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Study of e-Health nutritional interventions on disease patients based on meta-analysis

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Abstract

Food safety means that food is non-toxic, non-hazardous, meets the nutritional requirements and does not pose any acute, subacute or chronic risks to human health. Food safety and hygiene management measures adopted by the competent authorities should be based on risk assessment. The fast proliferation of text-messaging-based mobile health (mHealth) initiatives offers a chance to enhance food quality awareness and dietary habits, especially among difficult groups. Text messaging may be used to successfully prevent or cure health problems in people and encourage good health through the use of high-quality meals. In both industrialized and developing nations, dietary practices such as frequent eating of nutrient-poor products (as unhealthy snacking) and unwillingness to consume green leafy fruit and vegetables limit micronutrient intake. In this study, we comprehensively reviewed the scientific literature on the impact of mobile health on sickness prevention control and promotion. This study focuses on the deployment of mobile health in communicable disease preventive measures, chronic illness management, and maternal healthcare to give a benchmark for mobile health intervention research in China, based on the features of existing literature.

Keywords: food safety; mobile health; application program; health promotion; e-Health.

Practical Application: e-Health mobile application for good quality of food.

1 Introduction

Food intake assessment is a tough process since it needs participants to describe the food or drinks ingested in great detail. The fact that most customers have little awareness of the content or volume of food or beverages they eat on a regular basis adds to the difficulty of this endeavor. Furthermore, because a big percentage of food is now consumed away from home, keeping track of food consumption has become much more difficult. Since the early 1940s, tools for assessing food intake have been utilized in both research and practice, with four approaches usually used. When the food intake data is obtained, these techniques can be classified as retrospective or prospective. Food frequency surveys, diet history interviews, and 24-hour recollections are examples of retrospective approaches.

In contrast, prospective methods contain item records and are gathered before and/or at the time the food is ingested. The number of days required to collect or recollect meal information varies depending on the desired nutrient, with energy and macronutrients requiring fewer days than micronutrients (e.g., vitamin E, zinc). Each approach has its own set of advantages and disadvantages, and when applied to mHealth, it presents new problems and opportunities.

Mobile health technology (mHealth) is a healthcare model that uses mobile communication technologies such as Personal Digital Assistant (PDA), cell phones, and satellite communication to deliver healthcare services and information (Figure 1) (Schnall et al., 2018a, b). World Health Organization (WHO) has expanded its services to medical and public health services on this basis. Interventional mHealth technologies have been used to support health care workers in managing patients and conducting health education and other activities (Laar et al., 2019).

Compared with traditional health intervention models, mHealth technology can provide personalized and precise health interventions at the individual or group level and can provide continuous monitoring of their health status, thus promoting the formation of health behaviors, achieving disease prevention, improving the efficiency of chronic disease self-management, and providing more timely and convenient health services, while its mobility characteristics also facilitate access to the user (Muralidharan et al., 2017; Schnall et al., 2018a). The mobile nature also facilitates access to relevant information, including the geographic location of the user. The interventions of mobile health technologies usually include short message service (SMS), pictures and videos, voice calls, and Internet-based applications (Aschbrenner et al., 2016; Kumar et al., 2013).

2 Current state of mHealth technology intervention research

At present, the intervention studies of mobile health technology mainly focus on maternal and infant health promotion (universal breastfeeding, health promotion during pregnancy and child immunization program, etc.), chronic disease (diabetes and asthma, etc.), management, and infectious disease (AIDS and tuberculosis, etc.) prevention and control, which are briefly described one by one (Gilmore et al., 2017; Khan et al., 2020; Overdijkink et al., 2018).

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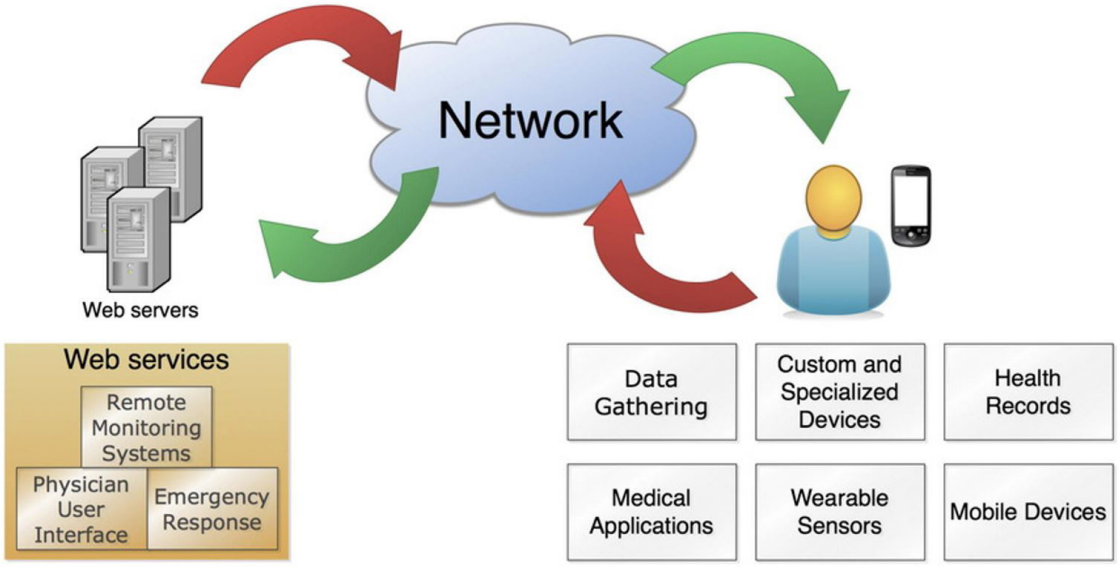

Figure 1. A typical m-Health service architecture.

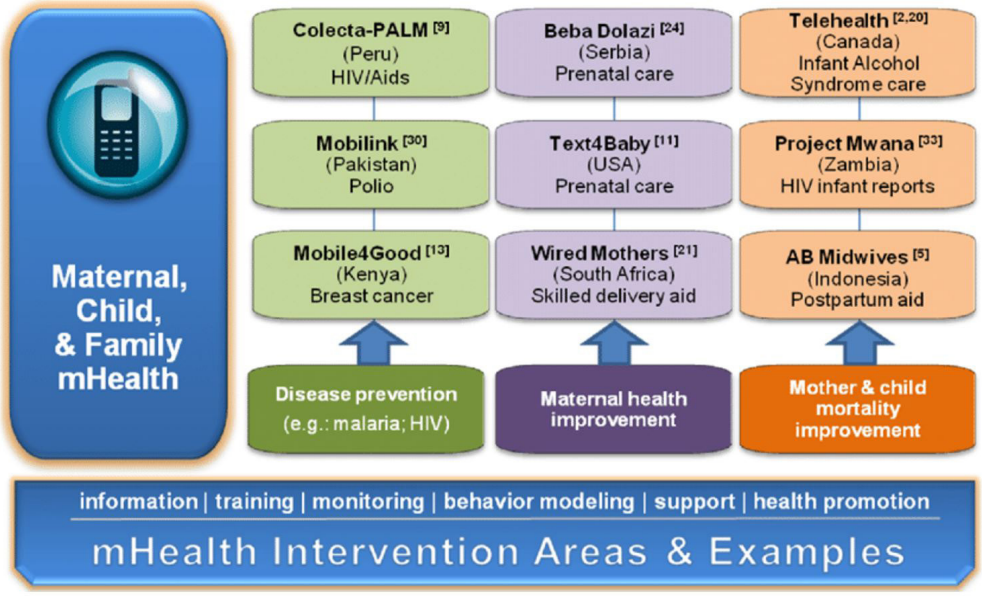

Figure 2. An overview of mHealth applications for maternal, child, and family health (MCFH).

2.1 Maternal and child health promotion

Breastfeeding

The Global Strategy for Infant and Young Child Feeding clearly states that infants should be exclusively breastfed for the first six months to achieve optimal growth, development, and health, and continue breastfeeding until two years of age or older (World Health Organization, 2003; Sobti et al., 2002). Health education for pregnant women is an important tool to improve breastfeeding, but traditional health education methods are time-consuming and expensive, and mobile health technology may offer new ways to promote breastfeeding promotion (Figure 2) (Dykes & Hall-Moran, 2009; Gupta et al., 2019).

An intervention study of 641 pregnant women in Shanghai, China, showed that pregnant women who received FMS/Frontline SMS pushing a maternal health message every four weeks and regular breastfeeding promotion had 2.27 times (95% CI: 1.44-3.59) higher exclusive breastfeeding rate at postnatal visits than those who received only conventional health messages (Gu et al., 2020; Zhang et al., 2015). Since the three breastfeeding rates were repeated measures, the breastfeeding rate was higher in the intervention group than in the control group at the 1st, 2nd, and 4th-month pediatric health checkups (OR = 2.08, 95% CI: 1.20 to 3.60) after controlling for time trends, whether or not they went to work after delivery, and imbalance factors in both groups.

Meta-analysis of three breastfeeding intervention studies in Nigeria showed that those who received prenatal health education on breastfeeding by SMS/phone had higher breastfeeding rates at one h (OR = 2.01, 95% CI: 1.27 to 2.75) and 3 to 4 months (OR = 1.88, 95% CI: 1.26 to 2.50) postnatally than the control group. The rates were higher than the control group (Alebel et al., 2017; Chowdhury et al., 2015; Lee et al., 2016).

Health education during pregnancy

The mother's health status during pregnancy is related to the growth, development, and health of the infant, so it is important to conduct health education during pregnancy to promote proper health awareness among pregnant women. A study on antenatal health education for pregnant women in Huaihua, Hunan Province, China, found that the cesarean delivery rate in the intervention group (35.6%) was lower than that in the control group (40.1%) from the first antenatal consultation to 42 d postpartum, when the intervention group used cell phone text messages to send health education content to pregnant women, with a statistically significant difference ($P < 0.001$) (Huang et al., 2018).

Another study found that the Millennium Villages Project (a project to promote development in rural areas to achieve the UN Millennium Development Goals), established in western Kenya, enrolled some pregnant and postpartum women in the area (Nakua et al., 2015). After six consecutive months of pushing information on pregnancy care and antenatal counseling to women enrolled in the Prenatal Care/Mother-to-Child HIV Interruption System, the women enrolled in the Millennium Village were more likely to attend antenatal counseling after standardizing their HIV status, considering that their HIV status may affect the number of antenatal counseling sessions. (95% CI: 1.10-6.01), and women enrolled in the system in Millennium Villages were 2.58 times more likely to attend antenatal counseling than unenrolled women (living in Millennium Villages) (95% CI: 1.10-6.01). outside the "millennium village") were 2.37 times more likely (95% CI: 0.99-5.67) (Mushamiri et al., 2015).

A study conducted in the United States showed that regular pushing of pregnancy health information to pregnant women was effective in helping women during pregnancy to "stay away from alcohol" and "adjust to motherhood. However, there is a lack of evidence to support the effectiveness of mHealth technology intervention studies in some regions (Song et al., 2012).

Research in Taiwan, China, pushed soothing music through an app to help pregnant women relieve tension during pregnancy and showed that the differences in birth month age (P=0.217), birth weight (P=0.782), and Apgar score (P=0.732) between the intervention and control groups of newborns were not statistically significant (Chang et al., 2008; Liu et al., 2010, 2016). A case-control study in Nigeria showed no statistically significant difference in maternal morbidity and the use of interventional mobile health technology or not (OR = 1.00, 95% CI: 0.58 to 1.74) (Olajubu et al., 2020; Omole et al., 2018). According to researches, women who utilize mobile apps or the Internet for health information have certain characteristics, which are included in Table 1.

Childhood immunization

Planned immunization plays an important role in preventing the prevalence of childhood infectious diseases and protecting children's health; however, the complex vaccination schedule and other reasons can cause some children to miss vaccinations, which will lay a hidden risk for child health and infectious disease prevention and control. To reduce the occurrence of missed immunizations in children, studies have been conducted abroad using mobile health technology to target child guardians for vaccination reminders (Ghedamu & Meier, 2019; Kao et al., 2021; Lyu et al., 2020).

Another study selected remote rural areas in Bangladesh and urban areas with a large concentration of street children as the study population, and investigated the full set of vaccination rates of children in these two areas in a baseline survey, and set up an intervention group and a control group in each of the two areas, with the intervention group area using smartphones to remind guardians of vaccinations and the control group not providing any reminders to guardians (Uddin et al., 2008; Uddin et al., 2009, 2016; Vasudevan et al., 2014). After one year of intervention, the results showed that the complete vaccination rate of children in the control group in remote rural areas decreased from 65.9% to 55.2% at baseline, while that of children in the intervention group increased from 58.9% to 76.8% at baseline, and the complete vaccination rate in the intervention group was better than that in the control group (OR = 3.80, 95% CI: 1.50 to 9.20). The complete vaccination rate of children in the control group decreased from 44.5% to 33.9% at baseline and increased from 40.7% to 57.1% at baseline in the intervention group, which was better than the control group (OR = 3.00, 95% CI: 1.60 to 6.40).

Research pooled the results of six randomized controlled trial studies in India and obtained similar findings that the vaccination rate in the intervention group was 45% higher than that in the control group (Estívariz et al., 2012; Owais et al., 2011). Nevertheless, another study showed that mHealth technology,

Table 1. Characteristics of women using mHealth.

Authors	Characteristics identified	Context of Study
Powell et al. (2011)	Higher Education Levels Age	Health-related Internet usage
Larsson (2009)	Higher Education levels	Pregnant women usage of the Internet
Kavlak et al. (2012)	Higher Education levels First pregnancy Work status	Pregnant women usage of the Internet
Evans et al. (2012)	Higher Education Levels	text4baby mobile health program
Diaz et al. (2002)	Higher Education levels Annual income of over $50.000	Health-related Internet usage
Bert et al. (2016)	Higher Education Level Living in urban/suburban areas Satisfying the average income	Smartphone apps for pregnant women

although effective in improving vaccination in Italy, is not widely used in practice, and there are fewer relevant studies. No studies based on mHealth technology for childhood immunization from our mainland are currently available in the literature.

2.2. Management of chronic diseases

Diabetes

Researches classified mHealth technologies for diabetes management into seven categories according to their uses (Alanzi, 2018; Choi et al., 2019, 2020; Kelly et al., 2020): (i) glycemic control and self-monitoring of blood glucose; (ii) medication guidance; (iii) clinical nutrition guidance; (iv) physical exercise; (v) weight loss; (vi) health education and (vii) blood pressure control.

The Meta-analysis results of another study based on 22 interventional trials showed that diabetic patients in the intervention group received health education using mobile health technologies (SMS service or Internet). At the same time, professional support was provided for their continuous monitoring of blood glucose. The monitoring results were fed back to their family doctors in real-time, who promptly adjusted the dosage of medication according to their blood glucose changes. In contrast, the control group used conventional monitoring In the control group, blood glucose was measured with the same equipment used for regular blood glucose monitoring, and the family doctor was followed up regularly and reported the recent blood glucose situation (Teeuw et al., 2010). After more than six months of follow-up, the glycosylated hemoglobin (HbA1c) of patients in the intervention group decreased by 0.5% (95% CI: 0.3-0.7%) on average compared with the control group. In addition, a study in the United States showed that if mHealth technology was supplemented with professional clinical guidance and timely feedback was obtained from patients after use, and patients would have a mean decrease in HbA1c of >0.5%. In recent years, diabetes health education has attracted great attention from WHO, the International Diabetes Federation, and domestic and foreign diabetes experts, who emphasize that diet education is a basic measure of diabetes treatment and should be used throughout the process of diabetes prevention and control (Borgundvaag et al., 2021; Bosch & Hunink, 1997; Darré et al., 2008).

The research introduced the balance of the three major nutrients, calorie balance and other nutritional knowledge to diabetic patients, and the intervention group used cell phone APP as the intervention means. The control group used conventional mission for health education. After one year of follow-up, it was found that diabetic patients who were educated through cell phone APP had better HbA1c, TG, TC, BMI, waist-hip ratio and other indexes than the conventional mission group ($P < 0.05$) (Reeds, 2009).

Asthma

Asthma patients generally control their symptoms through self-care, medication, and appropriate self-management techniques, but if asthma recurs for a long time, it will lead to complications such as slow-onset lung and bronchodilation, and airway damage is irreversible, which brings serious health damage and economic burden to patients. Mobile health technology can predict asthma occurrence, self-manage, and communicate with medical personnel by detecting real-time data on environmental markers, personal onset cycle, asthma symptoms, medication use, maximum expiratory flow rate, and blood oxygen saturation, which brings great convenience to asthma patients (Kosse et al., 2019; Simpson et al., 2017). The research used SMS to provide health education to asthma patients, and after 12 weeks of intervention, by comparing the Asthma Control Perception Scale, Asthma Control Questionnaire, Asthma Patient Quality of Life Questionnaire, and follow-up visits, it was shown that SMS intervention could significantly improve patients' asthma control perception ($P < 0.001$) and was superior to general outpatient education and PEF + education in terms of improving the rate of follow-up visits and quality of life manual education, two types of asthma education (Yun et al., 2012). However, the results of a 2013 review of asthma interventions using smartphones in the United States showed that the results of two randomized controlled trials did not demonstrate the effectiveness of interventions using such APPs for patients with asthma, and therefore need to be evaluated, optimized, and validated before promoting such APPs to clinicians and the public (Belisario et al., 2013).

3 Prevention and control of infectious diseases

3.1 AIDS

mHealth technology can effectively protect patient privacy by virtue of its virtual nature, remoteness, and accessibility and can be applied in less economically developed areas, providing a new approach to HIV prevention and control (Catalani et al., 2013). In Canada, research suggested that mHealth interventions for HIV include medication adherence interventions, follow-up reminders, disease support, pushing laboratory test results, and clinical diagnosis (Karanja et al., 2011). In the Millennium Villages project in Kenya, HIV-positive women in the antenatal care/maternal-infant HIV blockade system who received prenatal knowledge of HIV mother-to-child blockade and received drug interruptions had zero infant infections at 18 months postpartum, while HIV-positive women in the country who did not participate in the project had 9% infant HIV infections at 18 months postpartum. The infection rate of 9%, compared to a global level of 30% (Mushamiri et al., 2015).

In an intervention trial of adherence in HIV patients in the United States, researchers used a cell phone app to monitor medication adherence in HIV-positive patients, pushed health information to them regularly, informed them of the importance of taking their medication on time, and reminded them to take their medication on time, and eventually, the medication adherence in the intervention group was significantly better than that in the control group (OR = 1.49, 95% CI: 1.17 to 1.90) (Bazzi et al., 2019; Sax et al., 2012; Zhang et al., 2018).

In a study conducted in China to improve medication adherence in AIDS patients, the intervention group received six months of SMS health education and the control group received health education only at the AIDS clinic. The results showed

that the degree of medication adherence in the SMS group was higher than that in the control group, with a statistically significant difference (Z = 2.735, P = 0.006). Their medication time adherence was also better than that in the control group, with a statistically significant difference (Z = 3.913, P = 0.000) (Ruan et al., 2017).

3.2 Tuberculosis

The main treatment for tuberculosis is drugs, and the long duration of drug therapy, adverse effects and lack of knowledge about tuberculosis treatment, and economic poverty have resulted in the current low compliance of patients with medication and follow-up.

A study in the United States showed that treatment adherence of TB patients could be improved by sending cell phone text messages to patients or family members. A systematic review noted that multiple reminder systems (phone calls, text messages, reminder cards, etc.) positively improve TB patients' adherence to medication and visits (Sekandi et al., 2021).

In a study conducted in Pakistan on 30 patients with active TB, it was found that receiving daily text messages for medication reminders was effective in helping patients to take their medication on time, especially during holidays and weekends (Iribarren et al., 2014). In a study, patients with diagnosed pulmonary tuberculosis were selected for the study. The intervention group was followed up by telephone or SMS, while regular outpatient visits followed up the control group. After six months of follow-up, there were significant differences between the two groups in terms of knowledge about tuberculosis and treatment compliance, and differences in chest X-ray uptake, with both intervention groups outperforming the control group and The differences were statistically significant (P < 0.05) (Bediang et al., 2018).

4 Shortcomings of existing interventional mHealth technologies

4.1 Evaluation of effectiveness for mHealth technologies lags behind the pace of development of mHealth technologies

Randomized controlled trials are often considered the gold standard for testing the effectiveness of mHealth technologies. Still, research periods are usually long (reaching 5.5 years on average), and it takes a long time from the initial trial design to the final conclusion. Mobile communication technologies are currently evolving very rapidly. Even if a long randomized controlled trial proves that certain mobile health technology is effective, the technology may be outdated after a few years and lack replication value (Querido et al., 2020; Silva et al., 2019). Moreover, the cost of such trials is not low, the grouping of study subjects is difficult to be strictly randomized, and subject compliance is relatively low, all of which pose a severe test for clinical randomized controlled trials. For example, the effectiveness of SMS interventions was once widely tested and used as a common intervention. Still, in recent years, with the emergence of smartphones, various APPs have been widely used worldwide. The findings of previous studies on SMS interventions cannot be simply extrapolated to various APPs, so in the future, it is necessary to take into account the rapid development of mobile health technology and target interventional; therefore, future research is needed to establish a more rapid evaluation method considering the rapid development of mHealth technology and targeting the timeliness of interventional trials.

4.2 Lack of standards for evaluation and regulation of mHealth technology

mHealth, as an emerging medical model, faces many problems and challenges in the early stage of development. The regulation of mHealth intervention applications is still in the exploratory stage, and the lack of uniform standards has led to a high degree of arbitrariness in the content and varying quality of interventions. The practical application of mHealth technologies supported by randomized controlled trials for disease prevention and control is problematic because scientific evaluation criteria have not been established. For example, a study showed that risk factors for HIV infection (e.g., individual economic poverty) are often influential factors in the lack of access to mHealth services, and although randomized controlled trials have confirmed that mHealth technology can improve medication adherence among HIV patients, it is actually difficult for some poor patients to access mHealth services. Therefore, relevant evaluation criteria need to be developed to closely integrate trial results and practical applications.

In addition to the lack of unified effectiveness evaluation standards, there is also a lack of regulatory standards for mobile apps of health interventions that are currently used in large numbers. The security of personal privacy should not be neglected, especially personal health data, and relevant literature shows that only 30% of current APPs inform users whether their health data will be sent to third parties, so regulators need to develop relevant standards for the protection of patients' privacy.

5 Conclusion

The issue of food security and human health care has long been the focus of human attention. Food security, in addition to the availability of food, access to it, stability in the supply and receipt of food includes the benefit of healthy and quality food, in other words, attention to food safety. Food contamination by microbes, toxins, chemicals, and heavy metals occurs on the farm, during transportation, and during processing, preparation in restaurants. These contaminants cause disease and eventually death, damage to trade and business, food production and agriculture. Foodborne illness is one of the most common and severe public health problems in the world today, which has put a heavy burden on human life. These diseases are infectious or toxic in nature, usually caused by factors that enter the body through the intake of contaminated food.

Smartphones, in particular, provide a novel framework for nutritional evaluation, which has the promise to enhance efficiency and accuracy. Mobile devices are constantly being utilized to aid people in making food choices, self-monitoring dietary consumption in connection to disease management, tracking intake to inform evaluation, and supporting health professionals in providing nutrition intervention. Because of

their mobility, mobile devices like tablets and smartphones may be used to monitor food consumption and provide dietary feedback. Considering these benefits, one of the fastest-growing application genres in the field of mHealth in nutrition is weight loss and nutrition and calorie monitors. Due to lack of information on the content source and/or relevance to the user's native food supply, both of which are important to the accurate translation of dietary advice, this massive influx has questioned the credibility of mHealth nutrition applications advised to use them with caution.

With the rapid development of mobile communication technologies, convenient, efficient, and cost-effective mHealth technologies are changing the traditional healthcare paradigm at an unprecedented rate. Future research should improve the timeliness of randomized controlled trials and develop standards for evaluating and regulating mHealth technologies. Mobile health technology involves multiple disciplines at the same time and requires the participation and cooperation of multidisciplinary experts in the fields of health care, software, and information and communication in order to revolutionize global health care delivery in the future.

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