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Contextualizing research on transportation and health: A systems perspective

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ABSTRACT

During the past few decades, there has been a surge of interest in research seeking to understand how personal and public health are affected by transportation systems. A large and diverse literature has recently emerged as a result, which complements a rich literature developed beginning in the early 20th century. In this manuscript, we identify five unique research trajectories in health and transportation that, in many cases, seem unrelated. After exploring these five areas, we argue that a holistic viewpoint that links all of the ways transportation systems impact health will provide new opportunities for health and transport researchers. To do this, we present a causal loop diagram, which illustrates a systems perspective on the complex relationships between health and transportation. Finally, a discussion on future directions points out ways that such a perspective will benefit researchers going forward.

1. Introduction

Over the past few decades, a sea change has occurred in the thinking and research related to improving public health. Academics (Diez-Roux, 2000; Homer and Hirsch, 2006), foundations (Robert Wood Johnson Foundation, 2015; Sierra Health Foundation, 2015), and government institutions (World Health Organization, 2015a; Center for Disease Control and Prevention, 2015b), have recognized the need to consider a person's health as the outcome of many complexly interrelated components, where initial conditions and a wide range of variables can lead to often difficult to predict outcomes (Resnicow and Page, 2008). One major factor that is recognized for influencing health in myriad ways is transportation. While transportation, broadly defined, influences many parts of the social system, the past few decades have witnessed an increasing interest in its varied impacts on public health, and medical outcomes more generally. This is evidenced by new journals (Mindell, 2014), government engagement (Center for Disease Control and Prevention, 2015a), and conferences (Transportation Public Health Link, 2015).

Despite the increase in activity in the transportation and health space, a concise and comprehensive framework for the many ways transportation and mobility relate to health has yet to be put forward. A detailed report, titled "Health on the Move 2," (Transport and Health Study Group, 2011) takes a chapter-by-chapter approach and provides a wealth of information on various aspects of health and transportation research, but we believe the different categorizations and systems perspective provided within this manuscript complement the thorough report. Thus, the goal of this paper is to contextualize the wide array of research currently underway in the transportation and health universe, and propose a systems framework for future work. To do this, we first review the many different research trajectories found in the academic and institutional literature, and situate the work into five broad arenas:

- The direct impact of transportation on the physical environment.
- The direct impact of transportation on access to healthy spaces and facilities.
- The indirect and direct impacts on morbidity and mortality caused by transportation.
- The indirect impact of transportation infrastructure on healthy behaviors.
- The indirect impact of disease spread through transportation networks.

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These categories are meant to be representative of current discussions taking place in organizations like the International Transport Forum at the OECD and the Health and Transportation sub-committee of the Transportation Research Board, and are not necessarily the only way contemporary research on health and transportation can be grouped.

Next, to demonstrate that the importance of considering the relationships between these diverse arenas, a causal loop diagram (sometimes known as a mental model in the system dynamics literature (Doyle and Ford, 1998)) describing the various linkages in the health and transportation space is presented and described. This provides a systems perspective, allowing the complex relationships that exist in the transportation and health arena to be made explicit.

It is important to document that this domain is more than studies of mortality during transport collisions, asthma incidence near heavily trafficked highways, or access to the nearest hospital. Rather, these seemingly different pursuits should be connected back to the common thread of transportation. Using the causal loop diagram, we are able to show this by explicitly describing the flows of relationships and feedbacks present when thinking about the impacts transportation can have on a person's health and well-being.

The next section begins by presenting a brief historical review of the academic literature on health and transportation to provide further context. An accounting of work done in the previously mentioned five broad arenas follows this in the third section. In the fourth section, the causal loop diagram is presented and discussed, while the fifth and final section discusses potential avenues for further integrating these interrelated approaches.

2. Brief review of transportation and health research

The acknowledgment that a relationship exists between transportation and health is not new. Arguably, it could be traced back many centuries to thought concerning the control and containment of plagues. For example, in Mantua, Italy in the late 14th century, persons who had traveled to regions known to be affected by the plague were banned from reentering the city, demonstrating a basic understanding of the mechanics of disease diffusion (Porter, 1999). Another rich source of examples can be found in a piece by Horden (Horden, 2005), which examines travel as therapy and regimen for travelers during antiquity and medieval times in the Mediterranean. However, the link between health and travel, mobility, and transportation was often confused by beliefs that religion and magic were responsible for disease and illness; a belief that dissipated (slowly) beginning in the 18th century, when more empirical approaches to understanding health and wellness arose (Hays, 2009).

Perhaps a more contemporary starting point can be found during the emergence of public health as a domain of study in the late 19th and early 20th centuries. What follows is a brief review of letters and articles in scholarly journals related to health and transportation. However, it should be noted that it is not a comprehensive review, but rather a presentation of select works to demonstrate what types of questions and thought were occurring at this time.

Of particular interest to the public health community is the fact that, in 1911, the very first article published in the first volume of the American Journal of Public Health (then titled "Journal of the American Public Health Association) explores the spread of cholera, especially noting the role of traveling immigrants and military officers (Wyman, 1911). Common themes in early work include transporting military personnel (Berry, 1918), sanitation within ships and railway cars (Bierring, 1936; Bryce, 1911), and the effects of transportation on food (Bryce, 1913). In the 1920s the health impacts of automobiles were explored, including topics like the negative effects of exhaust (Henderson, 1922, Mcconnell, 1926), the impact on reducing active transportation (Long, 1924), as well as their direct role in injury and death due to crashes (Long, 1924). As air travel became more common, there was an increased focus on the impact air traffic had on public health. Early papers from the 1930s focused on vector borne diseases, like yellow fever, with a special emphasis on the inadvertent transport of insects on aircraft (Griffitts, 1933; Massey, 1931; Whitfield, 1939). Moving into the 1940s and 1950s, a discussion of transportation's role in access is evident, as health services became more institutionalized in places like North America (Davis and Smythe, 1949, Roemer et al., 1957).

The linkage between transportation and health is eventually furthered by the quantitative revolution that occurred in many of the social sciences, like geography (Burton, 1963), in the second half of the 20th century as well as interest from fields such as engineering (Schuman et al., 1977) and environmental health (Hofreuter, 1961). In fact it is in this period, that the public, academics, and governments develop a keen interest in the relationship. To help demonstrate this increase in awareness Fig. 1 shows a chart of the number of articles

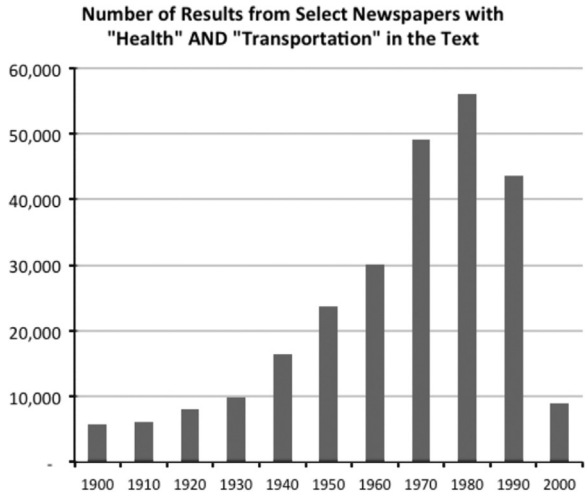

Fig. 1. Number of articles referencing "transportation" and "health" from 1900 to 2000 in four major North American newspapers.

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