

Chapter 5

Wearables, Artificial intelligence, and the Future of Healthcare

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ABSTRACT

Common underlying risk factors for chronic diseases include physical inactivity accompanying modern sedentary lifestyle, unhealthy eating habits, and tobacco use. Interestingly, these prominent risk factors fall under what is referred to as modifiable behavioral risk factors, emphasizing the importance of self-care to improve wellness and prevent the onset of many debilitating conditions. In that regard, advances in wearable devices capable of pervasively collecting data about oneself coupled with the analytic capability provided by artificial intelligence and machine learning can potentially upend how we care for ourselves. This chapter aims to assess the current state and future implications of using big data and artificial intelligence in wearables for health and wellbeing. The results of the systematic review capture key developments and emphasize the potential for leveraging AI and wearables for inducing a paradigm shift in improving health and wellbeing.

INTRODUCTION

Chronic diseases such as heart disease and diabetes are conditions that last one year or more and require ongoing medical attention or limit activities of daily living or both (Centers for Disease Control [CDC], 2018). Such conditions have been a major healthcare concern as a leading cause of death and a declining quality of life. According to the Center for Disease Control (CDC), heart disease and stroke are the leading causes of deaths in the US, while more than 29 million Americans have diabetes, and another 86

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million are at risk of type 2 diabetes (prediabetes). This results in an annual health expenditure of 86% of the nation's \$2.7 trillion (almost 18% of Gross Domestic Product (GDP)) for people with chronic and mental health conditions. The situation worldwide is not much different. According to the World Health Organization, non-communicable diseases (NCDs) kill 41 million people each year with cardiovascular diseases alone accounting for almost 44% (17.9 million people), followed by cancers, respiratory, diseases, and diabetes (World Health Organization [WHO], 2018).

While poverty and socioeconomic conditions can increase the risk for such disease conditions, the common underlying risk factors are physical inactivity accompanying modern sedentary lifestyle, unhealthy eating habits, and tobacco use. Interestingly, these prominent risk factors fall under what is referred to as modifiable behavioral risk factors. According to the World Health Organization (WHO), tobacco accounts for 7.2 million deaths every year, salt intake (part of unhealthy diets) accounts for 4.1 million deaths, while 1.6 million deaths are attributed to alcohol use and a similar figure attributed to insufficient activity (WHO, 2018).

In that regard, the proliferation of wearable technologies is hyped to drive a paradigm shift on how people care for their health and well-being as a society and as individuals. Nowadays, wearable technology is used as activity tracking devices, heart rate monitors, calorie counters, glucose (blood sugar) monitoring systems, hearing aids, and pacemakers, to name a few. In the last couple of years, smart patches and smart pills are groundbreaking improvements in the wearable health domain that are approved by the US Food and Drug Administration (FDA). The ingestible sensor in the pill transmits a message to a wearable patch, the patch then transmits the information to a mobile application. Healthcare professionals such as nurses and doctors employ wearable technology to monitor patients' vitals and conditions thereby increasing efficiency and reducing the time to gather health data (Mesh, 2018).

Many companies have either emerged as startups or directed entire product lines to the wearable market. These include tech giants such as Apple, Google, Samsung, and Huawei as well as more specialized companies such as Fitbit, Garmin, Moov, and Misfit. The key drivers for this wearable trend are patient monitoring, home healthcare, and fitness. According to market research and business intelligence firm IDTechEX, the wearable technology sales are expected to increase exponentially in the coming years with the market expected to reach \$150 billion by 2027 (Stefanie, 2018). The availability of more data about the current and future health of individuals, and the growth of wearables in the healthcare domain are the key features that galvanize the market right now.

The proliferation of wearables has resulted in the generation of large amounts of data (volume) at increasing velocity, and variety. Such data is commonly referred to as 'Big data' (S. Park, Chung, & Jayaraman, 2014). The data can take the form of a continuous stream of sensor data such as heart rate or blood glucose measurements as well as audio and video signals. While such data creates significant opportunities for improving health and well-being, it could also create a data rich information poor (DRIP) environment (Tien, 2013). However, recent advances in artificial intelligence and machine learning are offering new possibilities to wearable generated big data and genuinely transform healthcare.

Extant research provides a glimpse into the world of wearables with a particular emphasis on healthcare (Chan, Estève, Fourniols, Escriba, & Campo, 2012; Mukhopadhyay, 2015; S. Park et al., 2014; Swan, 2013). In these reviews, the emphasis is predominantly at the intersection of wearables and healthcare. In this chapter, we extend prior work with an emphasis on the role of artificial intelligence and machine learning in harnessing the big data generated by wearables with a focus on health and well-being. Specifically, we aim to address the following research questions:

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