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Review Article

The Application and Prospect of Mobile Health (mHealth) in Health Service for Older People Living Alone in Community: A Narrative Review

Dehui Kong, Jingjing Fu, Yan Hong, Siqi Liu, *Yu Luo

School of Nursing, Army Medical University (Third Military Medical University), Chongqing, China

***Corresponding Author:** Email: luoyuhlgl@tmmu.edu.cn

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Abstract

As a result of improvements in life expectancy and reductions in fertility rate, the increasing world population ageing brings huge challenges for both developed and developing countries. Such factors as fewer children, migration of children and widowhood further increase the number of older people living alone. Older adults prefer age in place, which means care in the home. As the main place older people live in, care in community absolutely needs more attention. Optimizing health services for the elderly living in community is of positive significance to health promotion and happiness enhancement. But the traditional health service for the elderly has drawbacks of poor timeliness and high labor cost. The rapid development of modern science and technology make it possible to apply mHealth in health service for the elderly. At present, mHealth is relatively mature in the communities of developed countries. This article presents the application of mHealth in many developed countries, as references for developing countries.

Keywords: Older people; mHealth; Live alone; Community

Introduction

The life expectancy of the population in most countries increased dramatically in the last decades, while the fertility rate fell. Hence, the proportion of older people in the total population is rising. The increasing population ageing is undoubtedly a great challenge for both developed and developing countries (1). For instance, in the next 25 years, China will be a "super-aged society" with 24.71% of its people aged 65 and above, up from 11.47% in 2019, with the proportion of older people living alone rising greatly (2). Developing countries with relative fewer medical resource will be faced with a series of social problems as they jump to the ageing society (3).

In this article, we introduce the application of mHealth in many developed countries, as references for developing countries to build a better integrative care system for older adults in community (4).

The *World Report on Ageing and Health* defined healthy ageing as "the process of developing and maintaining the functional ability that enables well-being in older age" (5). Whereas, longer life brings not only opportunity but disease, disability, dependency in later life (6). In 1984, the

WHO proposed that extension of lifespan is no longer the primary goal of medical management. Rather, improvement in functional independence and the achievement of better quality of life are becoming more important (7). Various health problems such as heart disease, stroke, diabetes and cancer come after the increase in life expectancy, making it difficult for older people to perform some daily activities (8). Therefore, older people need sophisticated transitional care and more comprehensive medical services (9). The increasing demand for health care service inevitably requires changes to medical and care modes to make it more rationalized (10).

The willingness of Chinese older people to live in a nursing home is relatively low (11). Studies in US and Australia also found that care in the home, not nursing home care, is what most older adults would prefer even if they need special care. Staying home is still the first choice even during an illness (12,13). Unlike their counterparts in hospital and nursing home, the older adults living alone in community are in greater need of support (14). As the main place where older people live in, the support of community to older people is significant (15). Hence, promoting community-based home care service for older people can help them live a healthier, more comfortable, independent and positive life (16). With advances in technology, smart devices providing more convenient and instant medical services will become the development trend. The combination of in-home care and remote monitoring can create a comfortable home environment for older people and keep them away from expensive and crowded hospital or nursing home, to ensure their maximum independence and participation (17,18). This not only suits the older people for the achievement of "healthy ageing", but also alleviates the burdens on caregivers and social medical resources (19).

Definition of Relevant Concept and Connotation

Older people living alone in community

"Living alone" means there's only one person in a family, i.e., living and sleeping alone without other people (20). About 29% of the 46 million community-dwelling older adults in America live alone (21). According to a nationwide survey, about 23 percent of China's seniors over the age of 65 live by themselves (22).

mHealth

The WHO defined mHealth (mobile health) as medical and public health practice supported by mobile and wireless devices, such as voice and short message service and application (app) (23). The mHealth has changed the traditional medical service mode around the world in recent years, making it possible to actively deal with ageing. Now, studies on mHealth in developed countries are more holistic and a quite complete system has been developed. Whereas, elderly care in developing countries still relies on frequent and regular visit or expensive medical facilities, which are hard to be achieved due to lack of caregivers. Yet long-term monitoring can help with early diagnosis and treatment of some developmental diseases.

Older people commonly believe that self-monitoring in a place where they live for a long time can lighten the burden on medical service (23). Without continual and instant medical treatment, some fatal accident may be ignored. Continual monitoring of physical signs and elderly activities can avoid part of emergencies (18). Therefore, enabling high-quality medical care and monitoring service at an affordable price is urgently needed, particularly for people having limited access to medical resource or to low-income earners (24).

Need of Older People Living Alone in Community for Health Service

Older people living alone are prone to such accidents as falls, bruises or fractures because of decline of body functions, mobility difficulty and frequent nighttime urination (25). Furthermore, when they fall down, caregivers cannot receive the alert in time, thus the older people often miss the golden time for treatment. Besides, older people living alone may be at higher risk of disability due to lack of family support (26). An Irani-

an survey on 1,544 older people aged 60 and older showed that older people living alone have a significantly increased chance of getting cognitive disorders, depression and various chronic diseases and falling (27).

In contrast to the normal elderly, older people living alone are more likely to generate unhealthy emotions like depression, indifference and loneliness, which will exacerbate the pre-existing disease and further exert a negative influence on quality of life (28). Moreover, loneliness in seniors is related to anxiety, depression and even suicide thoughts. A survey on over 60,000 older people in South Korea indicated that living alone is strongly associated with depressive symptoms (29). A 19-year follow-up in the UK reported that emotional loneliness predicts an increased risk of all-cause mortality in older adults who live alone (30). Thus, living alone is harmful to both physical and mental health of older people.

However, the paid medical services are expensive and unreachable to some low-income older people (17). A survey on older people living alone in three cities in China showed that they are low paid and most of them are at the middle or lower-middle level (31). Through mHealth, older adults could receive better support such as real-time monitoring, diagnosis, treatment and in almost every aspect of daily life (32).

Development Trends of mHealth in Health Service for Older Adults Living Alone in Community

Miniaturization and portability of hardware device

By 2021, the number of smartphone users globally will exceed 3.8 billion (33). Emerging technology plays a vital role in preventing older people from disability (34). Smartphones have been fitted with various sensors, such as GPS sensor, acceleration sensor, microphone and fingerprint reader, which allow for monitoring of several health parameters, providing material information of an individual's physical and mental health (24).

In recent years, consumers begin to purchase wearable devices, with one in six having a smartwatch or fitness band, promoting the continuity and convenience of monitoring (35). For example, Apple Watch can get a quick read on your heart rate and check your heart rhythm with the ECG app (36).

Additionally, early diagnosis and treatment of some diseases can be achieved by miniature smart devices. For example, smartphone-acquired photographs can be used to identify patients with diabetic retinopathy for early diagnosis and treatment, and the sensitivity and specificity of photographs were 91% and 99%, respectively (37). 3D-printed smartphone indirect lens adapter is also used for high-quality retinal images (38). Smart devices are more portable, able to perform some basic examination and monitoring in a non-invasive way.

Diversification of app development

Medical service is increasingly engaging with mHealth, thus more and more applications are developed. Over 325,000 health apps were on the market in 2017 (39). Research has shown that almost 60% of US smartphone users had downloaded a health app in 2015 (40). For example, Seoul National University's College of Nursing developed a clinical-guideline-based app for obesity management (41). SaltSwitch, an app developed by the University of Auckland to help patients with cardiovascular disease select lower-salt food (42). Shanghai Zhongshan Hospital joined hands with Perth University of Australia to monitor 300 patients from the Department of Cardiology with WeChat for one year. They found that the strategies, such as steps counting and remote blood pressure monitoring were helpful (43).

Besides, older people are often attacked by several chronic diseases. Now, mHealth apps for different systematic diseases have been used to help the elderly, especially those who live alone.

The air pollution rising over the past decade has increased the risk of chronic lung diseases (44). Irish researchers used the smartphone microphone as a cheap spirometer available on mobile platform (45). Smartphone is also applicable to lung function recovery training. For example, researchers developed an interactive game,

"Flappy Breath", in which users can avoid obstacles by controlling their breathing (46). Free app "LungScreen" can provide risk assessment for lung cancer (47).

In the aspect of mental and psychological monitoring, for example, an individual's stress level or affective state can be identified according to the communication sounds or sound recording with microphone (48). A study in the US used GPS data and motion information to identify depressive symptoms (49). iWander, with GPS, can monitor the wandering elderly with Alzheimer's disease (50).

Due to gradual deterioration of motor control with age, older people are at increased risk of fall and mobility disability (24). Fall-related fracture is strongly correlated with mortality (51). The application of mHealth can achieve real-time monitoring of older adults, and enable us to be aware of fall more quickly. There is smartphone app for fall detection and to provide fall prevention strategies (52). For instance, RollingBall and iFall are two Android apps, of which the former can conduct risk assessment of fall for older people; while the latter can send signals and alerts to ambulance man and detect the risk of fall (53).

According to the WHO, approximately one-third of persons aged 65 and older are affected by hearing loss (54). A smartphone app called "uHear" can be used for hearing loss test (19). Some researchers used smartphone-based app and Bluetooth-enabled receiver to provide auditory support for patients with hearing loss (55).

Additionally, MedRem is a smartwatch app that reminds users to take medication on time (56). Smartfall is an app for Android devices to detect falls using deep learning on smartwatch (57). However, many products for older adults on the market are incompatible with the habit, or functionally unable to meet more needs of the elderly. Researches showed that simplicity and convenience is one of the key factors for senior citizens to use an app (50). Hence, a user-friendly interface should be taken as an important indicator in app design.

Accessibility of remote monitoring and remote-control service

Remote monitoring system usually have several functions: to interpret received data; to send alert message in case of emergency; to record the user information in database for future analysis, like prediction of undiagnosed disease; and to monitor the user's condition in real time (1). The IoT is a network of connected smart devices organizing and sharing information, data and resources, decisions and feedbacks, which achieves interaction between people, between people and object and between objects (58).

Smart home, based on the concept of IoT, consists of environmental, motion and biological sensors and actuators, able to collect environmental information and measure activities and location of resident, offering home security monitoring or automatic control of home environment via the Internet at any place. Such physiological parameters as blood pressure, heart rate, oxygen saturation, respiratory rate can be measured with wearable devices. Actuator can control the environment such as giving injections of drugs like insulin (59). Thereby, hospital or medical organizations could monitor the physical condition of older people living alone in real time and resort to interventions remotely if necessary.

Convenience of mHealth service

Computers and smartphones collect, process and analyze data and send feedbacks to the resident or actuator. If any abnormality in the home environment or in the vital physical signs of the user is detected, it can send alerts in the form of phone, text message or email (59). Moreover, the application of AI enables robot to control peripherals of smart home and provide services (60). Particularly for older people living alone, in the context of traditional visit system, if it is difficult to make a self-help call in emergency, treatment may be delayed and even their lives are in danger.

Price acceptability

Smartphone can be obtained at a cheaper price. The price of app is also relatively low. However,

some versatile mHealth hardware devices, like smart home, are expensive. Researches showed that cost effectiveness is the most persuasive factor when older people think about large-scale intelligent technology (61). For developers, lowering the cost helps them attract elderly consumers. Meanwhile, if mHealth can be covered by health insurance for reimbursement, its utilization rate will rise for the purposes of saving medical resources and reducing cost (62).

Miscellaneous

Data security and user privacy protection

The data collected may contain sensitive, protected or confidential information that can endanger users' privacy and safety once leaked. Therefore, ensuring strong data encryption, database security and secured transmission channels of mHealth data is critical for developers (59). For example, the Centralized Fog Computing Monitoring System provides a security platform for medical service apps (63). For the elderly, they should be more cautious and set high-level authorization when using smart devices (64).

Improvements in data accuracy and reliability

Many experts have raised questions about the accuracy and reliability of smartphone-based health monitoring apps/systems, the majority of which lacked involvement of medical professionals (24). There were only 2 passed the test of psychiatrist out of 52 anxiety-symptoms-related apps (65). Therefore, medical professionals should highly involve in from app design to application. Meanwhile, such software or systems should be renewed and knowledge related be promoted when corresponding medical indexes are updated. Besides, a strict management policy should be implemented in app store to ensure data accuracy and reliability (66).

Other challenges

The application of mHealth also faces other challenges, like biological effect. For example, reducing transmissions and work cycle of sensor brings down radiation. As for portability, smart-garment and smartwatch can monitor the elderly when they exercise outdoors or go out. And for standardization, this requires implementation of subsequent regulatory policies and tests (1).

Mobile health has the potential to transform traditional medical service mode and means of clinical intervention and assist older people to live longer and healthier, conforming to "healthy ageing" (67). The positive effects include saving medical expenses, providing individual medical information and service and more efficient medical care process (68). Despite some challenges exist, mHealth still has the potential to advance health promotion for all human being, including senior citizens. Furthermore, mHealth is far less used compared to traditional medical care (69).

Conclusion

The proportion of older people living alone rises due to various factors like fewer children and migration of children to big cities. As the population ageing is increasing, the contradiction between rising demand of older people for health care and limited medical resources is growing. Whereas, old age usually means decreases in functions of many organs and systems and coexistence of several chronic diseases. Furthermore, older adults prefer "in-situ health care" to hospital or nursing home, for it not only satisfies their personal willingness, but also provides a familiar and comfortable dwelling environment. With the sustained development of technology, mHealth is likely to become a trend in community-based health care for older people living alone in the future and places a crucial role and is very promising for alleviating burdens on government and medical resources, and improving quality of medical care for older people.

Journalism ethics considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission,

redundancy, etc.) have been completely observed by the authors

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Conflict of interest

The authors declare no conflict of interest.

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