features the iconic figure of the Grim Reaper speaking to an elderly person. The Grim Reaper initiates, saying, "I am Death." In response, the elderly man, unafraid and unbothered, asks "You too? Do you sign?"

This is the sort of comic one might find in an audiologist's office, alongside a poster showing a sagittal section of the brain (specifically, the Central Auditory Nervous System (CANS), which includes the brainstem structures and pathways, Thalamic relays, and primary and secondary auditory cortices). This poster is often paired with a coronal section of the auditory-vestibular system (which typically begin with the ear canal on the left (outer ear, bounded by the tympanic membrane or "eardrum"), transitioning to the structures of the middle ear (ossicles, oval window), finally terminating at the auditory-vestibular nerve's connections with the cochlea (inner ear). In a sense, the light-hearted- if morbid- comic possibly functions to offset both the clearly hierarchical space of the clinic and the stigma attached to a diagnosis of hearing loss. In another sense, the comic reflects tensions between biomedical understandings of "communication disorders" and understandings of hearing loss or deafness as another facet of life. In the tense space of the clinic, we also see where older patients with hearing loss are more likely to experience adverse outcomes in clinical settings (Bartlett et al, 2008), in part due to discordance between the communication modalities of health systems and providers and those of patients living with hearing loss.

The internal spatial configuration of audiology clinics reflects techno-scientific investments in the redefinition and molecularization of hearing loss (Mauldin, 2016). The diagnostic technology and the sound-proofing walls of the test booths demarcate the space between the clinician and patient. The clinician is the expert who operates the technology, administers tests, and interprets the results. In contrast, the patient, set apart from the clinician, is somewhat out of place- quickly moved from here to there, with periods of waiting in between tests and device calibrations and adjustments. Moreover, these investments also reflect a profession constrained by broader political economies of health care that restrict their autonomy, pay, and prestige through health policies that classify them as 'non-medical' providers within a hierarchy in which medical or surgical treatments garner higher pay and prestige.

At the scale of the clinic, one can refer to the 'more-than-human' geographies of health care to consider the ways that (bio)medical technologies change the nature of "care" (Greenhough, 2011; Jackson and Neely, 2015). For example, in my preliminary fieldwork observing audiologists, it became clear that technological developments shaped the arrangement of the clinical space, with implications for clinical communication and practice. I noticed that the diagnostic equipment commonly used in assessing and diagnosing hearing loss functioned as barriers and markers of the "status" differential between the clinician and patient. In some cases, these objects- audiometers, computer screens, and so on- impeded effective communication with patients with hearing loss. This was particularly true where patients relied on sign language interpreters to communicate with their audiologist. I observed audiologists leaning to the side, past computer monitors that blocked their faces, to make sure that both the interpreters and the patients could lip-read.

But any discussion of the space of the clinic can be contextualized within a broader political economy of health care. In the case of audiology services, the space of the clinic is shaped by tensions inherent to professionalization in the wake of historically narrow scopes of practice, limited autonomy, pay, and prestige reflective of their status as "non-physician providers" per Centers for Medicare and Medicaid Services (CMS) classifications (CMS, 2016). I detailed this in the first and second chapters of this dissertation, so I will not belabor the point. The bottom line is that healthcare hierarchies and the healthcare policies that produce and reproduce the hierarchies have downstream and enduring effects on the accessibility of audiologist services across scales.

The task, then, is to understand how health policies shaping audiologists' pay, prestige, and autonomy as practitioners can and do shape their locational behaviors, and subsequently, what that means for the people who need their services. Medicare and most Medicaid programs do not cover audiology services (Arnold, Hyer, and Chisholm, 2017), and given the role of CMS as the *de facto* regulator of the U.S.'s highly decentralized health care system, one could say, "*As Medicare goes, so goes private insurance*" (Givan, 2016b, 105).

As such, it is important to account for the institutional and professional pressures faced by audiologists and other specialists, which then shape their location decisions and potentially exacerbate age, class, and racial disparities in spatial access to hearing health care. Through this dissertation project, I examined the potential effects of health policy on audiologists' locational tendencies and the subsequent accessibility of their services. In other words- how the structural (health care policies, clinical training landscapes) shaped spatial dimensions of hearing healthcare access on the part of providers and patients. Employing GIS, spatial statistical and epidemiologic methodologies, I addressed a series of research questions about spatial and social access to audiology services.

In the first empirical chapter (Ch. 2), I applied a mixed effects hurdle model to assess state-level policies, and county-level demographic, health, and clinical training landscape on audiologist availability (dichotomous outcome) and supply (count outcome). The findings showed an inverse care association (Tudor-Hart, 1971), whereby counties with older populations, lower median household incomes, and higher shares of older adults self-reporting hearing difficulty were less likely to have audiologists. Similarly, among counties with audiologists, counties with lower income levels and high need for services had fewer audiologists (Planey, 2019). Overall, in the absence of Medicare reimbursements of audiologist services beyond physician-referred assessments in support of a diagnosis (CMS, 2016), audiologists located in service areas with higher incomes (ability to pay out-of-pocket), and generally exhibited a strong urban bias in their locations.

The second empirical chapter (Ch. 3), coupled spatial cluster analysis (cross-L function, which summarize spatial dependence between events) and spatial regression models to examine whether audiologists' co-location with referring physicians reinforced disparities in spatial access to care along the axes of race, ethnicity, and class in the Chicago metropolitan area. To account for differences in population density, the study area was divided between the urban core, and the inner and outer-ring suburbs. The findings show that audiologists and primary care physicians strongly co-locate across the study area. The spatial error model results show that residents in Chicagoland's majority-Black, Latinx, and low-income census tracts have greater travel impedance to care. These findings suggest that policies that encourage provider co-location to facilitate care coordination and continuity may need to account for equity in care access, given that there are known inequities by race/ethnicity and class in access to primary care.

In undertaking this project, it became clear to me that the question of *scale* is central to studying the political economy of health care delivery systems. While we cannot claim to understand health care worker geographies without factoring for the clinical training landscape, health care policies governing reimbursements, or state-level licensing and scope of practice regulations, it is equally important to consider the clinic itself as a site of contestation and negotiation. For this reason, many studies of (bio)medicalization are also studies of the production of patient-consumers (Kay and Williams, 2009) and the role of patient 'expertise' in marketized health care provision (Dumit, 2013)- especially where the healthcare services are more exposed to market forces.

As such, I present a conceptual model (Ch. 4) of healthcare help-seeking and service use for the management of chronic conditions (hearing loss, specifically), that intersects scale and temporality to depict access as a process in time and space. In moving beyond access as an episode whereby a patient enters a health care system, we can better understand how patients manage chronic conditions as they progress or vary in their severity, while accounting for health care system characteristics (care continuity and coordination across the hierarchy of care; health care policy constraints on said continuity and coordination) and individual-level characteristics that might enable or undermine help-seeking. This is a significant contribution that bridges geographic understandings of healthcare access with models of help-seeking and service use to foreground the importance of scale. By attending to multi-scalar healthcare policies and healthcare system characteristics that shape healthcare delivery, we can better understand the system-level enabling and facilitating factors that interact with patients' individual and social resources and socio-ecological contexts that they navigate as they seek care.

Altogether, this dissertation is the first geographic study of audiologist service access in the U.S.. The core contributions of this project are threefold. First, (i) the application of political economy perspectives to the conceptualization and modeling of audiologist service access shaped the research questions in Chapters 2 and 3, which examined audiologist availability and accessibility at the national and local scales. The findings show that healthcare policies regulating the financing (reimbursement) of audiologist services can shape the spatial distribution of audiologists and drive a tendency to co-locate with referring physicians. Second (ii), this dissertation applies innovative spatial methods to address new questions of access in the context of varied healthcare policy and health workforce landscapes. In Chapters 2 and 3, I applied mixed effect hurdle models (which apprehend the interactive and scalar properties of measured covariates) to study audiologist availability nationally, and coupled cluster analysis and spatial regression approaches to study the co-location of audiologists with referring primary care providers, respectively. Although the spatial methods employed are not new, they have rarely been applied in analyzing spatial access to health services. Finally (iii), in Chapter 4, I contribute a synthesis and integration of existing models of care access to conceptualize healthcare help-seeking and service use for the management of hearing and balance disorders as a process in space-time, with multi-level contexts, including ecological contexts that patients navigate as they seek and use care and the healthcare policy contexts that shape healthcare service availability and accessibility. Most existing models conceive access as a unidirectional process extending from recognition to treatment. My model extends and deepens current perspectives by drawing attention to important multi-scalar, multidirectional, and spatiotemporal dimensions of access that are especially relevant for the management of chronic conditions, which may be comorbid with other age-related conditions.

This dissertation research has several policy implications. The overarching theme is that of inequity in care access. This work highlights a misalignment of need for care and healthcare supply (Chapter 2) and applies spatial analytic approaches to quantify and visualize spatial inequities in access to audiologist services at the regional scale, within the Chicago metropolitan area, particularly along the axes of race and class (Chapter 3). Importantly, this work is framed by an understanding of federal and state policies as key determinants in the allocation of healthcare resources, including the spatial distribution (outcomes of location decisions) of healthcare workers. Further, my findings in Chapter 2 reinforce prior work showing that healthcare workers tend to locate nearby clinical programs (Baer, Gesler, & Konrad, 2000), pointing to the key role of the clinical training landscape in shaping equitable distributions of healthcare workers. Finally, the conceptual model of healthcare access as a process in space-time, (Chapter 4) specifically addresses the context of care access for older adults in the U.S.. This conceptual model can be extended to guide future studies of older adults' management of comorbid conditions. This particularly applies to older adults taking common ototoxic medications, including antibiotics, chemotherapy drugs, loop diuretics (used to treat congestive heart failure, renal failure, hypertension, and cirrhosis), and non-opioid analgesics (non-steroidal anti-inflammatory drugs (NSAIDs) and acetaminophen) used to treat conditions like arthritis (Field et al, 2004; Garinis et al, 2017; Pratt et al, 2009).

The findings lend support for addressing the structural incentives that shape hearing healthcare delivery and accessibility through healthcare policies. To improve the affordability of audiologist services, policymakers can mandate that insurers (Medicare, Medicaid, and commercial) cover audiologist services. In terms of the financing of care, establishing higher reimbursements for audiologist services (including, but not limited to assessment and non-surgical treatment of hearing and balance disorders), in tandem with a screening program to diagnose hearing loss among Medicare beneficiaries. Moreover, the overall trend toward a decline in audiologist supply in the U.S. can be reversed with federal funding of audiologist training, to increase supply of audiologists, and address the needs of a growing population. Finally, to enable a more equitable spatial distribution of providers, federal and state governments can allocate funds to incentivize audiologist practice locations in underserved rural areas, which have older populations compared with their metropolitan counterparts (Cagney & York Cornwell, 2018). Taken together, these recommendations can improve the accessibility of hearing healthcare by making care more affordable and enabling better care coordination and continuity in the process of treating and managing hearing loss. This can save billions that would otherwise be expended on preventable hospitalizations due to outcomes borne of untreated hearing and balance disorders (Florence et al., 2018).

Future studies might triangulate the findings from this dissertation through the application of qualitative methods (photovoice, mobile interviews, focus groups) to better apprehend individual-level patient and provider decision-making in context to better understand healthcare access from both supply- and demand-supply sides. Further, the application of spatial analyses of audiologist service access in study areas beyond those studied in this project could inform health planning efforts to improve the health of the population. This can extend to a study of the co-location, care coordination between audiologists and clinical oncologists (see Garinis et al, 2017) to address the effects of ototoxic cancer treatments on patient quality of life and overall well-being.

Further, future studies may consider the role of new technologies, and the ways that they simultaneously enable self-diagnosis and exacerbate inequities in access. For example, tele-audiology services are most accessible in areas with broadband access, reinforcing the “first digital divide” along the axes of race, ethnicity, socio-economic status, and rurality (Riddlesden & Singleton, 2014). As a result, there may be a divergence in the accessibility of services, given that tele-audiology services are one of the most feasible ways to ‘extend’ an already limited supply of healthcare workers (Gladden, Beck, & Chandler, 2015). This work can also contribute to geographers’ growing interest in consumption-mediated health citizenship (Brown, 2003; Kearns & Barnett, 1997; Kivela, 2018), whereby consumption of healthcare goods and services is framed as a personal responsibility in the absence of an effective right to healthcare.

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