เทคโนโลยีจำลองตัวละครในการสอนและการให้ความรู้แก่ผู้ป่วย: การทบทวนวรรณกรรมแบบบูรณาการอย่างเป็นระบบ
Avatar-based Technology Interventions in Patient Education: A Systematic Integrative Review

นิพนธ์ปริทัศน์

Review Article

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บทคัดย่อ

วัตถุประสงค์: เพื่อทบทวนวรรณกรรมและหลักฐานงานวิจัยเกี่ยวกับการใช้นวัตกรรมเทคโนโลยีจำลองตัวละครในการสื่อสาร ส่งต่อข้อมูลและความรู้ทางสุขภาพให้กับผู้ป่วย **วิธีการศึกษา:** การทบทวนวรรณกรรมแบบบูรณาการอย่างเป็นระบบนี้คัดเลือกเฉพาะงานวิจัยเชิงทดลองแบบมีกลุ่มควบคุม โดยสืบค้นจากฐานข้อมูลอิเลคทรอนิกส์ ได้แก่ CINAHL, MEDLINE, PubMed, Scopus, Cochrane และ EMBASE รวมทั้งมีการประเมินคุณภาพของระเบียบวิธีวิจัยของงานวิจัยที่คัดเลือก **ผลการศึกษา:** มีงานวิจัยจำนวน 6 เรื่องที่ตรงตามเกณฑ์การคัดเข้า ผลการวิเคราะห์และสังเคราะห์พบว่าการใช้เทคโนโลยีจำลองตัวละครในการเพิ่มความรู้ด้านสุขภาพที่เกี่ยวข้องกับการปรับเปลี่ยนพฤติกรรมสุขภาพของผู้ป่วย แต่พบว่ายังมีหลักฐานงานวิจัยที่ยังไม่ชัดเจนและเพียงพอที่จะประเมินประสิทธิผลของรูปแบบเทคโนโลยีจำลองตัวละครต่อการรับรู้ความสามารถของตนเองของผู้ป่วย **สรุป:** การทบทวนวรรณกรรมนี้พบงานวิจัยเพื่อพิจารณาพัฒนารูปแบบการให้ความรู้แก่ผู้ป่วยโดยใช้เทคโนโลยีจำลองตัวละคร และเทคโนโลยีจำลองตัวละครเป็นเครื่องมือให้ความรู้แก่ผู้ป่วยในบริบททางสุขภาพต่าง ๆ ได้มากกว่าการให้ความรู้ในรูปแบบสื่อสิ่งพิมพ์ พบองค์ประกอบของการใช้รูปแบบเทคโนโลยีการจำลองตัวละครที่สามารถประยุกต์ใช้พัฒนารูปแบบการให้ความรู้ทางสุขภาพแก่ผู้ป่วยในการปฏิบัติการพยาบาลได้อย่างมีประสิทธิภาพต่อไป

คำสำคัญ: การทบทวนวรรณกรรมแบบบูรณาการอย่างเป็นระบบ, เทคโนโลยีจำลองตัวละคร, การปฏิบัติการพยาบาลในคลินิก, การให้ความรู้แก่ผู้ป่วย

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Abstract

Objective: To review the evidence for the avatar-based technology as an innovative and emerging intervention for delivery of health education in clinical practice. **Method:** This review followed a systematic review methodology. Randomised controlled trials in English language were searched in CINAHL, MEDLINE, PubMed, Scopus, Cochrane and EMBASE. Articles were assessed for quality of methodology. **Results:** Six randomised controlled trials met the eligibility criteria and were included in the review. Avatar-based technology interventions improved health knowledge, and health-relate behaviour. There was insufficient evidence to suggest the effectiveness of Avatar-based interventions on, self-efficacy, and of the interventions among the participants were unclear. **Conclusion:** This review established a scientific basis for avatar-based technology as an effective intervention for the transfer of knowledge and skill development for patients. Avatar-based education tools have a clear advantage over paper-based education materials. This review provides nurses with the state of science in relation for the avatar-based technology interventions in patient education. A summary of intervention components are provided to assist nurses to develop and use the avatar-based interventions in clinical practice.

Keywords: systematic integrative review, avatar-based technology, nursing practice, patient education

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Introduction

Self-care behaviour is the process of maintaining health through health-promoting practices in states of both health and illness.1 Individuals are able to limit symptoms when they understand the disease management and self-management and learn to undertake simple interventions.[2] The ability of a patient to control their health and illness through an effective care plan is significantly influenced by cognitive behavioural, social or situation factors.[3,4] A major problem of unhealthy behaviour is the resistance of patients to lifestyle advice, such as eating a healthy diet, doing more exercise and quitting smoking.[5-7] Numerous studies have shown that a large percentage of patients do not adhere to healthy lifestyle change, self-care behaviour or disease management.[8,9] The process of behaviour change is complicated and requires more than simply the acquisition of health knowledge.[10-12] To improve the effectiveness and efficacy of care, patient education plays a significant role in the decision-making processes of patients, seeking of medical care and behaviour change to improve health-related quality of life.[12-14]

Patient education is an important component of many disease management and health promotion programs.[1,8,15-18] Health care providers are under increasing pressure to provide

health information and resources to patients to encourage them to follow disease management programs and make informed decisions about their health behaviour.[1,3,19] Patient education has often been delivered face-to-face and supported by paper-based flyers, brochures and sometimes videos or DVDs.[20] However, as information technology has rapidly advanced, computer-based information and resources for supporting patient teaching, decision-making and information retrieval have become increasingly available.[21-25] Several authors have claimed that these new types of systems have many advantages compared to the more traditional means used for patient education.[26-29] The main advantage is that health information can be delivered in a more interactive and engaging way and has the ability to provide individually tailored information at a lower cost.[6,30-32]

An avatar is a computer-generated character representing people and interactive behaviours.[31] It is designed to carry out simulated 'human-like character' conversations with player or user, including appropriate use of mimicking human behaviours interaction such as talking and hand gestures.[33]

Moreover, avatars are computational human-like behaviour technology designed to build and maintain long-term, social-emotional relationships with their users.[34-36] They are particularly effective as relational agents, as many of the interaction strategies used to build and support interpersonal relationships involve non-verbal communication.[19,34,37] The use of avatar-based in patient education is growing, creating a new simulated avatar characters for patients during bedside education session and discharge plan from the comfort of their own home. As health and patients education changes to meet the needs of patients or caregivers, options such as avatar-based technologies need to be considered.[38,39] However, there is only limited research on the effectiveness and applicability of avatar-based technology interventions for patient education. This article used an integrative review approach that allowed the inclusion of randomised controlled trials (RCTs) to provide readers with a better understanding on the topic. It could allow readers a greater capacity to explore the relevance and applicability of avatar-based technologies as interventions for improving outcomes for patient education in clinical practice.

To date, the literature has demonstrated that the integration of avatar-based technology interventions to deliver health information has improved the health behaviour change process in a range of different health conditions. The aim of this review was to explore the effectiveness of avatar-based technology interventions in patient education. Specifically, there were two objectives. The first objective was to report and summarise the evidence on avatar-based technology interventions in patient education. The second one was to report how avatar-based technology interventions have improved knowledge, changed behaviours and enhanced self-efficacy and health related quality of life (HRQoL), as well as to report the participating patients' acceptability of and satisfaction with the application. The findings could be applied for further development of the practical intervention.

Methods

Database and search terms

This systematic integrative review used a systematic approach, including the methodological quality assessment outlined by Whittemore and Knafl[40] and a checklist for writing an systematic integrative review recommended by Torraco.[41] A systematic approach has been used to identify the included studies, extract and analyse the information, appraise the study quality, and present the findings in a usable format.[40,42] The synthesis of the data was conducted through a narrative analysis.[43] Finally, the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flowchart was used to present the process and result of this review.[44]

A systematic search of the literature was conducted for peer-reviewed articles written in Thai and English and published between 2009 and 2019. Informed by the review steps,[40] the literature was searched for published articles on avatar-based education interventions in clinical practice. A search of the CINAHL, MEDLINE, EMBASE, PubMed, PsycINFO, Web of Knowledge, Cochrane Library, ProQuest (health sub-set), Scopus and Web of Science databases was conducted using the following keywords: "avatar-based," "avatar-based education," "agent-based," "conversation agent," "intelligent agent," "computer agent," "conversational agent," "interactive computer agent," "embodies conversational agent," "patient education," "health education," "health knowledge," "self-care," "health related quality of life," "self-efficacy" and "consumer health information."

Criteria for study selection

In terms of types of studies, this review considered studies that evaluated the effectiveness of avatar-based technologies

in patient education. The avatar-based technology interventions could be either used alone or in combination with the "usual care." For types of participants, studies with participants with any medical conditions that required patient education were selected, regardless of age, ethnicity, gender or geographical location (i.e., metropolitan, rural or remote area). For intervention types, the selected studies used avatar-based technologies that were delivered either by nurse, physician or allied health educator via a computer, tablet-based device or mobile phone in a hospital (i.e., inpatient or outpatient) or in the community. Finally, in terms of types of outcomes, studies with knowledge as the primary outcome that was measured by valid and reliable instruments were selected. We also selected studies that measured secondary outcomes including self-care or behaviour change, self-efficacy, HRQoL and acceptability of or satisfaction with avatar-based technology interventions.

Methodological quality assessment

Two independent reviewers extracted data from and critically appraised the six selected studies. The data items extracted included the country in which the study was conducted, participant characteristics, objectives, intervention and control conditions and the length of follow-up. The extracted data from the reviewed studies were displayed and compared in tables based on the outcome measures. Two independent reviewers assessed all the included full-text papers through the standardised critical appraisal instrument from Critical Appraisal Skills Programme (CASP).[45] The CASP Randomised Controlled Trials Checklist was used to check the methodological validity of the included studies.

Results

Search outcomes

The initial search identified a total of 2,165 articles, while a manual search of other sources (i.e., Google search and the grey literature) identified a further 58 articles. In total, 2,223 articles were identified through all methods of searching. After removing duplicates, 1,946 articles remained for screening and another 1,925 articles were excluded. Full-text manuscripts were obtained from the remaining 21 articles. Based on a full-text review, 15 articles were excluded. Six RCT studies were identified. After assessment of the studies against the inclusion criteria, these six articles were included in the review (Table 1). The PRISMA flow diagram presents the overall process in Figure 1.

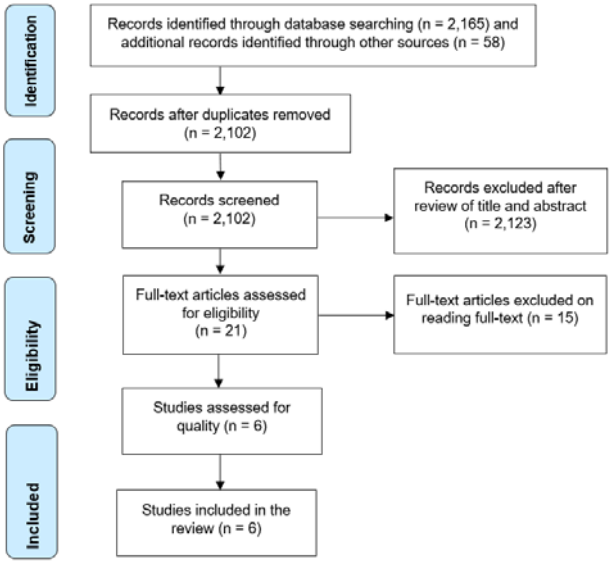

Figure 1 PRISMA flowchart showing the identification of studies.

Study characteristics

The six articles in this systematic integrative review were published between 2005 and 2017. All of the studies were RCTs that were conducted in the USA, with each being designed to evaluate the effectiveness of avatar-based technologies for the delivery of health information for patient education in the clinical practice area. Two studies were implemented in a hospital setting, while the other four were implemented in a community setting. The characteristics of the included studies are presented in Table 1.

Participant characteristics

This review included a total of 2,204 participants from the six selected studies. All the participants were adults ranging from 18 to 91 years of age. Five studies included both genders while one consisted of only women.[30] In total, there were 1,565 women and 648 men. The six studies in this review presented research on health education relating to general lifestyle health behaviours[46], self-management, including fruit and vegetable consumption and physical activity[33], breakfast eating habits, alcohol consumption and smoking[46], overactive bladder (OAB) education[30], depressive symptoms[47], and explaining medical documents to patients.[48] The outcome measures of all the included studies were defined differently through differing measurement methods and timeframes. The

outcomes were divided into primary and secondary outcomes (Table 2). The primary outcome of this review was that of the acquisition of knowledge. The secondary outcomes included improved self-care or behaviour change, increased HRQoL scores, improved self-efficacy and satisfaction with and acceptability of the intervention.

Table 1 Summary of included studies.

Study	Participants	Objectives	Intervention/control condition	Length of follow-up
Bickmore et al.[48] USA	Inpatients n = 29 adults Age: 28-91 years 19 females 10 males	Explaining consent form document	Three-armed RCT I: Document explanation by avatar I: Self-study C: Usual care (human explanation)	Until signed
An et al.[46] USA	Previous 30 days smokers n = 1,698 Age: 18-30 years 1,230 females 468 males	Health behaviour change: eating breakfast, exercise, alcohol consumption and cigarette smoking	3 armed RCT I: Online video-based with peer avatar coaching I: Personally tailored plus online video-based peer avatar coaching C: Usual care (personally tailored)	30 days and 12 weeks
Bickmore et al .[33] USA	Sedentary older adults n = 263 Mean age: 71.3±5.4 years 161 females 102 males	Daily walking step count Walking goal setting	Two-armed RCT I: Avatar exercise coach with take-home tablet computer and pedometer record C: Usual care with pedometer record	30 days and 12 weeks
Andrade et al.[30] USA	Women with at least three months of OAB symptoms n = 41 Age: 55-75 years	OAB self-management behaviours	Two-armed RCT I: Avatar-based C: Voice only online program	1, 6, and 12 weeks
Bickmore et al.[49] USA	Walk unaided n = 122 Age: 18 or older 48 males 74 females	Health behaviour change: physical activity, step walk with pedometer record, fruit and vegetable consumption	Four-armed RCT I: Online physical activity with avatar I: Online fruit and vegetable consumption with avatar I: Online physical activity plus fruit and vegetable consumption with avatar C: Usual care	2 months
Pinto et al.[47] USA	Young adults with two weeks depressive symptoms n = 60 Age: 18-25 years 40 females 20 males	Reduce depressive symptoms among young adults	Two-armed RCT I: Avatar-based C: Usual care	12 weeks

Note: I = intervention group, C = control group; OAB = overactive bladder; RCT = randomised controlled trial.

Study outcomes

1) Primary outcomes: Knowledge

The acquisition of knowledge was explicitly referred to in two of the six selected studies.[30,48] Both studies reported that avatar-based technology interventions were effective in delivering information and that the participants were generally able to use them without difficulty.[30,48] Each of the two studies indicated an improvement in health knowledge scores when the information was communicated through an avatar compared to face-to-face communication and self-study instruction. Bickmore et al found that participants who received information through a conversational avatar to explain health documents and a consent form were just as likely to improve their knowledge scores as those who received explanations from health care providers or through self-study.[48] In addition, the study reported that avatar-based delivery was useful in identifying those patients who needed additional assistance on health information.[48] Andrade et al demonstrated that at 12-week follow-up, the intervention resulted in an increase in OAB symptom knowledge scores when compared with usual care (*P*-value < 0.001).[30]

Table 2 Summary of primary and secondary outcomes.

Study	Outcomes	Intervention	Control / Usual care	Follow-up	*P*-value*
1) Primary outcome: Knowledge					
Bickmore et al[48]	Medical document knowledge scores	42.20 (20.33)	25.91 (11.36)	1 day	0.006*
Andrade et al[30]	OAB symptoms knowledge scores (mean average)	5.77	2.61	12 wks	< 0.001*
2) Secondary outcomes					
2.1 Behaviour change					
Bickmore et al[33]	Daily step count (adjusted mean)	4,041 steps/day 3,861 steps/day	3,499 steps/day 3,383 steps/day	2 mos 12 mos	0.01* 0.09
An et al[46]	Smoking abstinence rate	31%	11%	12 wks	< 0.0001*
	Number of days of change in drinking (mean change)	−1.87	−1.00	12 wks	< 0.0001*
	Number of days of eating breakfast (mean change)	7.58	2.20	12 wks	< 0.0001*
	Number of days of exercise (mean change)	5.08	1.74	12 wks	0.0058*
Bickmore et al[33]	Daily step count	7,398 steps/day	8,003 steps/day	2 mos	0.367
	Fruit and vegetable consumption (mean change)	3.4	0.6	2 mos	0.0005*
2.2 HRQoL					
Andrade et al[30]	OAB HRQoL scores (mean average)	90.9	79.52	12 wks	0.002*
2.3 Self-efficacy					
Andrade et al[30]	Self-efficacy for urinary incontinence scores (mean average)	8.27	7.41	12 wks	0.005*
2.4 Satisfaction/acceptability					
Bickmore et al[33]	Satisfaction (score range 1-7, mean average)	6.56	N/A	-	
Pinto et al[47]	Acceptability (score range 1-5, mean average)	4.45	N/A	-	

Note: *Statistical significance when *P*–value ≤ .05; F/U = follow-up, N/A = not applicable; OAB = overactive bladder; HRQoL = health-related quality of life; mos = months; wks = weeks.

2) Secondary outcomes

2.1 Behaviour change

Three of the six studies reported on the effectiveness of an avatar-based technology intervention for changing behaviour.[33,46] One study demonstrated the effectiveness of an avatar-based technology intervention for the daily step count of older adults[33], while another study detailed an intervention for daily step count and fruit and vegetable consumption.[33] One study reported multiple behaviour changes in young adult smokers, consisting of number of days of exercise, smoking, alcohol consumption and breakfast consumption.[46] Two studies measured daily step count[33,49], but only one study demonstrated a significant difference in the daily step count of older adults with an avatar coach (two-month follow-up, *P*-value = 0.01).[33] In this study, the authors compared the efficacy of an avatar-based exercise coach interacting on a daily basis with an intervention group in the

usual care using a pedometer record to increase walking among sedentary older adults.[33]

These studies demonstrated that those coached with an avatar walked significantly more steps on a daily basis than control-group participants at two-month follow-up (*P*-value = 0.01). The qualitative data from the interviews with the same participants also indicated high levels of satisfaction with the intervention in 90% of the participants. An et al conducted a three-group RCT measuring the delivery of health behaviour information to young adult smokers.[46] The participants were assigned to the following groups: 1) online health messages, 2) online health messages plus avatar peer support, and 3) usual care. The results showed that the second group had increased abstinence rates from smoking (*P*-value < 0.001), increased number of days of breakfast consumption (*P*-value < 0.001) and days of exercise (*P*-value = 0.0058) and reduced number of days of alcohol consumption (*P*-value < 0.001) at 12-week follow-up.[46]

2.2 Health-Related Quality of Life

Only one study assessed the effectiveness of an avatar-based technology intervention on HRQoL compared to a "voice only" online program.[30] In this study, it was found that avatar-based technologies used with women with OABs resulted in increased HRQoL scores compared to a control group at 12-week follow-up (*P*-value = 0.002).[30]

2.3 Self-Efficacy

One of the six studies examined the effectiveness of an avatar-based technology intervention on self-efficacy.[30] The results showed that the avatar-based intervention was statistically significant as measured by self-efficacy for urinary incontinence in OAB patients.[30]

2.4 Acceptability and Satisfaction

Two studies reported participants' satisfaction[33] with and acceptability[47] of an avatar-based technology. One study reported a higher mean average for acceptability in the intervention group in younger people with depressive symptoms (mean average = 4.45 out of 5).[47] Bickmore et al showed that an avatar-based exercise coach contributed to high levels of satisfaction for 90% of older sedentary adult participants (mean average = 6.56 out of 7).[33]

Discussions and Conclusion

This integrative review aimed to synthesise existing evidence on the effectiveness of avatar-based technology interventions for patient education. It has demonstrated that these types of interventions can improve knowledge acquisition in patient education in clinical practice.[30,48] Avatar-based technology interventions have also been shown to be effective for behaviour change.[33,46] However, there was insufficient evidence to recommend these interventions for improving HRQoL, self-efficacy[30] and acceptability of or satisfaction with the intervention.

In terms of **study primary outcome** which was **knowledge**, the available research on the use of avatar-based technology interventions demonstrates that positive change in knowledge may be beneficial for managing disease and changing behaviours. Two studies revealed that the intervention yielded significant results in terms of improving knowledge.[30,48] These studies reported that interactive avatar-based technology interventions could be potential tools to educate patients about medical documents, the consent process[48] and overactive bladder conditions.[30] This approach could increase knowledge in patients with specific health conditions because avatar-based technology interventions are able to improve health literacy in individuals using visual and auditory signals. Thus, avatar-based technology interventions may promote health knowledge and have a positive effect on patient outcomes.

Two systematic reviews reported that interactive media information technologies could be a potential tool for educating patients on their health conditions.[50,51] Interactive media technologies[50] and serious game interactive design[51] are able to account for health literacy through the use of visual and auditory signals that provide messages about various diseases. Thus, these technologies may have a positive effect on health outcomes. A number of authors have evaluated the effectiveness of interactive avatar-based interventions on health knowledge.[52-54] Three other studies, including two pilot studies and one pre-test post-test design evaluated avatar-based technology interventions for improving heart failure knowledge[53], insulin treatment knowledge[54] and ileostomy care knowledge.[52] Clark et al developed an avatar-based educational resource that was delivered by tablet computers and designed as an adjunct to traditional heart failure education.[53] The educational resource was provided to five

Aboriginal participants, resulting in a 20.8% increase in heart failure knowledge.[53] Another pilot study demonstrated improved insulin treatment knowledge via an online interactive video game education tool on type 1 diabetes mellitus patients at six-month follow-up.[54] One pre-test post-test study[52] explored the use of an interactive avatar-based intervention to educate new stoma patients about ileostomy care. After using the intervention, the knowledge scores of participants showed significant improvement when compared with their baseline knowledge scores.[52] In addition, interactive health teaching tools have been shown to be able to adapt content based on personal interests and specific diseases. One study reported, in accordance with one systematic review and meta-analysis, improved cancer care knowledge through the use of interactive technologies and videotapes for cancer patients.[55]

The above evidence endorsed the findings of other studies that patients often forget the information that health care providers and professionals tell them during education sessions, bedside teaching or consultations. Some patients have difficulty understanding health information in booklets and brochures.[56] Interactive media technology interventions have been shown to have a variable effect in enhancing patient involvement in decision-making processes on self-care, self-management and disease management.[57,58] Avatar-based technologies can provide a flexible learning environment in which patients can learn about their health condition in a personalised health setting through decision-making tools that provide tailored health information.[59,60] Additionally, a systematic review by Friedman et al reported that the use of multiple teaching techniques with specific information for patients should be provided rather than general health information.[61]

Overall, this present systematic review has revealed that positive and effective teaching strategies and delivery methods for patient education would include integrating technologies via visual messages to enhance learning and understanding in patients with low health literacy to increase their knowledge.[61] This review of RCTs supports the findings of previous research into the potential effectiveness of avatar-based technology interventions for patient education.

Regarding **behaviour change** and **self-care behavior**, which were two of the **secondary outcomes**, avatar-based technology interventions for patient education have also been shown to improve health behaviour change or self-care behaviour in patients with multiple health risks.[34,62] These interventions enhance activities that change behaviours such as daily step counting[49] and activities that lower alcohol and tobacco consumption.[46] As the results of this review, technological methods for maintaining self-care behaviour need to be included in patient education.[62] A study by Lo et al demonstrated that their chosen multimedia education program improved self-care behaviour in post-operative stoma patients.[63] Another study reported that the use of interactive technology interventions via serious games improved the self-care behaviour of insulin administration in patients with type 1 diabetes mellitus.[54] The reason for these findings could well be that the most effective way to change behaviour is through delivery of health information by empathic avatar characters via multimedia or interactive technologies to increase user engagement, persuasion and motivation similar to coaching by nurses or health care professional educators.[60,64] Health coaching is a behaviour change intervention that helps individuals to achieve individual health goals to change lifestyle behaviours, with the goal of decreasing the risk of health conditions and improving self-management and HRQoL.[65,66] In addition, interactive technologies have the capacity to facilitate involvement and learning in an active way because the information can be matched to the patients' preferences, needs, diseases and health risk behaviours.[67,68]

In relation to self-care behaviour, one pre-test post-test study demonstrated an avatar-based nursing intervention via a tablet-based educational resource about heart failure.[53] The results showed an increase in self-care behaviour in three domains, specifically, a 95% increase in self-care confidence, 26.1% increase in self-maintenance and 1.9%% increase in self-management.[53] Another single group study demonstrated improved diabetes self-care behaviour via a virtual world with an avatar on a website about diabetes self-care education.[69] The results showed improved diabetes self-care behaviour at six-month follow-up.[69] These findings could be due to the participants having long-term chronic conditions or health risks that may have contributed to their lack of knowledge and understanding of the importance of health risk factors and the negative effects of not changing their behaviours.[70] This review has revealed that avatar-based technology interventions have been used to track daily health behaviours and make positive lifestyle changes such as quitting smoking, increasing exercise and decreasing alcohol consumption.

In terms of self-efficacy, one of the secondary outcomes, one study in this review showed that the use of avatar-based

technology interventions in patient education significantly improved patients' self-efficacy.[30] Other studies about integrating interactive technologies for patient education revealed significant improvements in self-efficacy.[54,71,72] One pilot study reported that using serious game design in type 1 diabetes mellitus patients significantly improved insulin therapy self-efficacy scores at six-month follow-up.[54] A pre-test post-test intervention by Johnson et al demonstrated the effectiveness of virtual technologies in various diabetes management situations including selecting dishes from the menu in restaurants and making decisions in pharmacies, fitness centres, bookshops and convenience stores significantly improved self-efficacy in adults with type 2 diabetes mellitus.[71] Another RCT demonstrated improved self-efficacy in a group of young adults (aged 13 - 29 years old) with cancer via a three-dimensional interactive video game at three-month follow-up.[72] The reason for these positive findings could be that avatar-based technology interventions provide significant opportunities in health care settings through providing decision-making support rather than substituting for health care professionals.[30]

For the last two secondary outcomes, **satisfaction** and **acceptability**, two studies reported on participants' satisfaction[33] with and acceptability[47] of an avatar-based technology. One study reported a higher mean average of satisfaction for the avatar-based technology intervention group,[33] while another study reported higher levels of acceptability for avatar-based technology interventions in the intervention group.[47] One pre-test post-test study showed an 83% level of satisfaction when using a heart failure avatar peer mentor through a tablet- and computer-based educational resource.[53] Another study about technology interventions showed high levels of satisfaction when using an online video game about insulin therapy in younger patients with type 1 diabetes mellitus.[54]

In relation to the acceptability of these technologies, one pilot study demonstrated that 76% of participants accepted using an avatar mentor via a virtual world for diabetes education.[73] Therefore, interactive technologies for patient education were well obtained and patients were satisfied with the health information presented to assist their decision-making processes.[74] Through the use of interactive technologies, health care providers are able to tailor health information to patients' needs, and patients can control the flow of information and select what they want to view and when to log out of the system.[75]

In conlusion, this review is the first step in investigating the effectiveness of using avatar-based technologies. The results of this review suggest that avatar-based technologies can extend personal health information communication by nurses or health care professionals. Avatar-based technology interventions have been shown to increase knowledge in adults, elderly individuals and women with overactive bladder and have determined high levels of acceptability and satisfaction. The available research on the use of the avatar-based technologies shows that it can help patients and other individuals to achieve a greater understanding and recognition of disease management, healthy lifestyles and decision-making processes for changing behaviours to increase HRQoL. To capitalise on the advantages of these new patient educational learning technologies approach, health care professionals need to broaden their understandings of how people most appropriately learn through the avatar-based technologies and determine the effect of this knowledge on outcomes in health care context over time. The findings of this review may have implications for both nursing practice and patient education in relation to the delivery of health information interventions. This can only be accomplished through further research.

In terms of practice implications, avatar-based technology interventions have been shown to be an effective method of delivery for health information and an alternative tool for improving health knowledge, changes in behaviour and patient outcomes. Health care providers should actively select and adapt avatar-based technology methods to extend the reach of health behaviour and self-management principles to the clinical environment, community and home to provide individualised care and just-in-time information.[30,33,46] In this review, the avatar-based educational technologies have been shown to be effective among people with different conditions, with most outcomes being superior to the use of traditional methods. It remains a challenge to find the most suitable avatar-based technology design for particular patient groups. Although all avatar-based technologies were found to be effective, their design and content varied due to the intrinsic differences among different conditions and characteristics of the patient population. This may need to be considered when implementing or testing an avatar-based intervention in a specific population.[30,46,52]

The increased use of avatar-based technology interventions indicates that people living with health risks are interested in using methods to improve their knowledge, self-care, decision-making processes and clinical outcomes, in addition to changing their behaviours.[30,50] Although it have been found that the avatar-based technologies in patient education are an effective and powerful way to provide information and teach skills to patients and, it is not clear whether it is as beneficial when the health information needs to be regularly updated or when the skills gained require ongoing rectification.[33] Finally, if knowledge acquisition deprecates over time, the overall usefulness of the avatar-based technologies for patient education would be greatly reduced. This adds support to the need for customised health information that is adaptable enough to be modified to the dynamic nature of patients' ongoing health information.[30,33]

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