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ORIGINAL RESEARCH

Multimedia computer-assisted instruction for carers on exercise for older people: development and testing

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Abstract

Aim. This paper is a report of a study conducted to develop a multimedia computer-assisted instruction for informal carers and test its content validity, user difficulty and user satisfaction.

Background. Healthy ageing is an increasingly important public health target globally. Changes in technology offer the opportunity for e-health promotion as a means of educating populations and healthcare staff to meet public health targets.

Methods. Computer-assisted instruction was developed and tested systematically in four phases during 2008, and these are outlined. Phase 1 consisted of topic and content identification using a literature review. Phase 2 comprised refinement of the content using an academic panel of experts. Phase 3 was the production of computer-assisted instruction comprising problem clarification, algorithm designing with reference to a cognitive theory of multimedia learning and program coding. Phase 4 consisted of testing for content validity, and writing a computer-assisted instruction manual and testing it for user difficulty and satisfaction.

Results. The data from each phase informed the development and refinement of the computer-assisted instruction. Content validity was confirmed and 'test' users reported few difficulties in its use and high satisfaction.

Conclusion. This e-health promotion initiative is an example of how computer-assisted instruction may be developed to teach carers of older people.

Keywords: carers, computer-assisted instruction, e-health, health promotion, intervention development, older people, physical activity

Introduction

The proportion of older people in the population is growing worldwide. In 2000, there were 600 million people aged 60 years and over, and there will be 1·2 billion by 2025 and 2 billion by 2050 (WHO 2004). At present, over 60% of all older people are living in the developing world, and by 2025 75% of all older people will be in developing countries.

However, in the developed world, the very old (over 80 years of age) are the fastest growing population group (WHO 2009a). The latest data for those aged 60 years and over compared with other age groups in the United Kingdom, the United States of America (USA) and Thailand are 22%, 17% and 12%, respectively (WHO 2009b), demonstrating the importance of this age group. This growing ageing population is posing major health challenges throughout the world.

Healthy old age is desirable because it permits older people to remain independent and play a part in family and community life. Healthy ageing can enhance quality of life and postpone avoidable ill health and the onset of chronic diseases, such as cardiovascular diseases, diabetes mellitus and cancer (WHO 2004). Healthy ageing is a worldwide public health target (Department of Health 2001, 2009, WHO 2004, Department of Health and Human Services 2009), and increasing amounts of health promotion are devoted to achieving it.

However, approaches to health promotion are changing to reflect developments in technology. Thus, face-to-face health education is being replaced by e-education (electronic education) using computers and CD-ROMs or the Internet. Minimizing travel time, cost and inconvenience are benefits of e-health education (Drury 2005, Bashshur 2007), and studies have demonstrated both the effectiveness of and satisfaction with this new approach amongst older people and their carers (Kressig & Echt 2002, Moody *et al.* 2005, Marziali 2009, Ponpaipan *et al.* 2010). Thus, the evidence holds promise for e-health promotion.

Computer programs have been developed in the USA to assist older people to promote their own health (Kressig & Echt 2002, Moody *et al.* 2005) and Canada (Marziali 2009). These programs promote exercise and chronic disease self-care and its management, but none have been designed to educate carers of older people. In Thailand, health volunteers are either informal carers or unqualified staff who provide health support to people in a village or community; the term carer will be used in this paper to describe these people. Increasingly health and social care systems are using informal carers to augment the work of professional carers; however, their specific learning needs require attention if an e-learning tool is to be effective.

In this paper, we describe the development of an e-learning tool by nurses for carers of older people to promote physical activity, reflecting the important role of nurses as facilitators of personal self-care capabilities (Orem 1995).To this end, the principles of adult learning (Lieb 1991) were used in developing the content together with the five steps of computer program development (Sawyer *et al.* 1999) to yield a structurally sound multimedia computer-assisted instruction (CAI) to meet the needs of this sample. In addition, the five principles of the Cognitive Theory of Multimedia Learning (Mayer & Moreno 1998, Moreno & Mayer 1999, Mayer 2001) were used to underpin the design of the CAI to stimulate the process of learning of the informal carers. Particular attention was paid to content validity, user difficulty and user satisfaction to evaluate the usability of the developed multimedia CAI and ensure its high fidelity, that is, high quality production of visual and audio material and computer programming.

The study

Aim

The aim of the study was to develop a multimedia computer-assisted instruction for informal carers and test its content validity, user difficulty and user satisfaction.

Design

The study had four distinct phases:
Phase 1: Topic and content identification;
Phase 2: Initial refinement of the content;
Phase 3: Production of the CAI;
Phase 4: CAI testing for content validity, CAI-related manual writing and testing for user difficulty and user satisfaction (Table 1).

Phase 1: Topic and content identification

Health-promoting behaviours leading to healthy ageing amongst older people incorporate smoking cessation, ensuring good nutrition and increasing habitual physical activity (Kennie *et al.* 2003). Smoking cessation and consuming healthy foods have been the subject of national health campaigns in Thailand. Recently, the Thai government has launched a national strategy to achieve the target of 'Healthy Thailand' by 2017. One of the goals is that Thai people aged 6 years and over will exercise regularly wherever they live (Chiasakul 2004, Krittiyaphichartkul 2005). Thus, the promotion of physical exercise is a key health promotion activity.

Literature was sought from a variety of sources, including electronic databases (e.g. the Cochrane Library, the Joanna Briggs Institute, CINAHL, MEDLINE, ERIC ProQuest Dissertations and Theses of publications since 1999), books held in university libraries across Thailand and e-literature from trusted websites (e.g. the American College of Sports Medicine, the British Heart Foundation, and the Heart Association of Thailand), to identify content for inclusion in

Table 1 Overview of method for the development of a multimedia computer-assisted instruction (CAI)

Phase 1 Topic and content identification	Phase 2 Initial refinement of the content	Phase 3 Production of the CAI	Phase 4 CAI testing and CAI-related manual writing
Literature review: Journals and journal articles Dissertations and theses Books e-literature from trusted websites	Panel of 'doctoral dissertation committee' (n = 4) ↓ Face validity	First three steps of CAI production (Sawyer *et al.* 1999): 1. Problem clarification ↓ 2. Algorithm design with reference to five principles of the cognitive theory of multimedia learning (Mayer & Moreno 1998): Multiple representation principle Contiguity principle Split-attention principle Individual difference principle Coherence principle ↓ 3. Program coding	Last two steps of CAI production (Sawyer *et al.* 1999): 4. CAI testing 4.1 Alpha testing by the computer programmer ↓ Panel of 'geriatrics, gerontology and exercise experts' (n = 5) and 'CAI experts' (n = 3) ↓ Content validity (each topic rated for relevance on 4 point Likert Scale) ↓ 4.2 Beta testing by health volunteers (n = 3) ↓ 5. CAI-related manual writing ↓ User difficulty and satisfaction by carers (n = 31)

a first draft of the CAI. The content fell into two parts with supporting topic categories. Part I focused on exercise for older people in general and included reasons to exercise for older people; holistic ageing changes: physical, psychological, social and spiritual changes; benefits of exercise for older people; appropriate exercises for older people; beginners' guide to exercise; preparation for exercise; recovery after exercise; warning signs and symptoms to cease exercise; and treatments for minor exercise injuries. Part II focused on exercise for older people with common chronic diseases and included exercise for older people with heart disease, osteoporosis, osteoarthritis, diabetes mellitus, hypertension and renal disease.

Phase 2: Initial refinement of the content

The first draft of the CAI was reviewed for face validity by a university's doctoral dissertation committee comprising four professionals with expertize in health promotion with older people. The committee recommended changes and these were incorporated into another draft. The content was continuously refined for its appropriateness and ease of understanding of language until it was considered to be of a high standard; there were at least 18 drafts incorporating feedback from the committee in this iterative process.

The appropriateness of the content for informal carers was considered in the light of the published competencies (Primary Health Care Committee Office 1997) of health volunteers in Thailand. This resulted in the removal of 'holistic ageing changes' from Part I and all the content of Part II of the CAI, reflecting the limited knowledge base of the carers and concerns that they should not promote exercise amongst older people with established disease without medical supervision. However, two topic categories were added to provide information about making choices in relation to exercise and minor illness, which is especially important in Thailand because many older people take over-the-counter medications to treat colds and coughs. These medications contain chlorpheniramine (antihistamine), which has the side-effect of drowsiness.

The 10 modules of the CAI were sequentially arranged, with reasons to exercise coming first to highlight why older people should exercise. The benefits of exercise followed to motivate carers to learn how to promote exercise amongst older people. This reflected the principles of adult learning (Lieb 1991), namely that people focus on lessons useful to them. Thus, if carers know the reasons and benefits of exercise amongst older people, they will be interested in the content provided. Additionally, the learning content was ordered from easy to more difficult material and care was taken regarding the time-sequencing in exercise. These strategies were designed to maximize understanding and to illustrate how to exercise appropriately step by step.

The final draft of the CAI comprised a learning package of 10 topics or modules of learning focusing on: reasons to

exercise for older people; benefits of exercise for older people; types of exercise and benefits of each type; beginners' guide to exercise; preparation before exercise; appropriate exercises for older people; recovery after exercise; warning signs and symptoms to cease exercise; treatments for minor exercise injuries; and exercise and minor illnesses.

Phase 3: Production of the CAI

Steps in producing the program

The production comprised five steps: (1) clarify the problem – includes needed input, processing and output requirements; (2) design a solution – use modelling tools to chart the program (a flow chart of instructions called an algorithm) and modules or parts of the program; (3) code the program – use a programming language's syntax or rules to write the program; (4) test the program – remove any logic errors or 'bugs' in the program ('debug'); and (5) document and maintain the program – includes written instructions for users, explanation of the program and operating instructions (Sawyer *et al.* 1999). Phase 3 comprised the first three steps, while the remaining two are described in Phase 4.

Clarification of the problem. After considering associated factors such as the characteristics of end users and the budget, the most appropriate type of program for self-learning amongst carers was determined to be a multimedia Computer-Assisted Instruction (CAI). Input requirements were a keyboard and pointing device such as a mouse or touchpad. Processing requirements were the system software 'Windows 95/98/ME/NT/XP32/Vista32' (Microsoft Corporation, Redmond, WA, USA), the application software 'Adobe Flash Player Version 7 (Adobe Systems Incorporated, San Jose, CA, USA) or greater', RAM 256 MB and a CD-ROM drive. Output requirements were a monitor with a 1024 × 768 pixels screen resolution, sound card, speaker and/or printer if end users wanted to print the content in PDF format. These were the lowest level of computer specifications to display the developed program effectively.

Design of solution. An algorithm (Figure 1) was designed by the researcher and the computer programmer, using standard symbols for flow charts through a top-down approach and modularization (organizing content into modules). The storyboard, including messages, pictures and sound, was written for each module in the algorithm.

Structural design of the CAI. The structure of this multimedia CAI was designed in sequence using the algorithm shown in Figure 1. Thus, the user only needed to click to progress from the cover page to the objective page. At the content page, the user could select the module that they wished to learn by clicking on the buttons located on the left showing the titles of related content. This design reflects the fact that people learn best when they have the freedom to learn in their own way (Peterson 2009). The remaining pages, Media Page and About-Us Page, were displayed by clicking on their buttons. The design was for novice computer users, thereby maximizing potential utility. Some modules (2, 3, 6 & 9) comprised several pages due to the length of their content. The user could select pages by clicking on the appropriate buttons.

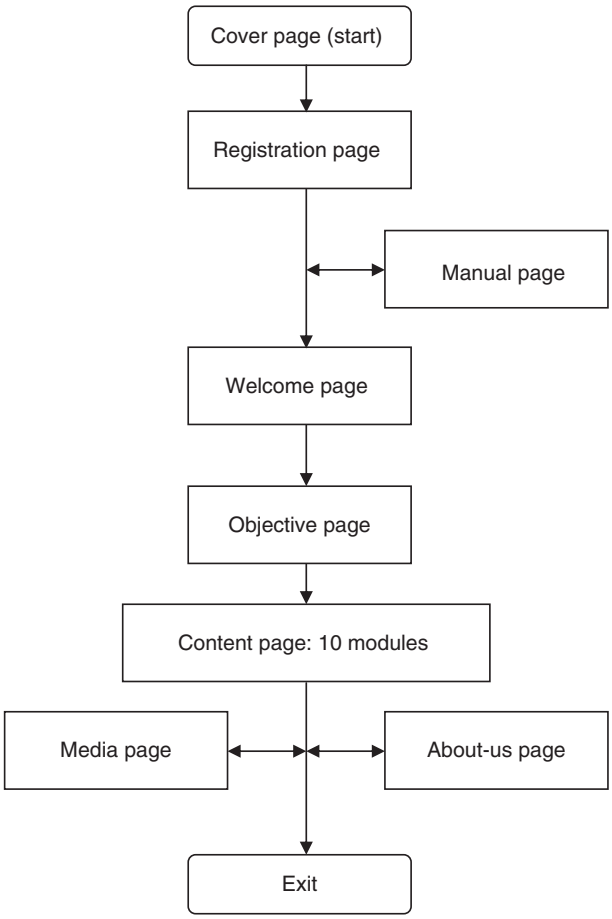

Figure 1 The algorithm of the multimedia computer-assisted program.

Selection of media. The CAI comprised a combination of text, picture, animation and voice. A digital camera was used to create the visual material and a well-known radio presenter provided the voice-over within the CAI. Music introduced the beginning and end of each module and was purposely selected to encourage a desire to exercise and included familiar Thai songs. A short excerpt of Mozart's Piano Sonata in D major (K 448) was also included because there is evidence of listening

enhancement and improved spatial-temporal task performance associated with Mozart's music, both generally (Wilson & Brown 1997) and in relation to specific compositions (Rauscher *et al.* 1993, Thompson *et al.* 2001), and particularly this piece of music. All music was selected to be congruent with the content displayed. Software such as Photoshop, Corel Draw, Ulead MediaStudio Pro and Audacity were used to edit the selected audio-visual multimedia.

The following five principles of the Cognitive Theory of Multimedia Learning (Mayer & Moreno 1998, Moreno & Mayer 1999, Mayer 2001) were used to inform the design:

Multiple representation principle: It is better to present an explanation in words and pictures than solely in words;

Contiguity principle: When giving a multimedia explanation, present corresponding words and pictures contiguously rather than separately;

Split-attention principle: When giving a multimedia explanation, present words as auditory narration rather than as visual on-screen text;

Individual difference principle: The foregoing principles are more important for low-knowledge than high-knowledge learners and for high-spatial rather than low-spatial learners;

Coherence principle: When giving a multimedia explanation, use few rather than many extraneous words and pictures informed the design of the multimedia presented. The voice-over was inserted contiguously with corresponding words and pictures. When giving explanations related to exercise, few words and pictures were used.

Coding the program. The 'Autoplay Media Studio 7.0' (Indigo Rose Corporation, Winnipeg, MB, Canada) and 'SWiSH Max2' (SWiSHzone.com Pty Ltd, Surry Hills, NSW, Australia) software packages was used to develop this program, which was coded as necessary when the regular functions of these were inadequate for the desired CAI characteristics.

Phase 4: CAI testing of the CAI for content validity, CAI-related manual writing and testing for user difficulty and user satisfaction

Testing the program

The program was then run by the computer programmer to check for malfunctions and to remove any bugs. This is called alpha testing.

Content validity

After alpha testing, the CAI was sent to eight experts for review to ensure content validity: a medical professor specializing in gerontological medicine and exercise, three university nurse educators specializing in gerontology and exercise and a university physical therapist educator specializing in exercise. They were asked to review the written content. In addition, three university CAI educators were asked to review the CAI.

Each health expert was asked to rate the content for level of relevance and the CAI experts were asked to rate the content for CAI relevancy. Both types of rating were done using a 4-point scale (1 – not relevant, 2 – item needs some revision or fairly relevant, 3 – relevant but need minor revision and 4 – very relevant). These ratings were used to decide which content of the CAI should be refined before beta testing. The five health experts rated all the topics as relevant, with the majority being rated as very relevant. Two of the three CAI experts rated all the modules as relevant or very relevant, while one rated all the modules as fairly relevant and in need of revision. Revisions were undertaken in light of the advice of the 'critical' CAI expert, with a final review by the doctoral dissertation committee before transferring the CAI to a CD-ROM.

Beta testing, that is testing in the real world, was undertaken with three carers as a pilot test. All these carers were novice computer users and were able to navigate and understand the CAI. However, the CAI design was refined because they experienced difficulty in accessing the material when it started from the cover page and ran over several pages.

Preparation of the manual and maintenance for the CAI

The manual for carers was written, and this process is called user documentation. Programmer documentation was also written for maintenance of the CAI, taking into account user difficulty and satisfaction testing with a larger sample of health volunteers (n = 31).

User difficulty and user satisfaction

Participants. Participants in this phase were 31 carers of older people and other age groups in the community and registered with the Ministry of Public Health, Thailand.

Instruments. The researcher-developed instrument *User Difficulty regarding the Use of the Computer Program Questionnaire (UDUCPQ)* asked users to rate each module of the CAI using a 5-point Likert scale: (1) very easy, (2) easy, (3) not sure, (4) difficult and (5) very difficult.

The researcher-developed *User Satisfaction regarding the Use of the Computer Program Questionnaire (USUCPQ)* used a 7-point Likert scale to rate the views of carers about the convenience, preference, interest, speed, usefulness,

Table 2 User difficulty measured on a 5-point Likert scale: (1) very easy, (2) easy, (3) not sure, (4) difficult and (5) very difficult

	User difficulty scores					
Module	1	2	3	4	5	Mode
1	3 (9·7)	22 (71·0)	4 (12·9)	2 (6·5)	0 (0)	2
2	3 (9·7)	22 (71·0)	4 (12·9)	1 (3·2)	1 (3·2)	2
3	2 (6·5)	25 (80·6)	3 (9·7)	1 (3·2)	0 (0)	2
4	2 (6·5)	17 (54·8)	7 (22·6)	5 (16·1)	0 (0)	2
5	4 (12·9)	22 (71·0)	4 (12·9)	1 (3·2)	0 (0)	2
6	6 (19·4)	22 (71·0)	3 (9·7)	0 (0)	0 (0)	2
7	3 (9·7)	20 (64·5)	7 (22·6)	1 (3·2)	0 (0)	2
8	3 (9·7)	23 (74·2)	5 (16·1)	0 (0)	0 (0)	2
9	4 (12·9)	23 (74·2)	4 (12·9)	0 (0)	0 (0)	2
10	2 (6·5)	17 (54·8)	10 (32·3)	2 (6·5)	0 (0)	2
Total						2

Values are expressed as *n* (%).

acceptability, practicality and adequacy of the CAI: (1) very highly dissatisfied, (2) highly dissatisfied, (3) fairly dissatisfied, (4) not sure, (5) fairly satisfied, (6) highly satisfied and (7) very highly satisfied. Additionally, an open-ended question was used to identify carers' problems and their suggestions for improving the CAI.

Ethical considerations

The study was approved by the appropriate research ethics review committee.

Results

User difficulty. The majority of the sample reported that they found the CAI modules easy or very easy (61·3–90·4%), with a minority reporting that they found them difficult or very difficult (0–16·1%); some modules were reported as presenting no difficulty (Table 2). However, a large group reported being unsure about the difficulty, especially relating to module 10, where nearly one-third reported being unsure how to rate their experience.

User satisfaction The majority of the sample reported high levels of satisfaction across the different attributes (77·5–96·8%), as can be seen in Table 3. The speed of the CAI program attracted least satisfaction, as can be seen by both the mode and low satisfaction scores. Twenty-six participants responded to the open question. These data fell into three themes: satisfaction (n = 16), views about content (n = 9), and recommendations to improve the CAI (n = 4), and there were eight additional comments. The satisfaction theme echoed the questionnaire data and typically commented on how good the CAI was: 'good' (ID 4, 5, 6, 7 & 31); 'gives a lot of knowledge' (ID 19); and 'it is useful for older people and persons who need to take care of older people' (ID 11). Typical comments about the content were: 'good content' (ID 11, 16 & 17); 'I liked it but wanted additional content' (ID 1, 13, 18, 29 & 30); and 'I want another program suggesting about health, such as consuming healthy foods and taking care of mental health' (ID 29). Four participants made recommendations to improve the CAI: 'I want more pictures' (ID 2 & 11) and 'I want motion pictures of exercise' (ID 1 & 6). Additional comments were: 'I want more training' (ID 21, 23, 24 & 26) and 'I want to promote this good program to other health volunteers and people who are in need' (ID 16).

Discussion

Study limitations

This was a small exploratory study with a limited sample of carers working in Thailand. Future nurse-led CAI initiatives will need to take account of the particular context in which they are to be delivered, because users of such initiatives may have differing needs to those in this study.

Table 3 User satisfaction measured on a 7-point Likert scale: (1) very highly dissatisfied, (2) highly dissatisfied, (3) fairly dissatisfied, (4) not sure, (5) fairly satisfied, (6) highly satisfied and (7) very highly satisfied

User satisfaction	1	2	3	4	5	6	7	Mode
Convenience	0 (0)	0 (0)	0 (0)	3 (9·6)	4 (12·9)	9 (29·1)	15 (48·4)	7
Preference	0 (0)	0 (0)	0 (0)	0 (0)	2 (6·4)	11 (35·5)	18 (58·1)	7
Interest	1 (3·2)	0 (0)	0 (0)	1 (3·2)	2 (6·4)	11 (35·5)	16 (51·7)	7
Speed	2 (6·4)	0 (0)	0 (0)	5 (16·1)	10 (32·3)	8 (25·8)	6 (19·4)	5
Usefulness	0 (0)	0 (0)	0 (0)	0 (0)	1 (3·2)	7 (22·6)	23 (74·2)	7
Acceptability	0 (0)	0 (0)	0 (0)	1 (3·2)	5 (16·1)	7 (22·6)	18 (58·1)	7
Practicality	0 (0)	0 (0)	0 (0)	3 (9·6)	1 (3·2)	12 (38·8)	15 (48·4)	7
Adequacy	1 (3·2)	1 (3·2)	0 (0)	1 (3·2)	4 (12·9)	14 (45·2)	10 (32·3)	6
Total								6·62

Values are expressed as *n* (%).

What is already known about this topic

- Healthy ageing is an increasingly important public health target globally.
- Changes in technology offer the opportunity for e-health promotion as a means of educating populations and healthcare staff to meet public health targets.
- Little is known about the detailed development of computer-based media for self-learning of novice users.

What this paper adds

- The principles of adult learning, five steps of computer program development and five principles of the Cognitive Theory of Multimedia Learning were applied to develop computer-assisted instruction for informal carers.
- Most users reported feeling at ease and highly satisfied after using this specially designed computer-assisted instruction.

Implications for practice and/or policy

- Carefully-developed multimedia computer-assisted instruction can be used as a tool to educate informal carers or unqualified staff to promote exercise for older adults.
- Nurses can apply these strategies to develop other computer-assisted instruction packages to promote health for use by novice users.
- Similar computer-assisted instruction packages could be developed to promote other areas of a healthy lifestyle.

Developing the program

A number of issues arose during the development and production of the CAI. Importantly, the capacity of the end-user and their intended role, namely carer, was over-estimated, and Part 2 of the original content was removed so that the risk of inappropriate exercise for older people with health problems was minimized. The Cognitive Theory of Multimedia Learning (Mayer & Moreno 1998, Moreno & Mayer 1999, Mayer 2001) provided key principles for decision-making relating to content delivery within the CAI, which appeared to yield a satisfactory product in terms of content validity and user satisfaction. Indeed, the user data suggested that the CAI presented few difficulties for its use by novice computer users, and user satisfaction was generally high. The only negative domain related to the speed of the CAI program and interestingly the open question data were overwhelmingly complimentary, with eight participants making recommendations to improve the CAI and extend the focus of health promotion beyond simply exercise, suggesting an appetite for additional training using this method.

The CAI was a relatively cheap approach to developing the health promotion skills of informal carers. The alternative of 'motion pictures' in a video or CD-ROM would be much more expensive, because of the additional costs of filming and higher specification output requirements so that streamed data may be displayed. Costs of production and computer hardware to meet output requirements need careful consideration, especially where there is competition for scarce resource (Cattan 2003, Iahad *et al.* 2004).

Conclusion

The increasing numbers of older people pose a challenge to healthcare systems globally. Further, the growing shortage of nurses means that carers are increasingly being used to support health gains. This CAI is an example of a nurse-led initiative to improve the health of older people in a developing nation through the rigorous development of a multimedia CAI, which generated high levels of satisfaction in its users. This nurse-developed initiative was demonstrated to be both easy to use by its target population and yielded high-satisfaction levels, providing a potential template for the development of similar initiatives in other important topics relating to health ageing, such as healthy eating and taking care of mental health. In this paper, we have set out the steps and principles for developing multimedia CAI to transfer health information to clients. However, more evidence is required regarding the effectiveness of this sort of e-health promotion and the key characteristics of the most successful initiatives and the respective roles of carers, nurses and nursing aides in the promotion of health and well-being for older people.

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Conflict of interest

No conflict of interest has been declared by the authors.

Author contributions

MP, WS, SJ, SP & OT were responsible for the study conception and design. MP performed the data collection. MP, WS, SJ, SP & OT performed the data analysis. MP & AW were responsible for the drafting of the manuscript. MP & AW made critical revisions to the paper for important intellectual content. WS, SJ, SP, OT & AW provided statistical expertize. MP, WS, SJ, SP & OT provided administrative, technical or material support. WS, SJ, SP, OT & AW supervised the study.

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