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Factors Influencing the Acceptance of AI in Mobile Health Apps in Malaysia

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Abstract: In today's fast-paced world, maintaining health and personal wellness has become a top priority. Artificial intelligence (AI) has emerged as a powerful tool in this effort, offering innovative solutions through mobile health applications. These applications use AI-driven algorithms to analyze user data, including sleep patterns, food intake, daily activity levels, diet preferences, stress indicators, and meditation, to provide personalized recommendations and insights. Mobile health applications have the potential to improve healthcare systems by enhancing health and disease management, communication, efficiency, treatment adherence, reducing costs, and increasing access to health interventions. This paper aims to provide a better understanding of the use of artificial intelligence in healthcare tools by examining the factors influencing the intention to use mobile health applications in Malaysia. It will discuss the extended UTAUT constructs and the concept of personal health characteristics, such as performance expectancy, effort expectancy, social influence, facilitating conditions, and health consciousness.

Keywords: *Artificial Intelligence, Mobile Health, Health Applications, UTAUT, Health Consciousness.*

1. Introduction and Background

Over the last decade, life expectancy has notably increased in many countries, largely due to declining fertility rates. Consequently, the proportion of older individuals within the global population is rising. This growing trend of aging populations presents significant challenges for both developed and developing nations (Kong et al., 2022). According to The World Health Organization (WHO), by 2030, one in every six people of the global population is expected to be 60 years or older marking an increase in the population from 1 billion to 1.4 billion in 2020 (WHO., 2011). Furthermore, by 2050, the number of individuals aged 60 and above is predicted to double to 2.1 billion, while those aged 80 and older are expected to triple, reaching 426 million. This underscores the worldwide increase in both the proportion and absolute number of older adults within the total population.

Consequently, the rise in life expectancy has been accompanied by a prevalence of various health issues such as stroke, heart disease, cancer, diabetes, and other chronic diseases of non-communicable disease (NCDs) for older people, posing undoubtedly challenges for them in carrying out daily activities. Thus, in recent decades, various new technologies have been developed to fulfill the scarcity of people's health-related needs particularly older people (Khan et al., 2020a). The integration of scientific and digital technology innovations has substantially affected the medical aspects and healthcare practices in coping with increasing aging populations. One of the widely used innovations of digital technologies in healthcare is mobile health applications (mHealth). Mobile health applications permit older adults to live longer and more independently and, most importantly, facilitate their healthcare needs. Besides, the growing number of smartphone users goes hand in hand with the dependence on mobile technology (Saidon, et al., 2023).

Life expectancy refers to the average number of years a person is expected to live. In Malaysia, there has been a notable increase in life expectancy over the years. Although higher than the average for upper-middle-income countries, it remains lower compared to high-income nations. In 2020, Malaysia's life expectancy reached 74.9 years, up from 74.5 years in 2014 and 64.2 years in 1969. This rise in lifespan, coupled with a drop in fertility rates below the replacement level of 2.1 in 2013, has contributed to an aging population (Koris, et al., 2024). The number of older adults has been steadily rising, from 3.4 million in 2019 to 3.5 million (10% of the total population) in 2020. It is projected that by 2040, 14.5% of Malaysia's population will be 65 years and older, making it an aged nation (Haron et al., 2024). In addition, The Economic Outlook 2023 report from the Ministry of Finance Malaysia highlighted the finding by the Department of Statistics Malaysia, noting that the country's aging population is dramatically increasing more quickly than anticipated. By 2050, over 15% of Malaysians

will be aged 65 and above. Despite the increase in life expectancy, the does not necessarily equate to better health for the older populations (Market Intelligence, 2024). Moreover, the Khazanah Research Institute projects that, Based on current trends, people are expected to spend 9.5 years in poor health due to chronic diseases.

Mobile health involves the use of mobile devices like smartphones, personal digital assistants, and other wireless technologies to aid in providing medical care and public health services, as defined by the World Health Organization (WHO). It involves leveraging these tools to improve access to healthcare, facilitate communication between patients and healthcare providers, and manage health conditions remotely. (WHO., 2011). Mobile health applications are developed for numerous health purposes such as decision support, medication adherence, reminders, reproductive health apps, and others. The global market has over 350,000 healthcare apps, indicating a massive growth in the number of mobile health applications (Statista, 2024). Older adults typically utilize health services more frequently than those in other age groups (Khan et al., 2020b). For example, the elderly in the Netherlands consist roughly 20% of the total population and, indeed, contribute approximately 80% to the total healthcare expenses (Davenport & Kalakota, 2019), suggesting a substantial increase in the utilization and cost of healthcare services worldwide.

These mobile health applications are beneficial to older adults and becoming more common to help the elderly's self-management of chronic diseases and independent living conditions (Wildenbos). Studies found that mobile health applications assist the elderly in controlling medical costs and provide support groups. However, to ensure the successful utilization of mobile health applications among older adults, mobile health applications must be simplified and have convenient features and functions such as artificial intelligence. Artificial Intelligence (AI) is the definition of technology that can improve human capabilities (Liu, 2017; Schwab, 2017). The assistance of Artificial Intelligence facilitates human daily routine through the advancement in education (i.e., virtual learning), customer service assistance (i.e., personalized assistants), health care (i.e., disease diagnosis, patient monitoring), etc. (Becker, 2018.; Davenport & Kalakota, 2019; Kashive et al., 2021).

Hence, the application of artificial intelligence (AI) in developing mHealth apps is being investigated to offer more personalized healthcare, prevent diseases, enhance treatment, monitor individuals with chronic conditions remotely, improve healthcare delivery, and reduce costs and diagnostic time (Garcia, et al., 2023), Researchers are investigating how artificial intelligence (AI) can be utilized in the creation of mHealth applications to provide individualized healthcare, prevent illnesses, enhance therapies, remotely oversee patients with chronic diseases, improve healthcare provision, and decrease both expenses and the duration needed for diagnoses (Afrah & Kose, 2020).

Any form of mobile technology can be utilized for mHealth, connecting and engaging users of various types. mHealth applications have been designed to support numerous aspects of health and healthcare delivery, including patient education, monitoring, behavior change, surveillance, prevention, health promotion, and awareness creation. These applications function through both synchronous formats (real-time interactions such as video conferencing) and asynchronous formats (delayed interactions like email and instant messaging) (Cossy-Gantner et al., 2018; Latif et al., 2017). mHealth apps have proven effective across various aspects of healthcare and medical procedures(WHO, 2018). They have been hailed as a solution to numerous healthcare hurdles in developing nations. However, the anticipation would not be fulfilled unless the factors influencing the acceptance of the mHealth app are thoroughly examined and reconstructed.

Although technology acceptance research has received considerable attention, particularly in terms of user acceptance, perceptions, and adherence, few studies have specifically summarized the factors influencing users' intention to adopt artificial intelligence in mHealth applications, which has yet to be fully conceptualized. This paper aims to identify the factors that drive the acceptance of mHealth among the elderly in Malaysia and integrate them into a proposed conceptual framework. The importance of this research is it offers recommendations for healthcare policy and encourages the use of mHealth among the growing elderly demographic.

2. Literature Review

Mobile health application (mHealth): The term mHealth refers to the use of mobile devices such as cell phones, personal digital assistants, patient monitoring tools, and other wireless devices to aid medical and public health activities (WHO, 2011). The significant adoption of mobile health apps is to enhance patient healthcare, efficiency, and quality of services of medical premises and healthcare providers, as well as to reduce medical bills and encourage individuals to be involved in their healthcare management (Addotey-Delove et al., 2020). mHealth applications enable access to health-related information, treatment support, personal digital assistance, and self-care to improve the effectiveness of healthcare services. Also, mHealth apps can facilitate the self-management of one or more aspects by providing users with tailored instructions, information, reminders, and guidance by capturing their health data. Special attention has been given to the effectiveness of mHealth applications technologies in resolving health-related needs and problems toward flexibility in providing medical treatment to all patients. mHealth applications provide low medical costs, save treatment time, wider access to medical services, and more confidential solutions, especially for highly private health problems. Therefore, mHealth applications can be seen as the critical factor between healthcare systems and people's well-being. Moreover, integrating artificial intelligence tools into mHealth applications would help enhance the nation's health standard towards reaching health and social equality.

Research on the adoption and acceptance of innovative mHealth applications has attracted significant interest from scholars. Various theoretical frameworks, such as the Technology Acceptance Model (TAM), Theory of Reasoned Action (TRA), Theory of Planned Behavior (TPB), and Unified Theory of Acceptance and Use of Technology (UTAUT), have been employed to explore and understand the factors that influence user intentions and behaviors towards information technology over time. According to Zhaou, behavioral intention plays a key role as a determinant of individual inclination to use technology. The level of determination an individual has to participate in a specific behavior is known as behavioral intention.

Technology Acceptance Model: Previously, researchers used TAM to determine the behavioral intention using Attitudes, Perceived Usefulness (PU), and Perceived Ease of Use (PEOU) constructs. Binyamin & Zafar, (2021); (Samadbeik et al., 2020); To et al., (2019) and Zhu et al., (2023) used TAM in their mobile health studies to determine behavior intention to use mHealth. For example, (Binyamin & Zafar, 2021b) found perceived ease of use, perceived usefulness, and attitude to the effective predictors and demonstrated influence towards behavioral intention to use mHealth applications. Despite TAM having suggested intention as the primary determinant of user behavior of information technology, Bao & Lee, (2023) argued that TAM is not a model developed specifically for or in the healthcare context. Researchers found that the model also showed low explanatory strength that needs for extension of the variables in explaining technology adoption in healthcare (Zin, Kim, Kim, & Feyissa, 2022),

Performance expectancy is defined as an individual's opinion that using technology will improve his/her job effectiveness (Venkatesh et al., 2016) In the context of the mHealth application, performance expectancy refers to how users perceive using mHealth applications will help them reduce their health-related threats. The unified Theory of Acceptance and Use of Technology (UTAUT) describes that performance expectancy is one of the factors that determine the use intention of new technology (Alaiad et al., 2019). Performance expectancy is derived from the preceding 7 versions of perceived usefulness (Technology Acceptance Model), result in anticipations (Social Cognitive Theory), comparative benefit (Innovation Diffusion Theory), and external drive (Motivational Model) (Venkatesh & Davis, 2003). Lim et al., (2021) identified performance expectancy was associated with the use of mHealth apps among primary care physicians to provide support for their clinical work on patients. Also, Semiz & Semiz, (2021) examine the UTAUT constructs among 354 mHealth users revealing that performance expectancy was the second most significant determinant affecting usage of mHealth. This study supported the findings by Alam et al (2020), which demonstrated performance expectancy has a positive effect on the behavioral intention to use mHealth. Hence, it is hypothesized that:
H1: Performance expectancy positively influences behavioral intention to use mHealth applications.

Effort expectancy refers to an individual's belief that technology is simple to use (Venkatesh et al, 2003). The ease of use is significantly linked to the intention to use mHealth since the health app is a novel application for the users (Alam et al., 2020). Effort expectancy encompasses the three preceding variables of perceived ease of

use from TAM, ease of use from Innovation Diffusion Theory, and complexity from MPCU (Alaiad et al., 2019). It is a crucial determinant of intention to use mHealth, as indicated by a prior study on smartphone users who are willing to utilize mHealth if the apps are beneficial (Hussein, 2018). Studies have revealed that effort expectancy has a positive impact on Saudi patients' intention to use mHealth (Alkhalifah, 2022). Furthermore, Ahadzadeh et al., (2021); Alam et al., (2020); Beh et al., (2021); Lim et al., (2021); Shiferaw et al., (2021); Wu et al., (2022) have recognized the positive influence of effort expectancy on the intention to use mHealth. Consequently, it is hypothesized that effort expectancy will positively influence the intention to use mHealth apps if the technology is user-friendly and convenient.
H2: Effort expectancy positively influences behavioral intention to use mHealth applications.

Social influence is defined as "the degree to which individuals perceive that the beliefs or opinions of significant others indicate they should use a new technology or system." (Venkatesh, Morris, Davis, & Davis, 2003). According to Alam et al (2020), social influence refers to how much individuals value the opinions of others regarding their use of mHealth applications. This concept is rooted in the image aspect of Innovation Diffusion Theory, the social factors of the Model of PC Use (MPCU), and the subjective norms of the Theory of Reasoned Action (TRA) and the Technology Acceptance Model 2 (TAM2) (Alaiad, Alsharo, & Alnsour, 2019). SI construct is where one's behavior is influenced by; their belief others will view them as a result of using the mHealth application. Besides, the examination of social influence has also been shown to significantly affect the intention to use mHealth applications during the pandemic Covid-19 (Semiz & Semiz, 2021). Based on the above analyses, it is hypothesized that:
H3: Social influence positively influences behavioral intention to use mHealth applications.

Venkatesh et al. (2003) define facilitating conditions as the degree to which one believes technical infrastructure and organization exist to provide support for the use of the system. In the context of mHealth applications, facilitating conditions refer to individual beliefs that technical and organizational infrastructure exists to facilitate the usage of mHealth apps (Alam, Hu, et al., 2020). Facilitating conditions are positively associated with the behavioral intention of using the smartphone for health-related technology. Samadbeik et al., (2020) examined and validated the influence of facilitating conditions construct on the intention to use mHealth apps on medical students and found influenced the intention to use mHealth. The previous result also shows that facilitating conditions of using mobile electronic medical records positively affects the intention to use health apps (Kim et al., 2015). Therefore, it can be hypothesized that:
H4: Facilitating conditions have a positive influence on behavioral intention to use mHealth applications.

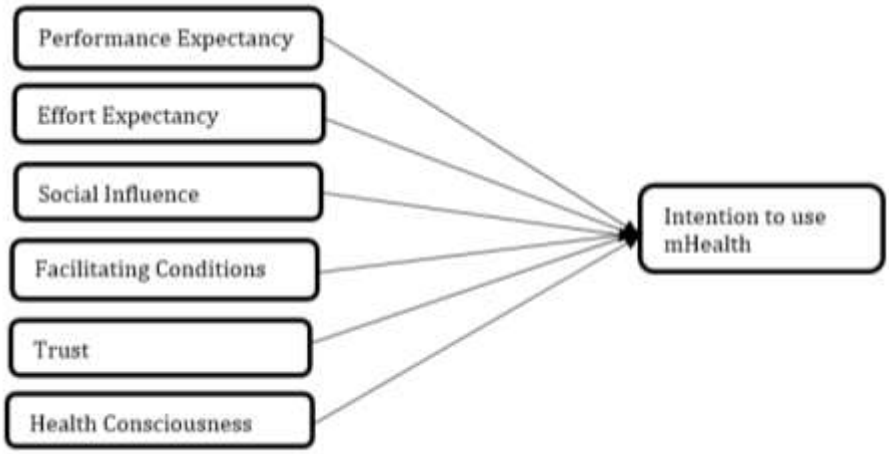
Trust in using new technology, especially health-related technology that will affect health and life-long threats is essential to promote the use and acceptance of new technologies. In this study, trust is defined as an individual's level of confidence in the safety of using a mHealth application (Handayani, Gelshirani, Azzahro, Pinem, & Hidayanto, 2020). The level of trust can be measured in terms of credibility, honesty, and reputation of mHealth service providers. Xia, et al., (2019) confirmed that patients' intention to adopt health-related technology is highly dependent on trust to support the finding (Alkhalifah, 2022; Zhao et al., 2018). Hence, users are more motivated to utilize mHealth applications when they have a high level of trust. However, there is a lack of detailed explanations regarding the influence of trust on the behavioral intention to use these applications, which this study aims to address and expand upon in the existing literature. Therefore, it is hypothesized that:
H5: Trust has a significant influence on behavioral intention to use mHealth applications.

According to Ahadzadeh et al., (2021), health consciousness is the intrinsic motivation individuals have to maintain good health and take responsibility for their well-being. It reflects how much people incorporate health concerns into their daily lives and their commitment to preserving their health (Barua & Barua, 2020b). Another study defines health consciousness as the level at which people take care of their health (Yee et al., 2019). Studies have linked health consciousness positively influencing the use of health applications (Alam et al., 2022b; Alam, Hu, et al., 2020b; To et al., 2019). Previously, health consciousness demonstrated a positive relationship with preventive healthcare behavior and showed a significant relationship with the use of mHealth applications (Meigasari, Handayani, Ayuningtyas, & Hidayanto, 2020). Moreover, health-conscious people are actively pursuing information on how to enhance their health accordingly. Not surprisingly, health-conscious people tend to frequently and actively seek more health-related knowledge. As a result, it is hypothesized that:

H6: Health consciousness has a significant influence on behavioral intention to use mHealth applications.

Hence, based on the review of the literature above, this study employs the conceptual framework as presented below in Figure 1.

Figure 1: Proposed conceptual framework



3. Research Methodology

This conceptual paper investigates new technology acceptance by focusing on published literature regarding the intention to use artificial intelligence in mHealth apps by older adults. Employing the theory synthesis and model research design, this study applied the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). As highlighted by (Jaakkola, 2020), conceptual papers help to bridge the gaps in the existing theories in unique ways, link different disciplines, provide a multi-level understanding, and broaden thinking scope. Hence, most of the impactful papers of recent years are conceptual papers that enable theory building unrestricted by empirical generalizations. PRISMA serves as a recognized standard for evaluating and scrutinizing the quality of previous studies as well as facilitating the identification of inclusion and exclusion criteria (Ramely et al., 2022).

A structured literature search of the two selected databases; Google Scholar, and Scopus. Google Scholar was used in this study because it provides a simple way to conduct a broad search for literature across disciplines and sources. However, according to Halevi et al., (2017), it is recommended that researchers not fully depend on Google Scholar in writing citations to improve transparency and ensure the quality of the article. Therefore, this study also includes Scopus, Emerald Insight, and Science Direct databases for making citations and finding relevant articles. Additionally, the articles gathered from these databases complement the sources collected from Google Scholar.

The search was limited to articles published in English, using keywords such as TITLE-ABS-KEY (“telemedicine”), (“health applications”), (“mobile health applications” AND “health management”), (“mobile health”), (“mHealth”), (“artificial intelligence” AND “telemedicine”), (“usage intention”), (“intention to use”), (“mHealth AND UTAUT”), (“mHealth” AND “health management”), and (“diseases”). Titles and abstracts were screened to eliminate duplicates, and all authors participated in this screening process. Studies meeting the inclusion criteria, which focused on mobile health (mHealth) and its use among users or patients in developing countries—specifically involving mobile phones—were selected through consensus for further review. Particular attention was given to factors influencing patients' acceptance of mHealth. Studies that did not specifically mention mHealth applications or artificial intelligence tools, but instead focused on telemedicine, telehealth, or organizations, were excluded. Additionally, hand searching supplemented the selection process, and the final decision on resource inclusion was made collaboratively by the three authors, while two authors conducted the full-text review and data abstraction.
This research employs a quantitative methodology to investigate the influence of performance expectancy,

effort expectancy, social influence, facilitating conditions, trust, and health consciousness on the intention of Malaysian users to adopt mHealth applications. The study focuses on older adults in Malaysia as the target population, specifically those aged 45 to 60, as this demographic is rapidly increasing. Additionally, the research indicates that the acceptance of mHealth applications is linked to internet and smartphone usage. By 2020, it was estimated that approximately 29 million people in Malaysia were smartphone users, with 86.6 percent of the population accessing the internet via their mobile devices (Siddharta, 2024). The minimum number of respondents will be 500, using non-probability sampling using convenience sampling techniques. The data from the participants will be gathered using a self-administered survey, which will be based on the previous study and modified accordingly. The data will be analyzed using SPSS version 28 which has been widely used by scholars around the world, especially for simple tests.

5. Managerial Implications and Recommendations

The swiftly aging global population brings both opportunities and challenges for healthcare systems, particularly in addressing non-communicable diseases (NCDs) that disproportionately impact older adults. This paper highlights the vital role that mobile health (mHealth) applications, augmented by artificial intelligence (AI), can play in enhancing the quality of life and healthcare outcomes for the elderly. As dependence on digital solutions grows, there are several key implications for healthcare providers, technology developers, and policymakers.

Firstly, the integration of AI into mHealth applications offers a significant opportunity to personalize healthcare delivery. AI-driven features such as predictive analytics, personalized health recommendations, and real-time monitoring can empower older adults to manage their health conditions more effectively. However, to ensure the widespread adoption of these technologies, developers must focus on creating user-centric designs that cater to the specific needs and capabilities of older adults. This involves simplifying user interfaces, ensuring ease of use, and providing clear instructions that reduce the learning curve. These considerations are crucial in addressing the barriers to technology adoption among older adults, who may have limited familiarity with digital tools (Hernandez, Adrian, Ferre, & Mora, 2022; Castro, et al., 2021)

Moreover, the acceptance of mHealth applications is greatly influenced by trust and security, particularly among older adults who may have increased concerns about the confidentiality and protection of their personal health information. Software developers and healthcare providers must give priority to data security through the implementation of strong encryption techniques, secure authentication procedures, and clear data management policies. Establishing and preserving trust is not only about safeguarding the technology but also about ensuring that users are well-informed and have confidence in the utilization of their data. This trust can be further reinforced through support from reputable healthcare organizations and professionals, as well as through adherence to international health data standards and regulations (Park, Lee, & Kim, 2024; Zhang et al., 2023).

The importance of healthcare providers in the successful adoption of mHealth applications cannot be emphasized enough. As trusted sources of health information, they are uniquely positioned to advocate for the use of these tools. They must receive the necessary knowledge and training to recommend suitable mHealth applications to their patients. Moreover, integrating mHealth tools into routine clinical practice can enhance the continuity of care, particularly for managing chronic conditions prevalent among older adults. This integration requires healthcare organizations to invest in training and infrastructure that supports the seamless use of mHealth applications within existing healthcare frameworks (Sun, et al., 2023; Maher, Khan, & Prikshat, 2023). In many advanced nations, local authorities have collaborated to transition traditional healthcare services to digital healthcare interventions by investing in the development of e-healthcare systems to deliver high-quality services. For example, the German government has introduced e-health cards for local patients to access healthcare and insurance. Canada, the government is actively encouraging the implementation of electronic health records and mobile health solutions for improved medical record management and patient care (Gu, et al., 2021).

Policymakers have a crucial role in promoting the adoption of mHealth technologies. By creating and implementing policies that foster the use of digital health solutions, governments can help ensure that the

benefits of mHealth are accessible to all, particularly vulnerable populations like the elderly. This includes providing subsidies or incentives for the development and use of mHealth applications, as well as ensuring that these technologies are inclusive and accessible to those with varying levels of digital literacy. Additionally, policymakers should support research and development initiatives to further integrate AI into mHealth applications and create frameworks that address ethical concerns related to AI in healthcare (Thompson, et al., 2023).

Finally, collaboration among stakeholders—such as healthcare providers, technology developers, policymakers, and the elderly—is crucial for effectively implementing mHealth applications. This collaboration should focus on continuous feedback and improvement of mHealth tools to meet the changing needs of the aging population, it is important to ensure that medical tools remain relevant and effective. Engaging older adults in the design and development process can provide meaningful insights into their preferences and challenges, towards more effective and user-centered solutions (Zheng et al., 2022; Park et al., 2021). The successful adoption and integration of AI-enhanced mHealth applications into healthcare systems require a concerted effort from multiple stakeholders. By focusing on user-centric design, building trust, equipping healthcare providers, enacting supportive policies, and fostering collaboration, the potential of mHealth to improve the lives of older adults can be fully realized. These recommendations offer a roadmap for stakeholders to navigate the complexities of an aging population and the growing burden of NCDs, ensuring that digital health solutions effectively meet the needs of those who need them most.

Conclusion

In conclusion, this concept paper proposes to identify the antecedents that influence the intention to use AI-based mHealth applications in Malaysia. One important discovery from this study is the introduction of a theoretical framework that has not been previously explored by researchers. It is crucial to identify the connections between personal health characteristics and concepts, as this has a significant impact on the behavioral intention to use AI-based mHealth applications. This study contributes a new potential relationship between personal health characteristics (health consciousness) and trust as they extend to the UTAUT model. The integrated UTAUT model with additional variables was used to determine the behavioral intention to use mHealth applications based on personal health characteristics.

According to the findings above, this study hypothesized that the UTAUT construct will have positive determinants toward behavioral intention to use AI-based mobile health interventions. However, future studies need to pay more attention to validate the influence of trust and health consciousness that might have different impacts on intention based on prior studies. This research will serve as a base for future studies. This research therefore has provided many questions in need of further research. Additional research is required to determine whether the proposed framework can effectively explain the phenomenon, by expanding the sample of respondents and focusing on specific mHealth applications. In addition, future work may explore different constructs that influence the intention to use mHealth applications such as complexity. Besides, this would be helpful for the app designers and developers in creating the mHealth applications with AI tools.

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