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## Importance of ICT tools for learning nutritional security for rural women: A review

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#### Abstract

A healthy and balanced diet is the foundation of driving a healthy way of life for both men and women. However, as adolescence starts, carrying with it changes to the body and hormones. Women have distinctive healthful necessities from men. Adequate nutrition is an important foundation of any person's well-being. It is especially basic for women on the grounds that nutritional deficiency adversely affects the health of women as well as on the strength of their children's. Children of malnourished women are bound to confront intellectual impedances, short height, lower resistance to infections, and a higher danger of illness and death for the duration of their lives. Malnutrition (nourishing inadequacy) characterized as weakness brought about by insufficiencies of calories, protein, nutrients, and minerals cooperating with diseases and other chronic frailty and social conditions, saps the strength and prosperity of millions of women's and adolescent girls around the world. For good health women need to give special consideration to calcium, iron and foliate (folic corrosive) intake. The quality of care and feeding offered to childrens critically dependent on women's education, social status, and workload. ICTs can play an important role to educate the rural women to nutritional security. ICTs have become a strongly in strengthening individuals' healthy lifestyle, taking into account nutrition intake and physical activity levels.

**Keywords:** ICT, nutrition, rural women, Tele-nutrition, artificial intelligence, machine learning

#### Introduction

The role of women is very important in the development of any country. The status of women is the best indicator of the progress of any nation. The status and development of women influence the development of the country, as they not only constitute half of its population, but also affect the growth of the remaining half of its population. Women in rural areas are deprived of minimum facilities of knowledge and education. The overwhelming majority of the labor that sustains life – growing food, cooking, raising children, caring for the elderly, running the household, carrying water – is done by women, and, universally, this work is defined as: Status is given and no salary is given and while doing all this, women do not pay attention to their health and nutrition and the condition of malnutrition arises. ICTs can play an important role to educate the rural women to nutritional security. ICTs have become a strongly in strengthening individuals' healthy lifestyle, taking into account nutrition intake and physical activity levels.

Information and Communication Technology (ICT) is a system that includes any communication device encompassing radio, television, cellular phones, computers and network, hardware and software, satellite system etc. as well as the various services associated with them, which include video conferring and distance learning (Echezona 2008). According to Olurankinse (2007) ICT means of learning through electrical and electronic hardware as well as electronic computing software.

The purpose of this paper is to explore the role of ICT in enhancing agricultural nutrition awareness and empowering Indian rural women through a review of ICT initiatives in India. The conclusion of this paper is that most ICT initiatives are disseminating useful new information and knowledge to rural women, but they are still not able to access it due to lack of access to many complementary sources of support and services. ICT in the field of nutrition includes various traditional strategies such as interactive video sessions using computers and mobiles, apps, nutrition software and programs, text messages and online chats, and PPT etc. which became a source of knowledge, mentoring, learning and learning. ICT provides a more personalized approach than traditional methods as these web sources have more means to access past records and the ability to monitor current status such as by taking pictures of food consumed or in mobile notes.

Making notes of food consumed Carrying a physical and mental burden relief notebook (Mello, 2017).

### Review of ICT applications

The different ICT based applications in the field of nutrition security are presented below-

#### Artificial intelligence, machine learning and nutrition

Artificial intelligence (AI) is a branch of computer science that aims to enable computers to perform exemplary thought processes, learning abilities and knowledge management and to find more and more applications in experimental and clinical medicine. Machine learning is a branch of the AI that deals with algorithms that automatically improve through experience. Machine learning algorithms give the computer the ability to learn without being explicitly programmed. There are many important applications of Artificial intelligence in both biomedical science and clinical medicine. According to Deo, R.C. *et al*, 2015 machine learning – both supervised and unsupervised – can be applied to clinical datasets to develop risk models <sup>[1]</sup>. This can significantly support the analysis of patient data <sup>[2]</sup>. Handelman, G.S., *et al*, 2018 suggest that that Machine learning is the future of computer-assisted diagnostics, biomedical research, and personalized medicine <sup>[3]</sup>. Woldaregay, A.Z. *et al* conclude that in blood glucose prediction and in the development of the so-called artificial pancreas (a closed-loop system), machine learning techniques are becoming increasingly popular in diabetes research <sup>[4]</sup>. In research on gut microbiota, machine learning algorithms and artificial intelligence based approaches have been used, especially because of the large datasets collected in these studies. <sup>[5]</sup> Liu *et al*. proved that an ML algorithm integrating baseline microbial signatures of the intestinal microbiota can accurately predict the patient's glycemic response to physical effort <sup>[6]</sup>.

#### Mobiles and Nutrition

Today mobile is the strongest and fastest medium of providing information for agricultural nutrition awareness in rural areas. However, the use of mobiles for nutritional awareness in rural areas in India still needs attention. Mobile phones are a promising tool to improve the livelihoods & nutrition of small farmers in developing countries (Aker & Ksoll, 2016; Nakasone *et al.*, 2014; Aker & Mbiti, 2010).

Hebden *et al*, describe the process of developing four smartphone applications to raise young adults "motivation in the improvement of their nutrition and physical activity behaviors" <sup>[7]</sup>. The purpose of the applications was to enhance subjects self-reflection on their physical activity and consumption of takeout foods [fast food], fruit, vegetables and sugar-sweetened drinks.

Kerr *et al.*, reported that a 6-month nutrition intervention project aiming at young adults "improvement of eating behaviors, makes use of a mobile application called "CHAT" that keeps a record of the food images consumed as well as invites the intervention group to perform dietary changes through tailored feedback on their food intake via a text message <sup>[8]</sup>. The use of mobile applications and different technologies has provided opportunities for the real-time collection of valuable nutrition-related data. Machine learning has allowed for more complex analysis of increasing amounts of collected data. The combination of these tools has also translated into practical clinical applications, such as decision support tools, risk prediction and dietary optimization. Mobile

health applications represent an opportunity for remote monitoring of patient engagement, data gathering and outcomes outside the health care facility. As of now, an estimated 165,000 mobile health apps exist in the public domain with health management and disease management in leading areas <sup>[9]</sup>. In 2020, the mobile health market was valued at \$40 billion and is expected to grow by 17.7% from 2021 to 2028 <sup>[10]</sup>. Despite widespread use among individuals, apps remain an ongoing area of investigation for its use in health care management. Apps for diabetes, for example, can provide users with a better understanding of how their blood sugar management relates to their diet and behavior. While many applications exist, a 2018 technical brief by the Agency for Healthcare Research and Quality evaluated mobile apps currently available for diabetes self-management and found that out of hundreds of apps for diabetes, studies showed that Only 5 were associated with clinically meaningful improvement. In biomarkers such as hemoglobin A1c (HgbA1c) <sup>[11]</sup>.

#### Software and Nutrition

Many software applications are being developed nowadays to solve health related problems. The health sector can benefit from using Artificial Intelligence (AI) to solve health problems and make the right decisions. The use of computer systems, especially in nutrition, has helped modern man to find a balanced diet and prevent obesity from becoming the most prominent disease of our society (Bosco *et al*, 2009). There are many software applications and specialist expert systems available on the market today that propose diet and menu planning with nutritional assessment, such as CAMP, Prism, camper, Diet Pale VIE-PNN (Bosko, 2009). Samsung S4 smart phone recently released the expert system called S-Health as one of the applications that can daily monitor calories intake, weight and workouts, and calculate the basal metabolic rate (BMR), recommending a daily amount of calories intake for the diet. This application can also fetch calories information from a database of common food items (Samsung, 2013). Agri-Nutrition expert system offers a holistic approach in nutrition diagnosis and management, as it comprises both identification of the problem and the means to deal with it in a standardized, profound and efficient way <sup>[12]</sup>.

Lewis *et al*. argue that information technology can influence food choices by increasing consumer's personal interest in taking care of their own health status <sup>[13]</sup>. In particular, a hand-held device or phone can record daily nutrient information during food intake, and in addition, a more personalized profile of the nutritional needs of consumers may be possible. In addition, devices such as "body buggies" that measure total energy expenditure throughout the day and send it to an online database can provide consumers with the feedback they need to achieve body weight goals.

Koch *et al*. Bringing to light an expanding, cross-disciplinary research topic related to the care of older people, such as their nutrition, physical activity, and drug delivery, with the aid of information technology, sensor technology and information systems <sup>[14]</sup>, because the health problems of the elderly differ according to their age as well as their gender.

Lopez *et al.*, motion sensors inside a mobile phone convert accelerometer counts into energy expenditure by taking into account heart rate, body and environment temperature under free-living conditions <sup>[15]</sup>.

Bickmore *et al*. launch ontology of health behavior change, deployed for diet promotion <sup>[16]</sup>.

### Tele-nutrition education

When a registered dietitian provides medical nutrition therapy to patients via online video-communication services such as Zoom, Google Meets, Skype is known as Telenutrition. Telenutrition is the branch under Telehealth being implemented in healthcare. Telenutrition involves interactive use, by a registered dietitian may provide multiple different nutrition-related services through the use of telenutrition. According to Fuhrman *et al* 2009 "Services provided by registered dietitians include nutritional screening, nutritional assessment, nutritional diagnosis, patient education and counseling, monitoring and follow-up etc."

The application of telehealth principles by registered dietitians or doctors to deliver medical nutrition therapy is termed telenutrition (Chung & Chung, 2010) [17].

Keating *et al.* published their work assessing the agreement and reliability between clinician-measured and patient self-measured clinical and functional assessments for use in remote monitoring, in a home-based setting, using telehealth. They noted that patient self-assessed clinical and functional outcome measures for metabolic health and fitness had good agreement and reliability on average with face-to-face clinician-assessed outcome measures, but that aside from body weight, no clinical or functional outcome was deemed acceptable when compared with minimal clinically important difference [18].

Hercberg *et al.* investigate the relationship between nutrition and health outcomes in a 10-year follow-up, web-based study called "The Nutrinet-Sante Study", located in France. At the starting point of the study, volunteers record 3 × 24h dietary intake, socio-demographic and lifestyle questionnaires, health, anthropometric questionnaires and physical activity questionnaires. Every year, the participants must once again fill in the abovementioned questionnaires as well as the 3 × 24h dietary records. Moreover, every month they will receive informative e-mails, reminding them of the necessity to update their personal profiles on their food behavior, nutritional and health by filling out a new questionnaire via the website [19]. Neuenschwander *et al.* conducted a comparative study between a web-based and an in-person nutrition education program for low-income adults. In this study the technical part of the interventions, such as their content and duration was similar. Traditional in-person nutrition education and web-based nutrition education both showed significant nutrition-related behavior outcomes. Moreover, the nutrition-related design decreased cost of accessibility and easy implementation [20].

Vandelanotte *et al.* (2013) conducted a pilot-study aimed to examine middle-aged, Australian men's opinions and perceptions regarding the use of internet in the improvement of their physical activity and nutrition behaviors. It is noteworthy that the aforementioned target group show low interest levels to engagement in health intervention programs. Indeed, middle-aged men support the use of websites as a means to self-monitor their physical activity and nutrition behaviors on the condition that conferred interventions are accessible, understandable, appealing, reliable and concise [21].

Gibney *et al.* argue that the use of web-based, personalized nutrition applications for the collection of food data in an intervention study should be, first of all, plausible and user-friendly, even though appropriate and exact data entry from the participants is less possible. Furthermore, personalized feedback towards the participants should be easy-to-use,

based on simple visual tools, instead of any numeric data. Food choice advice should be focused on meal intake and ranges of nutrient intake, presented on the computer screen by making a classification, depending on the participant's average nutritional needs [22].

Hong *et al.* created a kid-friendly, web-based nutrition education searching system that includes both video scripts of the cooking process of healthy recipes and easy-to-learn nutritional information with lots of search methods. Children can search for a menu of their choice using keyword expressions such as food material, age group, menu type, menu style and nutrient or upper and lower limits of calories and nutrients they choose [23].

Hong *et al.* created a web expert system for nutrition management and counseling, which takes into consideration gender, age and diseases so as to compose general and therapeutic meals. The system compares e-databases, originating from user's information and experts' recommendations in the sense that the latest assess on-line the nutrients and calories included in a meal, chosen by the user of the system [24].

Vereecken *et al.* made a comparative study on the feasibility of young children's nutrition assessment, based on their dietary habits and their parents' sociodemographic variables, by implementing either an online assessment tool or a paper and pencil questionnaire. No significant differences were found in relation to nutrient and food group recordings, except water. Parents who preferred to fill out pencil food diaries were younger and had lower education levels. From parents who completed the online questionnaire, the majority indicated that it was user-friendly, engaging and clear [25].

### Web based –nutrition education

The World Wide Web (WWW) offers some very good opportunities for nutrition educators, in all phases of the process of development, implementation and evaluation of nutrition education interventions. Furthermore, there is evidence that many people already use the WWW to find information on health and disease. A healthy life is partly dependent on dietary behaviors. Nutrition education is the one way to promote health-promoting dietary habits in the last decades. Several potentially important new channels for health communication have emerged, such as interactive computer programs (Martin Gould & Anderson, 2000) [26]. Health communication has changed in several ways using WWW. The professionals can prepare and develop nutrition education materials in a fast and inexpensive way with the help of WWW. Web-based intervention on nutritional counseling for medical, nursing, and health professions students significantly improved their nutritional counseling knowledge and confidence after the intervention, which can simulate more nutritional counseling conversations with patients (Jeffrey Xia BS *et al.*, 2020) [27]. WWW can be used to make nutrition education information and nutrition education materials more available and accessible and is a preferred source of health information for many consumers (Patrick *et al.*, 1999; Williams *et al.*, 2002). Van Dillen *et al.*, 2003) [28]. The Internet and WWW can also be used to personalize, optimize nutrition education messages through automated tailoring systems as well as through long-distance individual nutrition counseling (Brug *et al.*, 2003) [29]. Computer-based nutrition education has been identified as one of the more promising nutrition education techniques (Brug *et al.*, 2003).

### Distance learning and applications

Distance education is an effective way of providing high-quality, standardized knowledge as well as disease preventive techniques in the field of nutrition. At a time when physical classes are not possible, distance learning is really the need of the hour. It is considered an effective way to provide quality and standardized knowledge like never before, while removing any risk of disease. ICT has proven to be a good tool in recent years for the medical field, especially for food composition data as well as food composition data users to help dietitians, nutritionists, food scientists and medical doctors share knowledge and information and to help broadcast.

Abusabha *et al* (1999) reported that a mixed model approach to distance learning, which combined satellite teleconferencing with local hands-on activity sessions demonstrated a marked increase in how community nutrition professionals believed they should be trained is required<sup>[30]</sup>.

Litchfield *et al* (2000) used a model of learner-centred distance learning. They showed potential in dietetics education to improve competency, technical competency, professional participation skills and lifelong learning skills<sup>[31]</sup>.

Busstra *et al.* attempted to create an efficient educational tool for producers and compilers of food composition data as well as for food composition data users, such as nutritionists, food scientists, dietitians, medical doctors and epidemiologists. This interactive e-learning module focuses on its proactive character and self-driven knowledge acquisition base to stabilize learners' competency in high quality food composition data production and use. In addition, learning process is structured in a way that macronutrient analysis training would become suitable for non-chemists, thus making the course more adaptable to learners' heterogeneous needs. The postgraduate students participating in the course thought very highly of the aforementioned, digital learning material on account of both its educational and instructional principles<sup>[32]</sup>.

Charrondieria *et al.* describe a distance-learning application called "The Food Composition Study Guide", which focuses on self-based learning and evaluation techniques in the areas of food composition, management and use. Every distance learning program, such as a study guide, is remotely accessible using electronic communication. Its design and delivery make it a well-lauded remedial tool to validate and broaden students' knowledge in a standardized and cost-effective manner, improving the availability, comparability and quality of food composition data<sup>[33]</sup>.

Stan *et al.* conducted a research in the area of a postgraduate, distance course in South Africa, studying the nutritional needs of people suffering from the Acquired Immune Deficiency Syndrome (AIDS) as part of the socio-economic impact of HIV. AIDS epidemics had never been investigated or described before. Postgraduate students' views on both the design and implementation of the e-learning program were rather positive, while it was believed that their individual disabilities or barriers to computer literacy and Internet access would lead to an undesirable failure to meet learning goals. In addition, students' positive learning experiences increase as long as their individual needs and abilities are taken into account, including any constraints on necessary resources such as accessible technology, budget and available time<sup>[34]</sup>.

Martínez *et al.*, created a transdisciplinary, collaborative, postgraduate project, powered by wiki spaces, concerning the

Mediterranean Diet and its social, economic, cultural and health related facets. According to students' evaluation of the project, the holistic and collaborative learning approach about the Mediterranean Diet was followed by the acquisition of additional competences and skills, such as the effective use of information and communication technology<sup>[35]</sup>.

Trovato *et al.*, suggest that professional post-graduate training in experts' enhanced skills and knowledge for convincing patient's to adapt to the Mediterranean Diet lifestyle, through e-learning, is a fundamental tool for the fulfilment of "Predictive, Preventive and Personalized Medicine". Predictive Medicine is based upon the clinical excellence of younger doctors in relation to their subject's nutrition and physical activity assessment. Preventive Medicine counters with the establishment of nutrition friendly schools, striving for children's balanced diet. Finally, Personalized Medicine binds the subject's tailored and timely diagnosis with nutrition and lifestyle changes. Overall, dietitians and medical doctors must share skills and competences in order to boost their patient's motivation and self-efficacy, making clear of the fact that behavioral psychology must have a vital role in Medical Education<sup>[36]</sup>.

### Radio and Television

Radio and television programs reach large audiences in no time. Jokes, stories, dramas etc., which are related to the nutritional problem, spread through these mediums help in creating nutrition awareness on a large scale. Al-Hasan *et al.* (2011) found that radio has contributed to improving awareness and knowledge of solutions to community development problems ranging from culture, rural development, education, sanitation and hygiene, agriculture, local governance, etc.<sup>[37]</sup>.

Since the introduction of television in the late 1950s, it has been an important source of food advertisements, and television is seen as an important source of health and nutrition information. Keeping this in mind, in 2012, the Ministry of Women and Child Development, Government of India, in collaboration with UNICEF, launched the 'KuposhanBhago' (Malnutrition, Quit India) campaign to remove discrimination against the girl child in providing food to households. . Pregnant mothers and children ( $\leq 2$  years), importance of breastfeeding, infant feeding and balanced nutrition<sup>[38]</sup>. The campaign ran for over 34 weeks on TV and radio channels. Exposure to television food marketing is an important factor among others influencing people's diets, eating preferences and health outcomes<sup>[38, 39]</sup>. The role of celebrities in promoting healthy eating habits and physical activity of adolescents was studied<sup>[40]</sup>. The study reported that commercial food and beverage products endorsed by celebrities were consumed by the majority of adolescents. Even brief exposure to advertisements can influence food preferences and advertisements embedded in popular cartoons have been shown to influence children's food preferences<sup>[41, 42, 43]</sup>.

### New media/information communication technologies (ICTs)

An advanced communication strategy using information communication technologies (ICT) can act as a transformative agent of social and behavior modification by integrating technology with education. The role of ICT-mediated education programs was examined, which focus on first-order changes such as changes in knowledge, attitudes and

practices. While studies elsewhere demonstrated that computer-based nutritional teaching methods in school settings could be useful in providing additional and modern support to traditional teaching methods<sup>[44, 45]</sup>. A study by NIN showed that CD-ROM-based learning did not add anything other than what adolescents learned about nutrition in the classroom through the traditional teaching method<sup>[46]</sup>. With the changing scenario, ICT is being seen as a potential tool not only to link education with nutrition knowledge through personal entertainment but also as a potential tool for behavior improvement. According to Hedao R *et al.* (2017), more evidence is needed for the development of a relevant health and nutrition content and the formulation of an effective intervention tool, or to establish whether ICT could be used as a standalone tool for nutrition education<sup>[47]</sup>. New media-based approaches are being looked at as key components under POSHAN Abhiyaan, introducing ICT-based real-time monitoring systems for Anganwadis and encouraging Anganwadi workers to use these tools. Similarly, a wide resource of online education tools such as flip charts, flashcards, pamphlets, posters, booklets, manuals, charts and leaflets supplementary media materials are also being made available for various stakeholders<sup>[48]</sup>.

Smartphone based mobile applications (apps) are also tools available to provide interactive nutrition education, calorie counting and activity tracking for users. One such app developed by NIN in 2018 is “Nutrify India” now which acts as a nutritional guide. The app helps users assess their nutrient intake from food and keep track of energy balance. The app has expanded usability to most of the Indian states as all the food names are provided in 17 Indian languages. One study analyzed the quality of some popular apps and assessed their effectiveness in modifying lifestyle among users. Although considered beneficial by users, the apps only intentionally increased physical activity modestly, but their sub-quality and inconsistent use resulted in limited/no change in their anthropometric and dietary patterns of study participants<sup>[49]</sup>. The study concluded that mobile apps may not be useful as standalone tools to promote lifestyle and nutrition in the context of their study.

### Conclusion

ICT has been a major support for people during contagion spread specially for health and nutrition. They have proved to be quite flexible, cost-effective and serve multiple purposes, to cater large number of population. Nutritional interventions should be accurate and trustworthy as a lot of people rely on this information and it relates to their health and acknowledgment (Drigas & Karyotaki, 2013)<sup>[50]</sup>. Most of the ICTs are disseminating new information and knowledge on agriculture, health and nutrition among rural women. However, due to the continuing digital divide between urban and rural areas and also between men and women, many rural women are yet to fully benefit from the potential of ICTs. Dietary intake and physical activity in everyday life are both constituents of a healthy lifestyle. Moreover, flexible, multiple purpose and cost-effective nutrition applications offer the opportunity of serving the needs of a large number of the population at a low cost, thus enhancing preventive medicine and reducing the inherent difficulties of the deprived part of the society. Finally, such applications should be accurate and trustworthy in order to gain interested party's acknowledgement and acceptance, ranging from healthcare professionals to individuals, concerned about their health

status. While new information and knowledge is necessary, it is not sufficient to bring about women empowerment. To make use of the information, women would need access to other sources of support and services. Women who are part of other development initiatives or groups and those who have access to other sources of service and support were able to better use the information and knowledge disseminated through ICTs. The potential of ICT tools varied widely in reaching rural women. There is no ideal ICT tool that fits all situations. Need to develop a basket of ICTs effective tools to empower rural farm women's through nutritional awareness under various agriculture nutritional projects.

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