# How does PCC reduce the probability of chronic diseases in adults? The sequential mediation role of PEHR and health literacy.v

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## *Abstract*

Research has demonstrated links between patient-centered communication (PCC) and patients' health outcomes. However, little is known about the links between PCC and specific chronic diseases. Besides, research has also demonstrated links between personal electronic health record (PEHR)usage and health literacy, while little is known about the two variables as mediators in the relationship between PCC and chronic disease. This study is one of the first to examine the influence of PCC on adults' chronic disease through sequential mediators: PEHR and health literacy. With a general basis of Street et al.'s pathway model, we proposed and tested sequential mediation pathways linking patient-centered communication to the adult population's chronic disease, mediated by PEHR and sequentially mediated by PEHR and health literacy. Data from the 2022 iteration (updated May 16, 2023) of the Health Information National Trends Survey (HINTS6) were used for this study. This study focused on adults aged 18 and above. Results indicated that after controlling participants' age, gender, education, and income, PCC is related to adult people's chronic disease outcomes either directly or indirectly. Specifically, PEHR significantly mediates the associations between PCC and the adults' chronic disease probabilities. Noteworthily, findings from this study also revealed that PEHR and health literacy sequentially mediate the relationship between PCC and chronic disease probabilities.

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# How does PCC reduce the probability of chronic diseases in adults? The sequential mediation role of PEHR and health literacy.

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## ABSTRACT

Research has demonstrated links between patient-centered communication (PCC) and patients' health outcomes. However, little is known about the links between PCC and specific chronic diseases. Besides, research has also demonstrated links between personal electronic health record (PEHR)usage and health literacy, while little is known about the two variables as mediators in the relationship between PCC and chronic disease. This study is one of the first to examine the influence of PCC on adults' chronic disease through sequential mediators: PEHR and health literacy. With a general basis of Street et al.'s pathway model, we proposed and tested sequential mediation pathways linking patient-centered communication to the adult population's chronic disease, mediated by PEHR and sequentially mediated by PEHR and health literacy. Data from the 2022 iteration (updated May 16, 2023) of the Health Information National Trends Survey (HINTS6) were used for this study. This study focused on adults aged 18 and above. Results indicated that after controlling participants' age, gender, education, and income, PCC is related to adult people's chronic disease outcomes either directly or indirectly. Specifically, PEHR significantly mediates the associations between PCC and the adults' chronic disease probabilities. Noteworthily, findings from this study also revealed that PEHR and health literacy sequentially mediate the relationship between PCC and chronic disease probabilities.

## Conceptual Framework

The conceptual framework of this research draws from Street et al.'s (Street et al., 2009a) pathway model linking clinician-patient communication to health outcomes. Specifically, Street et al. (Street et al., 2009a) proposed both direct and indirect pathways linking PCC to improved health outcomes. Health outcomes can be affected by PCC (Mitsutake et al., 2023). On the one hand, PCC may improve one's health and well-being straightforwardly. Previous research suggests that better PCC would be associated with a lower probability of death(Meterko et al., 2010), and nonverbal cues and empathic conversations in PCC can alleviate patients' negative emotions (e.g., anxiety and despair) (Street & Epstein,2007). Besides, health-related information from PCC can also help alleviate patients' reluctance to use health-related technology like Online medical record use (Q. Wu & Jiang, 2023). On the other hand, in most situations, PCC exerts indirect effects on health outcomes through proximal and intermediate outcomes (Street et al., 2009a). More accurately, PCC could influence patients' health through health self-efficacy(Finney Rutten et al., 2016a), proximal outcomes of communication (e.g., shared understanding and patient involvement), and intermediate outcomes (e.g., self-management skills and social support) in sequence(Street et al., 2009b).

The current study focuses on the relationship between PCC and chronic disease for three main reasons. Firstly, as the prevalence of PCC continues to increase, there is a growing need for trend analysis to provide health researchers with a comprehensive understanding of the evolving relationship between PCC and health outcomes. This knowledge is crucial as it can inform health communication agendas and contribute to the improvement of the healthcare system (Booth et al., 2012; Schiafo, 2008). Therefore, it is pivotal to utilize new cycles of HINTS data to establish a trend analysis examining the association between PCC and chronic disease. Additionally, conducting more precise examinations that investigate different dimensions of PCC can contribute to a more nuanced understanding of its impact(Street et al., 2009a), thus expanding the exploration of other factors relevant to PCC and chronic disease. Secondly, considering that PCC plays a significant role in prevention and management, which are crucial factors in addressing chronic disease(Wildevuur & Simonse, 2015), it is worthwhile to investigate how PCC may affect chronic disease. Lastly, previous studies on patient-centered care (PCC) studies have primarily relied on data from HINTS 5 or earlier cycles. However, this study utilizes a larger sample size from the data collected in HINTS 6 (2022), allowing for a more robust and comprehensive analysis.

Chronic diseases, including conditions such as hypertension, diabetes, chronic obstructive pulmonary disease, heart disease, and mental illness, have a significant impact on public health(Booth et al., 2012). According to a survey conducted by the Centers for Disease Control and Prevention (CDC), a considerable number of Americans die from chronic diseases each year, resulting in substantial economic losses (Yen et al., 2022). Therefore, effectively managing chronic conditions to improve health outcomes and reduce the burden of chronic diseases is a crucial societal goal(Gorina et al., 2019).

Previous research has highlighted the significant influence of health-related technology use on individuals' health(Rajamani et al., 2022; S. Yu et al., 2023a), Firstly, technology used for health purposes enables individuals to understand and manage diseases. For example, studies have shown that the use of online health information technology can be beneficial for the management of chronic diseases(Rao et al., 2012); Wearable devices also have the potential to positively impact physical activity levels among chronic patients, particularly in individuals with hypertension. High-frequency

use of wearable devices can significantly improve the duration and frequency of physical activity(S. Yu et al., 2023a).

Secondly, the health information individuals acquire through technology has the potential to influence their decision-making process. Certain cohorts of chronic disease patients demonstrate higher usage of health information technology (HIT) and may have more personalized decision-making influenced by HIT(Rajamani et al., 2022). Furthermore, research suggests that health information technology use can assist patients in making informed decisions regarding early prevention and disease control(Francisco et al., 2022). Thirdly, health-related technology use can impact individuals' perceptions of health and health behaviors(Kreps & Neuhauser, 2010). Studies have found that social interaction between users and spectators through interactive running apps can enhance users' sense of connection and improve their perceptions of the app's usefulness (Molina & Sundar, 2020). Additionally, the utilization of specific features within mobile apps can positively predict users' behavioral outcomes(Payne et al., 2015). In summary, previous research has demonstrated the significant influence of health-related technology use on individuals' health. It facilitates disease management, influences decision-making processes, and impacts perceptions of health and health behaviors. Understanding the role and impact of technology use in the context of PCC and chronic disease is essential for developing effective interventions and improving health outcomes.

Personal electronic health record (PEHR) is a crucial health-related technology that serves as a digital version of a patient's chart, encompassing personal contact information, medical history, test results, diagnoses, and treatments (Zheng & Jiang, 2022). Over the past decade, PEHR systems have emerged as essential tools for health management at both the hospital and individual levels (P. L. Liu et al., 2022). Research has demonstrated the positive impact of medical record use on chronic diseases, highlighting its potential for early prevention and disease control in patients(Francisco et al., 2022; Totzkay et al., 2017).Firstly, PEHRs, as health information technology (HIT), provide patients with access to a wealth of health-related information and communication channels (Ojinnaka & Adepoju, 2021a). With EHR access, patients can review past clinical notes, examine lab test results and medications, utilize messaging systems to communicate with healthcare providers, and access billing information associated with clinical visits (Zheng & Jiang, 2022). Therefore, healthcare strategies and provider communication emphasize the importance of encouraging patients, especially those with chronic conditions, to leverage patient portals for effective disease management(Calixte et al., 2021a). Secondly, research indicates a positive association between HIT and information-seeking behavior, a cornerstone of patient activation in chronic disease self-management(Paige et al., 2021). Access to detailed information allows patients to gain a deeper understanding of their treatment options and exercise more control over their health conditions. Thirdly, PEHRs enable patients to access a broader range of health-related information, empowering them to make informed decisions about their health and engage in behaviors that prevent diseases (Ronda et al., 2014). Health-related technologies, as highlighted by Kreps and Neuhauser, activate and engage patients in the health decision-making process. Furthermore, studies have demonstrated the significant role of PEHR portals in improving health self-efficacy, ultimately contributing to patients' physical and psychological well-being (Baudendistel et al., 2015; Jilka et al., 2015; Kruse et al., 2015; Otte-Trojel et al., 2014).

However, despite the extensive research on PEHR usage and general health, there is limited research on the effects of PEHR portals specifically on patients with chronic health conditions (P. L. Liu et al., 2022). Additionally, both the frequency and diversity of PEHR usage have slightly increased over the years, but overall usage remains low(Babione et al., 2023; Calixte et al., 2021b). Notably, individuals aged 65 and older are less likely to use medical records, especially for sharing health information

with other providers(Calixte et al., 2021b). Addressing barriers to accessing online medical records is crucial, and doctor-patient communication plays a vital role in overcoming these barriers (Zheng & Jiang, 2022). Previous research has shown that higher levels of patient-centered care (PCC) result in increased utilization of health records, as PCC provides patients with information about their treatment and guidance on how to use electronic medical records(Zaidi et al., 2022; Zheng & Jiang, 2022). Hence, doctor-patient communication may be positively associated with the frequency of PEHR usage (Babione et al., 2023).

Health literacy refers to the ability to seek, comprehend, evaluate, and apply health information for solving health problems or making health-related decisions (Ishikawa & Yano, 2008; Speros & Aprn, 2005). Using personal electronic health records (PEHR) requires a high level of health literacy(Ford et al., 2016; Khoong et al., 2020; Wigfall & Tanner, 2018). However, frequent utilization of PEHR technologies can also contribute to increasing an individual's health literacy. Firstly, doctor-patient communication has been positively associated with the frequency of personal electronic health record (PEHR) usage(Zheng & Jiang, 2022). PEHR use can act as a mediator between patient-centered care (PCC) and health literacy because PCC provides patients with more information about healthcare, treatment options, and instructions on how to use personal health technologies(Calixte et al., 2021b). Therefore, PEHR usage facilitated by PCC may increase an individual's health literacy. Secondly, the rich health information contained within PEHRs helps individuals understand and effectively utilize health-related information. Previous studies have shown that PEHR usage provides patients with greater access to their personal health information, enabling them to make well-informed healthcare decisions and prevent potential diseases(Clarke et al., 2021). Consequently, the functionality of PEHRs may increase the health literacy of individuals who use them.

Considering the role of PCC in EHR usage and the aforementioned benefits of EHR usage, there is a potential for the frequency of EHR use to enhance an individual's health literacy. Additionally, substantial evidence highlights the significant impact of patient-centered care on overall health outcomes, including the provision of health-related information, the use of health technologies, and disease prevention (Moser et al., 2022; S. Wu et al., 2022). Patient-centered care plays a critical role in improving the quality of healthcare delivery.

However, there is limited research on the direct and indirect relationship between patient-centered communication (PCC) and chronic diseases. Only one study has examined the relationship between patient-centered communication and health self-efficacy among populations with multiple chronic conditions (Finney Rutten et al., 2016a), and it does not provide specific factors explaining how it influences health outcomes. Furthermore, there is a lack of research focusing on the use of health information technology to improve personal health literacy. Previous studies have primarily viewed health literacy as a motivating factor or prerequisite condition. For example, improving health literacy is seen as a means to promote healthcare engagement (Wigfall & Tanner, 2018) or to facilitate the use of electronic health records (PEHR) (Khoong et al., 2020). Moreover, empirical studies investigating the specific impact of medical record use on chronic diseases are lacking. Therefore, it is worthwhile to examine the relationship among PCC, electronic medical record use, health literacy, and chronic disease probabilities. This research aims to investigate whether the use of EHRs can serve as a mediator to increase health literacy and subsequently reduce the probability of developing chronic diseases.

To address the aforementioned research gaps, this study explores the relationships between PCC and chronic diseases, including general health and mental health, both directly and indirectly through two crucial mediators: personal electronic health record use and health literacy. These factors are particularly relevant to chronic disease prevention. The study proposes and tests mediation pathways

that link PCC to chronic disease probabilities, with an additional examination of the mediating roles of personal electronic health record use and health literacy (see Figure 1). Specifically, three types of associations are hypothesized regarding PCC and chronic disease probabilities. First, PCC is directly related to chronic disease probabilities. Second, personal electronic health record use mediates the distal association between PCC and chronic disease probabilities. Third, personal electronic health record use and electronic health literacy have a chain mediation role in the relationship between PCC and chronic disease probabilities. Based on the points, the research question proposed to explore the relationship between PCC and probabilities of chronic disease in adults is as follows:

**RQ1:** What is the relationship between patient-centered communication (PCC) and the probabilities of chronic disease in adults?

**RQ2:** How do personal electronic health record (PHER) use and health literacy contribute to the probabilities of chronic disease in adults?

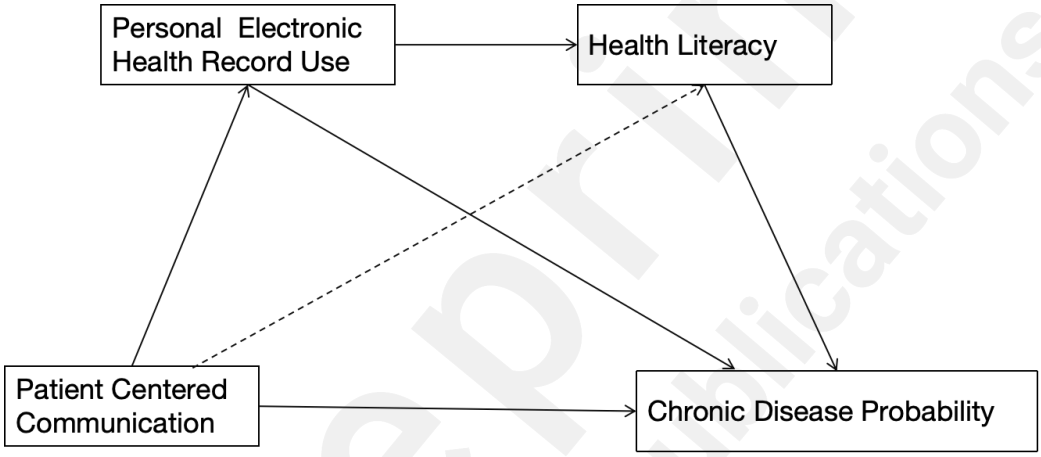


**Figure 1:** the concept framework

## Literature review and hypotheses

### *Self-determination theory*

This study builds upon the theoretical framework of self-determination theory (SDT) to develop research hypotheses. According to SDT, healthcare providers can promote patient activation by addressing three fundamental needs: autonomy, competence, and relatedness(Totzkay et al., 2017). Autonomy refers to the need for individuals to feel in control of their decisions, competence relates to their confidence and effectiveness in performing activities, and relatedness reflects the need to establish social connections (Deci & Ryan, 2008).

Recent research suggests that when individuals' needs for autonomy, competence, and relatedness are met, behaviors such as cancer screening(Ryan et al., 2008), weight loss(L. Li et al., 2023) and chronic disease rehabilitation, such as chronic low back pain rehabilitation (Murray et al., 2019)or diabetes rehabilitation (Rasmussen et al., 2023), become integrated into their self-concept and are self-initiated (Ryan et al., 2008). This integration reflects intrinsic motivation, where behavior is driven by inherent enjoyment. Interestingly, SDT research has demonstrated that even extrinsically motivated behavior, prompted by external factors such as parental recommendation (Totzkay et al., 2017; P. Liu et al., 2023) external education (Murray et al., 2019)or physician communication

(Martela et al., 2021) can also integrate and be enacted and sustained (Deci & Ryan, 2008; Hagger & Chatzisarantis, 2009). It is important to note that neglecting any of the three needs (autonomy, competence, and relatedness) is not conducive to optimal, healthy development (Deci & Ryan, 2000). Therefore, all three needs are essential for positive health outcomes. Moreover, studies have shown that individuals with a regular source of care report more patient-centered communication experiences and higher ratings of care quality.

This self-determined behavior is more likely to be enacted and sustained, as optimal, healthy development does not occur when autonomy, relatedness, or competence needs are neglected (Deci & Ryan, 2000) This underscores the importance of addressing all three needs for positive health outcomes. Furthermore, research indicates that individuals with regular sources of care report more patient-centered communication experiences and higher ratings of care quality(Finney Rutten et al., 2015). Given its sensible perspective and wide application in the health domain, SDT can provide a suitable framework to explain the relationship between prior patient-centered communication experiences and the probabilities of chronic disease.

SDT has also been applied to understand the effects of various technologies on individuals' health behavior. For instance, Li, Lun, et al. (2022) (L. Li et al., 2023) found that previous online weight-loss experiences impact individuals' perceived competence and autonomy in similar future tasks, influencing their intrinsic motivation and subsequent goal outcomes. Similarly, a recent study demonstrated that using SDT as a guiding framework, self-monitoring, social support, and platform rewards in a mobile fitness app can enhance users' physical activity levels(Tsai et al., 2021). Given its sensible perspective and broad applicability in the health domain, SDT provides a suitable mechanism for explaining the relationship between prior patient-centered communication experiences and general health outcomes. Specifically, it is believed that prior patient-centered communication experiences may influence users' satisfaction with competence and subsequently impact their behavior to improve general health outcomes.

It should be noted that this study relied on existing secondary data and did not collect data on individuals' basic psychological needs. In other words, the study was unable to directly measure individuals' basic psychological needs, which is also a limitation. Therefore, the study employed SDT as a framework to develop research hypotheses and establish relationships between variables, rather than directly examining how prior experiences of success and failure impact individuals' psychological needs. Figure 1 illustrates the research framework, and the subsequent discussion will focus on specific hypotheses based on SDT.

### *PCC and chronic disease risk*

PCC is an innovative approach to healthcare policy and practice that encompasses a holistic and comprehensive delivery of care(Miles & Mezzich, 2011). Recent attention to the patient experience has recognized PCC as a global public health priority, aiming to provide whole-person care, promote lifelong engagement, and improve treatment and quality of life outcomes(De Man et al., 2016; Lazarus et al., 2021). PCC is considered a crucial component of patient-centered care(Moser et al., 2022) and is recognized as an optimal communication approach and a marker of quality care that enhances health outcomes and overall well-being(R. M. Epstein et al., 2017). Due to its significant advantages, PCC has been extensively promoted and integrated into medical training programs across different cultural contexts(Hawkins & Mitchell, 2018; X. Liu et al., 2015; Santarém Semedo et al., 2020; J. Wu et al., 2023). Epstein and Street (Street & Epstein,2007) outlined six fundamental functions of PCC in the National Cancer Institute (NCI) monograph, including exchanging information, addressing emotions, navigating uncertainty, cultivating healing relationships, making

decisions, and empowering patients in self-management. While each of these elements plays a distinct role in fostering collaborative interactions between patients and providers, they all align with the overarching objective of PCC, which is to integrate the unique needs, values, and preferences of individual patients to facilitate their active involvement in clinical decision-making. (Street & Epstein,2007).

Current research indicates that strengthening PCC can positively impact individuals' health conditions. Several studies have utilized multiple cycles of HINTS data to explore the relationship between PCC and health conditions. For instance, Wu, Qiaofei (Q. Wu & Jiang, 2023) examined the effects of PCC on emotional health and found a positive relationship between PCC and emotional well-being (Trends Survey 5 Cycle 3 dataset) (Q. Wu & Jiang, 2023). Blanch-Hartigan et al. investigated the effect of PCC on cancer survivors and observed a positive association between treatment summary receipt and PCC functions (Blanch-Hartigan et al., n.d.). Liu, Piper Liping (2023) discovered the positive role of PCC in improving the health competence and outcomes of older adults(P. Liu et al., 2023). These studies collectively demonstrate the importance of PCC in directly or indirectly improving patients' health.

Previous research has identified three main functions of PCC that can reduce the probability of developing chronic diseases or improve health conditions. First, PCC helps patients gain a better understanding of their treatment options, which is crucial to their health outcomes. For example, PCC promotes shared decision-making and accommodates patients' needs and preferences, allowing them to make informed decisions about their treatment and reduce the risk of disease(Mukamba et al., 2023). Second, PCC is closely related to individuals' health behaviors. Studies have shown that higher levels of PCC are associated with an increase in healthy behaviors for disease prevention and health improvement (Moser et al., 2022). Furthermore, the substantial evidence highlights the significant impact of PCC on general health behavior outcomes (Moser et al., 2022; S. Wu et al., 2022). Third, PCC allows patients to exchange health-related information and empowers them in self-management(Kim et al., 2020). This includes exchanging health-related information with healthcare providers or family members, leading to more frequent use of health technologies and increased attention to disease prevention (Moser et al., 2022; S. Wu et al., 2022). Additionally, this exchange of information can improve health-related knowledge and self-efficacy, particularly among populations with multiple chronic conditions (Finney Rutten et al., 2016a). Overall, communication factors, as demonstrated by previous research, are highly correlated with prevention behaviors and management outcomes for chronic diseases(Mitsutake et al., 2023).

Given the substantial evidence highlighting the significant impact of patient-centered communication (PCC) on health outcomes (Moser et al., 2022), particularly in terms of exchanging health-related information, utilizing health technologies, and promoting disease prevention (Moser et al., 2022; S. Wu et al., 2022), we hypothesize that individuals who receive higher levels of PCC will have a lower risk of developing chronic diseases. Therefore, we propose the following hypothesis:

**H1:** There is a positive correlation between adults' PCC score and their probability of chronic diseases.

### *The mediation role of PEHR*

Personal electronic health records (PEHR) are accessible to patients through patient portals, such as MyChart in Epic, allowing them to conveniently access their personal health information from anywhere, including their homes and workplaces (Q. Wu & Jiang, 2023). There are various definitions and options for terms like "online medical records," "personal electronic health records,"

"Electronic personal health information technology use," or simply "personal health records" (Blanch-Hartigan et al., 2015; P. Liu et al., 2023; Q. Wu & Jiang, 2023), for this paper, we define online medical records as "personal electronic health records" (PEHR).

Over the past decade, patient-accessible electronic health record (PEHR) systems have become essential tools for health management, benefiting both hospitals and individuals (P. L. Liu et al., 2022). Research has shown that the use of medical records has a positive impact on chronic diseases, serving as an early prevention and control measure for patients (Francisco et al., 2022; Totzkay et al., 2017). Firstly, it provides patients with more health-related information and facilitates communication, thus enabling patients to actively participate in the health decision-making process(Kreps & Neuhauser, 2010; Ojinnaka & Adepoju, 2021b). With access to PEHRs, patients can view past clinical notes, review lab test results and medications, use the messaging system to communicate with healthcare providers, and check clinical visit bills(Zheng & Jiang, 2022). Secondly, the use of PEHR is positively associated with information seeking. Particularly, PEHR portals play a significant role in improving health self-efficacy, ultimately contributing to patients' physical and psychological well-being (P. L. Liu et al., 2022). This is also a crucial aspect of patient activation in chronic disease self-management (Paige et al., 2021), allowing patients to better understand their treatment and have more control over their health conditions. Thirdly, PEHR enables patients to access more health-related information, thereby increasing the likelihood of making informed decisions about their health and engaging in behaviors to prevent diseases(Molina & Sundar, 2020).

Previous research indicates a positive association between doctor-patient communication and the frequency of PEHR usage (Babione et al., 2023). Higher levels of patient-centered communication (PCC) are linked to increased utilization of medical records(Zaidi et al., 2022). Furthermore, previous studies have demonstrated the significant influence of health-related technology use (Rao et al., 2012; S. Yu et al., 2023a) on chronic diseases. For example, using online health-related technology to gather information is beneficial for the management of chronic diseases (Mitsutake et al., 2023). Additionally, patient portals provide an effective method for secure communication between patients (or their proxies) and healthcare providers(S. Yu et al., 2023a). Wearable devices may also have positive effects on physical activity for chronic patients(S. Yu et al., 2023b). Moreover, certain chronic disease cohorts appear to have higher health information technology (HIT) usage than others (Rajamani et al., 2022). Health information technology (HIT) can enhance optimal healthcare access and utilization among individuals living with chronic diseases(Ojinnaka & Adepoju, 2021b). Based on the aforementioned correlations between PCC, PEHR, and chronic diseases, the following hypothesis is proposed:

**H2:** Using personal electronic health records mediates the negative relationship between adults' PCC scores and their probabilities of developing chronic diseases.

### *The chain mediation role of PEHR and health literacy*

Health literacy is defined as the ability to seek, find, understand, and appraise health information and apply that knowledge to solving a health problem or making a health-related decision (Ishikawa & Yano, 2008; Speros & Aprn, 2005). Both technology usage and communication factors may increase an individual's health literacy (Norman & Skinner, 2006).Firstly, research has shown that technology utilization can have various effects on an individual's knowledge, awareness, and skills (Griffiths et al., 2006; Haberlin et al., 2018). The use of personal electronic health record (PEHR) technology in healthcare provides benefits such as convenience for patients and healthcare providers, easy access to health-related information, and personalized feedback from healthcare providers (Griffiths et al.,

2006; Haberlin et al., 2018). Previous studies have demonstrated that PEHR usage is important in increasing health-related awareness and improving cancer prevention behaviors (Carey et al., 2015; Majeed & Khan, 2019; Plackett et al., 2020). In addition, information in the technology platform allows individuals to know more details. Besides, research shows that the media richness can utilizing technologies that offer rich media features like interactive e-learning platforms can enhance an individual's knowledge acquisition (Daft & Lengel, 1986). Additionally, the information available through technology platforms allows individuals to acquire more detailed knowledge. Moreover, research has shown that utilizing technologies that offer rich media features, such as interactive e-learning platforms, can enhance an individual's knowledge acquisition (Daft & Lengel, 1986). Therefore, based on a high level of knowledge, individuals are more likely to make informed decisions.

Secondly, communication factors also have a potential effect on an individual's health literacy. Health-related communication can influence an individual's information behavior and attention (Daft & Lengel, 1986). For example, online communication related to health can change people's information attention and increase their information-seeking behavior (Khoong et al., 2020), Furthermore, patient-centered communication (PCC) can improve patients' self-efficacy (L. Yu et al., 2021), and self-efficacy refers to an individual's confidence in their ability to take care of their health (Finney Rutten et al., 2016b). It is highly correlated with literacy (Z. Li et al., 2023). Moreover, research suggests that efficacy can be affected by technology experience (Ojinnaka & Adepoju, 2021a). Therefore, we postulate that PEHRs have a positive impact on health literacy, and PCC may positively affect health literacy through the use of electronic medical records.

Furthermore, PCC may affect adults' health literacy through PEHR usage. The primary function of patient portals is to provide patients with access to their personal health information, enabling them to make well-informed healthcare decisions and prevent potential diseases (Clarke et al., 2021). A systematic review examined the impact of electronic medical record (EMR) use on patient-provider communication and relationships. A key finding from their study was that positive EMR communication behaviors included the notion of facilitating questions, which is a common goal of decision support tools such as decision aids and patient education materials(Giles, 2015). Patient portals also serve as an effective method for secure communication between patients (or their proxies) and healthcare providers. With the increasing acceptance of patient portals in private practices, patients have a unique opportunity to manage their healthcare needs (Mitsutake et al., 2023), Through PCC, individuals may become motivated to understand their PEHR and their health conditions, leading to a greater willingness to check their medical conditions, diagnostics, or prescriptions more closely and increasing EMR usage. Therefore, we postulate that PCC increases the need and willingness for frequent PEHR use, which in turn improves health literacy. Furthermore, due to the rich health information available in PEHR(Braa et al., 2007), their health literacy and make informed decisions about their health conditions to reduce the probability of chronic diseases. Based on the potential effect of PCC on health literacy and the availability of health-related information in EMRs, we hypothesize that:

**H3:** The relationship between PCC and chronic disease probability is sequentially mediated by the use of personal electronic medical records and health literacy.

# Methods

## *Sample*

The data used in this study were obtained from the Health Information National Trends Survey (HINTS) conducted by the National Cancer Institute in 2022 (HINTS 6). The dataset used in this

study is the updated version as of May 16, 2023. HINTS is a nationally representative cross-sectional survey that employs stratified sampling methods to capture information about the American public's knowledge, attitudes, and behaviors related to health. Detailed information about the survey design and methodology can be found on the HINTS website (http://hints.cancer.gov). HINTS 6 utilized a self-administered mailed questionnaire, and the sampling frame was provided by the Marketing System Group, which includes addresses across the United States. For the purpose of this study, the sample was restricted to adults aged 18 years or older, as determined by a dichotomous question about respondents' gender. The final sample for analysis consisted of 5,462 participants who completed HINTS 6.

### *Measures*

Patient-centered communication (PCC) was measured by seven questions derived from previous research studies (Goethals et al., 2020; McKeown et al., 2023; Q. Wu & Jiang, 2023). The respondents were asked to rate their communication experiences with healthcare professionals over the past 12 months on a four-point scale, ranging from 1 (always) to 4 (never). The seven items included the following: (1) Give you the chance to ask all the health-related questions you had; (2) Give the attention you needed to your feelings and emotions; (3) Involve you in decisions about your health care as much as you wanted; (4) Make sure you understood the things you needed to do to take care of your health; (5) Explain things in a way you could understand; (6) spend enough time with you; and (7) Help you deal with feelings of uncertainty about your health or health care. The responses to these questions were reverse-coded and averaged to create a composite score. Higher scores indicated a higher level of patient-centered communication (M = 5.2, SD = 0.30, Cronbach's alpha = 0.98). The descriptive Statistics of Focal Variables are summarized in Table 2.

The use of personal electronic health records (PEHR) was measured using four items adapted from previous research conducted by P. L. Liu et al. (2023) (P. L. Liu, Ye, et al., 2023). The respondents were asked whether they had utilized their online medical record or patient portal in the past 12 months to perform the following actions: (1) Look up test results; (2) Download your health information to your computer or mobile device, such as a cell phone or tablet ;(3) Electronically send your medical information to a third party (such as another health care provider, a family member, or a smartphone health app) (4) View clinical notes (a health care provider’s written notes that describe your visit). The responses to these items were coded as 0 for "no" and 1 for "yes," and the scores were summed to create an index of PEHR use. Higher scores indicated greater utilization of PEHR technology (Cronbach's alpha = 0.95, M = 1.92, SD = 0.38). The descriptive Statistics of Focal Variables are summarized in Table 2.

Health literacy was measured using five items adapted from studies by Mitsutake et al. (2023) and S. Yu et al. (2023) (Mitsutake et al., 2023; S. Yu et al., 2023a) it was measured using five items: (1) It took a lot of effort to get the information you needed; (2) You felt frustrated during your search for the information; (3) You were concerned about the quality of the information;(4) The information you found was hard to understand; (5) confidence in getting health information; The first four items are based on a 4-point scale ranging from strongly disagree (1), disagree (2), agree (3), and to strongly agree (4). For analysis, all items were dichotomized (0 = disagree; 1 = agree). The last health literacy item (confidence in getting health information) was measured on a 4-point scale from not confident at all (0), a little confident (1), somewhat confident (2), very confident (3), and completely confident (4). For descriptive analysis, it was dichotomized as not very confident (0) or very confident (1). The five items were summed to create the index of health literacy. A higher value represented a higher level of health literacy (Cronbach's alpha = 0.88, M = 1.67, SD = 0.26;). The descriptive Statistics of Focal Variables are summarized in Table 2.

Chronic diseases were measured using five subquestions derived from previous articles(Mitsutake et al., 2023; S. Yu et al., 2023a). The respondents were asked if a doctor or health professional had ever informed them of having any of the following medical conditions:(1) Diabetes or high blood sugar; (2) High blood pressure or hypertension; (3)A heart condition such as heart attack, angina, or congestive heart failure; (4) Chronic lung disease, asthma, emphysema, or chronic bronchitis; (5) Depression or anxiety disorder; The scores of the five items were summed to create an index of chronic disease. Higher scores indicated a higher probability of having chronic diseases (M = 1.17, SD = 0.22). The descriptive Statistics of Focal Variables are summarized in Table 2.

Education level was assessed using seven categories: 1 = less than eight years, 2 = eight through 11 years, 3 = 12 years or completed high school, 4 = post-high school training other than college, 5 = some college, 6 = college graduate, 7 = postgraduate. For descriptive analysis, the education level was dichotomized as "under some college" (0) or "some college and above" (1). The sample characteristics are summarized in Table 1.

Demographic information included respondents' age, gender (1 = male, 0 = female), education level, and annual household income. Education was measured on a seven-point scale, while household income was measured on a nine-point scale. The sample characteristics are summarized in Table 1.

**Table 1.** Sample Characteristics.

| Characteristic | Value |
|---|---|
| Age in years, mean (SD) | 55.6 (17.0) |
| Gender, *n* (%) | |
| Male | 2307 (36.9%) |
| Female | 3535 (56.5%) |
| Education, *n* (%) | |
| Less than 8 years | 116 (1.9%) |
| 8 through 11 years | 271 (4.3%) |
| 12 years or completed high school | 1068 (17.1%) |
| Post high school training other than college | 433 (6.9%) |
| Some college | 1239 (19.8%) |
| College graduate | 1613 (25.8%) |
| Postgraduate | 1108 (17.7%) |
| Annual income (USD), *n* (%) | |
| 0 to 9,999 | 389 (6.2%) |
| 10,000 to 14,999 | 304 (4.9%) |
| 15,000 to 19,999 | 266 (4.3%) |
| 20,000 to 34,999 | 729 (11.7%) |
| 35,000 to 49,999 | 732 (11.7%) |
| 50,000 to 74,999 | 937 (15.0%) |
| 75,000 to 99,999 | 732 (11.7%) |
| 100,000 to 199,999 | 694 (11.1%) |
| 200,000 or more | 1012 (16.2%) |
| Non valid(dumy) | 457 (7.3%) |
| *N* | 5780 |

### *Data analysis*

The data analysis was conducted using SPSS 27 to examine the relationships between the research variables. To ensure comparability, all variable scales were converted into a standard measurement scale ranging from 0 to 1, as recommended by Jiang et al. (P. L. Liu, 2020). This conversion involved subtracting 1 from a 5-point rating to adjust the scale to start at 0 and then dividing it by 4 to compress the scale (P. L. Liu et al., 2022). Descriptive statistics for the focal research variables are presented in Table 2, providing an overview of the data. Subsequently, the chain mediation model was tested using Model 6 from the SPSS macro-PROCESS. The analysis controlled for demographic variables such as age, gender, education, and household income. Associations among patient-centered communication (PCC), personal electronic health records use (PEHR), health literacy, and chronic disease were examined using bootstrapping procedures with 5000 samples. This approach allowed us to generate a 95% confidence interval for the observed relationships (David Pincus, 2022).

## Results

Table 1 provides an overview of the socio-demographic characteristics of the participants, while Table 2 presents the descriptive statistics for the focal variables. Descriptive statistics were also examined for patient-centered communication (PCC), mental health, and general health. Analyzing the data, it was found that the average age of the participants was approximately 56 years. Men exhibited slightly lower participation rates, ranging from 40.8% to 44.5%. Around half of the respondents reported having some college education, while the majority had an annual household income between $75,000 and $99,999.

H1 proposed that an individual's PCC scale would have a negative impact on their probability of chronic diseases. As shown in Table 3, the individual's PCC scale was found to be negatively associated with chronic diseases (coefficient = -0.08, $p < 0.001$), providing support for H1.

H2 suggested that personal electronic medical record use mediates the negative relationship between an individual's PCC scale and their risk of chronic diseases. The results in Table 3 indicate a negative association between personal electronic medical record use and chronic disease risks (coefficient = -0.012, $p < 0.001$). The bootstrap analysis supported the mediation effect (coefficient = -0.016, 95% CI: [-0.0229, -0.0092]). The absence of zero in the confidence intervals obtained through bootstrapping indicates the significance of the indirect effect. Therefore, H2 was supported.

Table 3 also reveals a positive association between personal electronic medical record use and health literacy (coefficient = 0.130, $p < 0.001$), as well as between health literacy and chronic disease probabilities (coefficient = -0.029, $p < 0.05$). Furthermore, PCC was found to be negatively related to chronic diseases through the serial mediation of personal electronic medical record use and individual chronic disease risk (coefficient = -0.001, 95% CI: [-0.0020, -0.0004]), providing support for H3.

**Table 2.** Descriptive Statistics of Focal Variables (N = 5462).

| | Inappli-cable | Always | Usually | Sometimes | Never | Non valid |
|---|---|---|---|---|---|---|
| **PCC** | | | | | | |
| 1. Give you the chance to ask all the health-related questions you | 10.0% | 1.1% | 8.1% | 27.1% | 50.8% | 2.9% |

| | | | | | | |
|---|---|---|---|---|---|---|
| had? | | | | | | |
| 2. Gve the attention you needed to your feelings and emotions | 10.0% | 3.3% | 15.2% | 15.7% | 29.5% | 3.2% |
| 3. Involve you in decisions about your health care as much as you wanted | 10.0% | 1.9% | 10.6% | 28.5% | 45.8% | 3.2% |
| 4. Make sure you understood the things you needed to do to take care of your health | 10.0% | 1.3% | 8.6% | 27.2% | 49.8% | 3.0% |
| 5. Eexplain things in a way you could understand | 10.0% | 1.0% | 7.0% | 27.5% | 51.5% | 3.0% |
| 6. Spend enough time with you | 10.0% | 3.4% | 16.6% | 30.0% | 36.5% | 3.4% |
| 7. Help you deal with feelings of uncertainty about your health or health care | 10.0% | 4.8% | 16.8% | 29.7% | 34.9% | 3.7% |

| | Inapplicable | Yes | No | Non Valid |
|---|---|---|---|---|
| **PEHR** | 34.2% | 6.1% | 52.6% | 7.0% |
| 1. Look up test results | | | | |
| 2. computer or mobile device, such as a cell phone or tablet | 34.5% | 40.1% | 18.5% | 6.9% |
| 3. Electronically send your medical information to a third party (such as another health care provider, a family member, or a smartphone health app) | 34.5% | 47.3% | 11.3% | 6.9% |
| 4. View clinical notes (a health care provider's written notes that describe your visit) | 34.5% | 17.5% | 41.2% | 6.8% |

| | Yes | No | Non Valid |
|---|---|---|---|
| **Chronic Disease** | | | |
| Has a doctor or other health professional ever told you that you had any of the following medical conditions | | | |
| 1. Diabetes or high blood sugar | 20.9% | 20.9% | 4.0% |
| 2. High blood pressure or hypertension | 43.5% | 43.5% | 3.9% |
| 3. A heart condition such as heart attack, angina, or congestive heart failure | 9.7% | 9.7% | 3.8% |
| 4. NChronic lung disease, asthma, emphysema, or chronic bronchitis | 13.2% | 13.2% | 3.7% |
| 5. Depression or anxiety disorder | 25.2% | 25.2% | 3.9% |

| | Inappli-cable | Strogly disagree | Somewhat disagaee | Somewh-at agaee | Strogl-yagree | Non valid |
|---|---|---|---|---|---|---|

| | | | | | | |
|---|---|---|---|---|---|---|
| **Health Literacy Q1-4 The ability to process, and understand basic health information** Based on the results of your most recent search for information about cancer, how much do you agree or disagree with each of the following statements? | | | | | | |
| 1. It took a lot of effort to get the information you needed | 51.4% | 11.6% | 16.7% | 13.6% | 3.7% | 3.0% |
| 2. Search for the information | 51.4% | 14.7% | 14.6% | 12.4% | 3.5% | 3.3% |
| 3. You were concerned about the quality of the information | 51.5% | 8.8% | 11.8% | 16.9% | 7.8% | 3.1% |
| 4. Hard to understand. | 51.5% | 12.2% | 16.8% | 12.9% | 3.4% | 3.2% |

| | Not at all | A little | Somewhat | Very | Completely |
|---|---|---|---|---|---|
| **Health Literacy Q5 The ability to obtain health information** How confident are you that you can find helpful health resources on the Internet? | 5.9% | 9.5% | 38.0% | 33.0% | 11.5% |

**Table 3.** Mediation Models.

| | $b_p$ | $\beta$ | SE | 95%Boot CI | $p^a$ |
|---|---|---|---|---|---|
| **DV: Psychological health (Model 1)** | | | | | |
| PCC→ PEHR ($a_1$ path) | .290 | .166 | .016 | [.259, .322] | <.001 |
| PEHR→Chronic Disease ($b_1$ path) | -.041 | -.051 | .008 | [-.0573, -.0246] | <.001 |
| PEHR →Health Literacy ($l_1$ path) | .130 | .163 | .010 | [.111, .149] | <.001 |
| Health Literacy→Chronic Disease ($b_2$ path) | -.029 | -.030 | .011 | [-.0517, -.0068] | .011 |
| PCC→Chronic Disease (direct effect, $d$ path) | -.068 | -.049 | .010 | [-.0873, -.0479] | <.001 |
| PCC→Chronic Disease (total effect, $c$ path) | -.080 | -.060 | .010 | [-.0995, .0612] | <.001 |
| PCC→ PEHR →Chronic Disease (indirect effect, $a_1 \times b_1$) | -.012 | -.009 | .003 | [-.0229, -.0092] | / |
| PCC→PEHR→Health Literacy→Chronic Disease (indirect effect, $a_1 \times b_2 \times l_1$) | -.002 | -.001 | .001 | [-.0027, -.0004] | / |

## Discussion

The present study investigated the potential mechanisms linking chronic disease probability to young adults, specifically focusing on patient-centered communication (PCC), personal electronic medical record use, and health literacy. The results revealed a negative association between PCC and the probability of chronic disease, either directly or indirectly through the mediator of personal electronic medical record use. Additionally, the sequential mediating effect of personal electronic medical record use and health literacy in the relationship between PCC and chronic disease demonstrated that PCC can enhance health literacy by encouraging adults to use personal medical records, thereby reducing the likelihood of chronic disease.

### *Theoretical implications*

The research findings have several theoretical implications. First, the study contributes to the literature on patient-provider communication by highlighting the significant role of personal electronic medical record use and health literacy in facilitating behavior change and preventing chronic disease through PCC. These findings enhance our comprehension of how PCC influences individuals' utilization of health-related technology and their overall health outcomes. Additionally, these results align with previous research indicating that PCC can enhance individuals' health competence(P. L. Liu, Zhang, et al., 2023), thus expanding the scope of Self-Determination Theory (SDT) in the realm of health communication.

The study's results indicate that PCC is directly or indirectly related to adults' health outcomes, regardless of time series. Health competence emerges as a prominent mediator between PCC and adults' health outcomes, as well as their willingness to use personal health records. This study provides theoretical implications for health communication scholars, building upon Street et al.'s (Street et al., 2009a) pathway mediation model of patient-provider communication with robust empirical evidence. Gaining a deeper understanding of the relationship between patient-provider communication, health competence (to use of electronic medical records), health literacy, and health outcomes is crucial for researchers and practitioners seeking to improve healthcare delivery and enhance adults' healthcare skills to promote better health.

Second, this study provides new insights into SDT theory. According to SDT, providers facilitate activation by attending to patients' needs for autonomy, competence, and relatedness (Deci & Ryan, 2000; Ong et al., 1995; Tsai et al., 2021) In line with the observed increase in competence, PCC is found to increase the frequency of personal medical record use, likely due to the increased information provided during PCC. Additionally, individuals' access to and use of medical care technology, such as personal electronic medical records, can enhance their health literacy by extending the competence gained from using personal medical records. Consequently, this research provides new insight that effective communication may not only enhance individuals' competence in making the right decisions but also extend their competence beyond the decision-making process, resulting in improved health outcomes.

Third, this study extends prior research by confirming the mediating role of health literacy. The findings align with previous research emphasizing the crucial role of patient involvement in health-related decision-making, which ultimately determines healthcare outcomes (Entwistle & Watt, 2006; Vahdat et al., 2014). Patients who actively participate in the decision-making process can receive professional advice while expressing their concerns and preferences about the treatment (Vahdat et al., 2014). Consequently, they have a better understanding and more information about their electronic medical records, leading to increased competence in using personal medical records. Moreover, high PCC scores indicate that patients have a higher ability to use electronic records because providers explain the methods and assist them in addressing any technical issues. Furthermore, as individuals use their electronic medical records more frequently, they are more likely to explore medical information. Based on the improved competence provided by the care provider and the rich information available in personal medical records, their health literacy increases. Higher health literacy enables individuals to make informed decisions that help prevent chronic diseases.

### *Practical implications*

This study also has important practical implications. First, it highlights the significant role of PCC in influencing adults' electronic medical record use and, consequently, their health outcomes. Aligning with previous studies, it suggests that doctors should enhance patient-centered communication, educate patients about the benefits of electronic health records (EHRs), and promote EHR adoption in terms of frequency and diversity (Zheng & Jiang, 2022). Specifically, healthcare education programs focusing on improving providers' PCC skills can be implemented (Calixte et al., 2021b). These programs can educate providers on how to effectively communicate with adult patients, eliciting and understanding patients' feelings and concerns about electronic medical records, considering patients within their psychological context, reaching shared understanding regarding patients' problems and treatment decisions, and empowering patients by engaging them in their personal electronic medical record access and use (Toni et al., 2021).Second, in addition to improving providers' PCC skills, equal attention should be given to improving adults' medical communication skills. The findings suggest that communicating health information through electronic medical records remains an effective strategy for behavior change and improving public health. Practitioners should employ cross-channel health intervention strategies to reach a wider audience, utilizing both traditional medical records (e.g., paper records) and electronic medical records to provide informative disease-related information (Fu et al., 2020), particularly targeting young adults who are familiar with information technology and the internet.

Third, The finding herein indicated that adults who were engaged in PCC may perceive higher levels of health competence, this is consistent with prior research findings suggesting that effective patient-provider communication contributes to improved health literacy (Schillinger et al., 2003). A patient-physician encounter that meets the PCC criteria would allow patients to better understand their problems and reach a shared understanding of medical treatment decisions(R. Epstein & Jr, 2007; P. L. Liu & Jiang, 2021), thus contributing to enhanced health literacy. As adult patients' health literacy improves, they are more likely to adhere to medications and treatment recommendations(Sharkey et al., 2017), and they become more capable of obtaining needed information and support for health management (Millar et al., 2020), and they would be empowered to maintain good health(Shin & Lee, 2018).

Given the sequential mediating role of health literacy in the relationships among PCC, electronic medical record use, and chronic disease, practitioners should incorporate health literacy into their interventions. Adult patients, especially those with inferior health conditions, may face barriers in articulating their problems and understanding treatment plans. Patient-centered strategies that allow adult patients to ask health-related questions, acquire necessary information, and express their feelings and concerns can improve their health literacy and enhance the patient experience of care, leading to improved health outcomes. Therefore, PCC would increase adults' health literacy, and those with adequate health literacy would be more capable of preventing chronic disease and making the right decision about chronic disease prevention. That can reduce their probability of getting chronic disease(Diviani et al., 2015). As adult patients become more familiar with using personal electronic medical records, healthcare providers should provide guidance and support to help them navigate and interpret the information effectively (Jiang, 2017).

### *Limitations*

While this study provides valuable insights into the relationships among patient-centered communication, personal electronic medical record use, health literacy, and chronic disease, there are some limitations to consider. First, the study relied on self-reported measures, which may introduce response bias. Future research could incorporate objective measures, such as medical record usage data or objective health outcomes, to validate the findings. Second, the study focused on general

adults, and the findings may not generalize to other age groups. Future studies could explore the relationships in different age cohorts to examine potential variations. Third, the study used a cross-sectional design, limiting causal interpretations. Longitudinal studies or experimental designs could provide more robust evidence of the causal relationships between the variables. Finally, the study focused on patient-centered communication, personal electronic medical record use, and health literacy as key factors. Future research could explore additional variables that may contribute to the prevention of chronic diseases, such as socio-economic factors, health behaviors, and access to healthcare services.

## Conclusion

In the context of an aging society, understanding the factors that promote the health and well-being of older adults is of critical importance. This study utilized new data and provided empirical evidence to establish a relationship between patient-centered communication (PCC) and chronic health outcomes in adults, both directly and indirectly. Drawing upon the principles of Self-Determination Theory (SDT), we identified health literacy and the use of electronic medical records as significant mediators linking PCC to the probability of chronic disease in adults. Additionally, our findings indicated that the scale of PCC employed may have varying influences on patients' health literacy, which in turn affects their health outcomes related to chronic disease. These findings have significant implications for creating interactive environments, fostering efficient patient-provider relationships, and improving health-related technology use, all of which are key factors in the prevention of chronic diseases and the promotion of overall health in adults.

In conclusion, this study emphasizes the importance of patient-centered communication in reducing the probability of getting chronic disease among adults. The empirical evidence establishes a direct and indirect relationship between PCC and chronic health outcomes. Our findings highlight the mediating role of PHER in linking PCC to the probability of chronic disease in adults. Furthermore, we demonstrate that different scales of PCC may have distinct influences on patients' health literacy through PHER, subsequently impacting their health outcomes related to chronic disease. Understanding these associations is crucial in creating interactive environments, fostering efficient patient-provider relationships, and enhancing health competence, all of which play pivotal roles in the prevention of chronic diseases and the overall health condition of adults.

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# Supplementary Files

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# Figures

The concept framework.