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Acceptance of Virtual Reality Exergames Among Chinese Older Adults

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ABSTRACT
It is well documented that exergames are enjoyable to play and can significantly improve older adults' health and well-being. However, there is limited research on exploring factors affecting these users' acceptance of such games, especially in virtual reality (VR), a relatively newer technology. This study proposes an extended version of the Technology Acceptance Model (TAM). We use variables from TAM related to older Chinese adults and specific to VR exergames to explore and confirm critical factors that could influence these users' acceptance of such games in VR. We tested the proposed model with 51 older Chinese adults (aged 65 and above) after playing three commercial VR exergames (Beat Saber, FitXR, Dance Central). Results show that these older adults who are younger and retired and have a higher education, better financial means, and a good health condition have a more positive view of VR exergames. In addition, Perceived Usefulness, Perceived Ease of Use, and Perceived Enjoyment positively affect the intention to play VR exergames. Self-Satisfaction has a positive impact on Perceived Ease of Use and Perceived Usefulness. However, unlike previous studies, our results suggest that Facilitating Conditions have a negative effect on Perceived Ease of Use. Finally, we discuss the theoretical and practical implications of our results.

1. Introduction

A rapidly growing aging society has generated a global rise in healthcare spending due to a higher demand for medical and long-term care services. The rising costs and associated changes have become a growing challenge to the sustainability of public finances and current medical facilities in many countries, including China. According to National Bureau of Statistics of China (2020), the total population aged 65 and above reached 176.3 million (12.6% of the population) in 2020 and is expected to reach 240 million in 2030 and 365 million (30% of the population) in 2050.

Age-related changes, such as decrements in gait parameters Grabiner et al. (2001), motor control (Ketcham & Stelmach, 2004), and cognition (Hennebelle et al., 2014), tend to affect negatively older adults' physical and mental health and their social interactions with others (Dominick et al., 2002; Hennessy et al., 1994; Moriarty et al., 2003). However, many of these age-related changes are consequences of unhealthy lifestyles, which can be caused particularly by a sedentary lifestyle (Mikus et al., 2012) but can be changed when there is early awareness, a suitable environment, the right motivation, and available supporting technology.

Maintaining an active lifestyle with regular physical activity is a key component of healthy aging. Regular physical exercise has been shown to positively slow down age-related declines. For instance, Mikus et al. (2012) have shown that being physically more active, like taking more steps, could reduce the development of Type 2 diabetes. Older adults who do physical activities regularly can slow down their physical decline and decondition (Goldspink, 2005; Taylor et al., 2004). Furthermore, older adults who engage in moderate physical activity levels have a reduced risk of falling and lower symptoms of depression and anxiety, and live independently longer (Bherer et al., 2013).

Although knowing the potential benefits of doing physical activities, numerous barriers prevent older adults from exercising, including not knowing how to initiate an exercise regimen (Klompstra et al., 2014), poor weather conditions, and inadequate public transport to public activity centers (Velazquez et al., 2013). One technology-supported solution that has been designed and widely used for older adults to overcome these barriers is exergaming, a type of physical activity that is part of a video game. Prior studies have shown that exergames can increase enjoyment and intrinsic motivation compared to conventional kinds of exercises (Bailey & Mclnnis, 2011; Finkelstein & Suma, 2011; Monedero et al., 2015). The literature also suggests that exergames, like conventional exercises, help promote physical health (e.g., balance, mobility, strength, physical fitness) and mental or cognitive health (i.e., balance confidence, executive functions, reaction time) among older adults (Xu, Liang, Baghaei, Wu Berberich, & Yue, 2020). In summary,

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exergames represent a reliable technology that can enhance older adults' physical abilities and mental health and, therefore, support these users to live healthier and more independent lives.

Given the recent emergence of virtual reality (VR) technology (Zeng et al., 2018) and an increasing number of studies pointing to positive outcomes of VR exergames (Barathi et al., 2018; Xu, Liang, et al., 2021; Xu et al., 2019; Xu, Liang, Zhang, & Baghaei, 2020; Xu, Yu, Liang, & Baghaei, 2021), this paper aims to investigate the factors which have a significant impact on the Chinese older adults' intention to play or use VR exergames. These factors include constructs from the Technology Acceptance Model (TAM) (Davis, 1989; Venkatesh & Davis, 2000), together with additional hypothesized factors (Facilitating Conditions, Self-Satisfaction, Cost Tolerance, Personal Innovativeness, Perceived Enjoyment, Perceived Immersion, and Cybersickness) derived from previous studies involving Chinese older adults (Ma et al., 2016) and VR (Disztinger et al., 2017; Monteiro et al., 2018; Sagnier et al., 2020). Furthermore, we aim to explore the relation between Chinese older adults' demographic characteristics and their intention to use VR exergames.

The article is structured as follows. The following section provides an overview of the literature that helped frame our research model via 12 hypotheses. Section 3 describes the research methodology based on a user experiment approach. Section 4 presents our results, and Section 5 discusses what these might indicate. The article concludes by assessing the limitations of the present study and presenting its implications and recommendations to help better frame VR exergames for Chinese older adults.

2. Theoretical framework and hypotheses

Several models have been proposed to explain technology acceptance behaviors, including the Theory of Reasoned Action (TRA) (Fishbein & Ajzen, 1975), the Technology Acceptance Model (TAM) (Davis, 1989), the Technology Acceptance Model 2 (TAM2) (Venkatesh & Davis, 2000), and the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003). Among these proposed technology acceptance models, TAM is the most widely used model to measure the acceptability of how users come to accept and use technology (Hsiao & Yang, 2011; Venkatesh & Davis, 2000).

Although TAM is a reliable acceptance theory, it sometimes suffers from inadequate explanatory power since the technological, cultural, usage context, and longitudinal behavioral processes affect the validity of the constructs in TAM (Johnson et al., 2014; Schepers & Wetzels, 2007; Sun & Zhang, 2006). The ability of the original TAM to predict self-reported intention to use and actual use is limited (Bagozzi, 2007; Taylor & Todd, 1995). However, several studies have shown the effectiveness of extending TAM by incorporating new constructs to increase its explanatory power (Dishaw & Strong, 1999; Hsu & Lu, 2004; Liu et al., 2010). For instance, Ma et al. (2016) proposed a model based on TAM but more specific to the older population of mainland China regarding smartphone use. In addition, Sagnier et al. (2020) extended TAM to predict users' acceptance of VR to support their learning of aeronautical assembly tasks.

In this study, we propose a model that extends TAM with the addition of relevant constructs specific to Chinese older adults (i.e., Facilitating Conditions, Self-Satisfaction, and Cost Tolerance (Ma et al., 2016) and VR exergames (i.e., Personal Innovativeness, Immersion, Cybersickness, and Enjoyment (Disztinger et al., 2017; Sagnier et al., 2020).

"Facilitating Conditions," "Self-satisfaction" and "Cost Tolerance" are rated highly by Chinese older adults when they use new technology and have been employed in previous research, for example, when smartphones were perceived to be new by these users (Ma et al. (2016). "Immersion," "Cybersickness," and "Enjoyment" are unique characteristics of VR technology and have been widely used as standard metrics for measuring experience in VR and VR exergame research (Ijaz et al., 2020; Ioannou et al., 2019; Xu, Liang, He, et al., 2020; Xu, Liang, Zhang, & Baghaei, 2020; Xu, Yu, et al., 2021). "Personal Innovativeness" is also a relevant and unique factor for VR since commercially viable VR headsets were released in 2016 and after. As such, VR is still a relatively new technology for most older adults in China. To the best of our knowledge, this is the first study that has looked at creating a TAM on the acceptance of VR exergames among older Chinese adults.

2.1. Perceived usefulness and perceived ease of use

Perceived Usefulness and Perceived Ease of Use are two main common constructs in TAM and TAM2 (Davis, 1989; Venkatesh & Davis, 2000), where Perceived Usefulness is originally defined as "the degree to which a person believes that using a particular system would enhance his or her job performance" (Davis, 1989), while Perceived Ease of Use refers to "the degree to which a person believes that using a particular system would be free of effort" (Davis, 1989). Several studies have shown that Perceived Usefulness is the strongest predictor of Intention to Use (King & He, 2006). However, there is lack of consensus on the effect of Perceived Ease of Use on Intention to Use (King & He, 2006; Yousafzai et al., 2007). Some studies (Agarwal & Prasad, 1997) claim that Perceived Ease of Use has a direct impact on Intention to Use, while others suggest that this effect is indirect and mediated by Perceived Usefulness (Davis, 1989) or is weaker than the line connecting Perceived Usefulness to Intention to Use (King & He, 2006).

In this study, Perceived Usefulness is defined as "the degree to which a person believes that using a particular system would enhance his or her health status." Previous research has suggested that older adults are more focused on the potential health benefits of playing exergames (Subramanian et al., 2020). We have kept the original definition of Perceived Ease of Use as "the degree to which a person believes that using a particular system would be free of effort". The hypotheses related to Perceived Usefulness, Perceived Ease of Use, and Intention to Use in our proposed model are as follows:

H1: Perceived Usefulness has a significant positive influence on Intention to Use VR exergames.

H2.1: Perceived Ease of Use is positively associated with Intention to Use VR exergames.

H2.2: Perceived Ease of Use is positively associated with Perceived Usefulness.

2.2. Facilitating conditions

Prior research (Gerling et al., 2012; Subramanian et al., 2020) suggests that attention must be given to the training of institutionalized older adults to facilitate gesture learning for interacting with motion-based exergames. In China, limited by education and social service systems, most older people may not have sufficient knowledge and, to some extent, the ability or learning opportunities to engage with technological products, especially more emergent ones, like VR. Thus, resource and technology Facilitating Conditions may be a potential solution to promote VR exergames' acceptance by the older adults in China. The literature suggests that Facilitating Conditions could positively affect smartphones' Perceived Ease of Use among Chinese older adults (Ma et al., 2016). Considering that VR is still relatively new to Chinese older adults, we hypothesize that:

H3: Facilitating Conditions positively affect Perceived Ease of Use.

2.3. Self-satisfaction

Self-Satisfaction is the degree to which a product/service gives the user satisfaction with his or her achievements (Park et al., 2013). Examples include user perception of having an individual and distinct personality and achieving something new and challenging, which requires significant effort and belief in oneself and one's abilities reflected by a product/service. They can generate great motivation through Self-Satisfaction. In mainland China, individual self-esteem and self-related life satisfaction are stronger in older adults than in younger adults (Zhang & Leung, 2002). Ma et al. (2016) confirmed that Self-Satisfaction has a positive effect on Chinese older adults' acceptance of smartphones regarding Perceived Ease of Use and Perceived Usefulness. Therefore, we propose the following two hypotheses:

H4.1: Self-Satisfaction has a positive effect on exergaming in VR and increases Perceived Ease of Use.

H4.2: Self-Satisfaction has a positive effect on exergaming in VR and increases Perceived Usefulness.

2.4. Cost tolerance

Disztinger et al. (2017) suggest that accessibility (or affordability) may not affect the adoption of VR technology for travel planning in the general population. However, several studies have pointed out that socio-economic issues (e.g., job status, occupation, and income level) that often confront older adults can influence their adoption of technology products and services (Bina & Giaglis, 2005; Ho & Kwok, 2002). Previous research (Chen & Chan, 2014; Ma et al., 2016) has indicated that the economic factor was critical for the acceptance of technology among Hong Kong and mainland Chinese seniors. Since the cost of 6 degrees-of-freedom VR headsets is similar to a smartphone, we believe that there is a need to include Cost Tolerance as a factor in our model. In this study, Cost Tolerance has been added a direct factor in determining the behavioral intention of older adults in playing VR exergames. Cost Tolerance was found to positively increase the intention to use smartphones among Chinese seniors (Ma et al., 2016). Therefore, we hypothesize that:

H5: Cost Tolerance has a positive effect on exergaming in VR; higher Cost Tolerance increases Intention to Use VR exergames.

2.5. Perceived enjoyment

Several researchers have studied the effect of enjoyment on user acceptance. For instance, Davis et al. (1992) have shown that enjoyment positively impacts Perceived Usefulness and the Intention to Use technology in the workplace. Childers et al. (2001) have found that Perceived Enjoyment could influence users' attitudes, Perceived Usefulness, and Perceived Ease of Use towards online shopping. Likewise, van der Heijden (2004) suggest that Perceived Enjoyment and Perceived Ease of Use are, for hedonic systems, stronger predictors of Intention to Use than Perceived Usefulness.

Studies have shown that the prediction of Intention to Use is improved when enjoyment is included (Kauer et al., 2013; van Schaik & Ling, 2011). Tokel and Isler (2015) have found that Perceived Enjoyment has a positive effect on Perceived Usefulness, Perceived Ease of Use, and the Intention to Use virtual worlds as learning spaces. Disztinger et al. (2017) have suggested that Perceived Enjoyment positively affects the Intention to Use VR for travel planning. In addition, older adults are more motivated by exergames that are fun to play (enjoyment) (Subramanian et al., 2020). Given that these studies have shown the importance of Perceived Enjoyment and its positive impact on the Intention to Use a new technology, we propose the following hypothesis:

H6: Perceived Enjoyment has a positive effect on Intention to Use VR exergames.

2.6. Cybersickness

Cybersickness is a relatively common negative outcome of exposure to virtual environments, especially in games (Monteiro et al., 2021; Shi et al., 2021; Wang, Liang, et al., 2022; Wang, Shi, et al., 2022). Symptoms differ according to each individual, the type of equipment used, and how it is

Table 1. Constructs developed in the proposed model, VREAMCOA.

Constructs	Definitions	Hypotheses
PU	The degree to which a person believes that playing VR exergames would improve his/her health status (Davis, 1989).	**H1:** PU has significantly positive influences on IU.
PEOU	The extent to which a person believes that playing VR exergames is free of effort (Davis, 1989).	**H2.1–H2.2:** PEOU is significantly positively associated with IU and PU.
FC	Objective factors in the environment that can make technology usage easy (Venkatesh et al., 2003).	**H3:** FC positively affects PEOU.
SS	Degree to which a product/service gives the user satisfaction with himself/herself or his/her achievements (Park et al., 2013).	**H4.1–4.2:** SS has a positive effect on VR exergame acceptance, increases PEOU and PU.
CT	The willingness to afford the costs of VR exergames considering one's income and measuring the value of the product (Ma et al., 2016).	**H5:** CT has a positive effect on VR exergame acceptance; higher cost tolerance increases IU.
PE	The extent to which playing VR exergames is perceived to be enjoyable, apart from any performance consequences that may be anticipated (Davis et al., 1992).	**H6:** PE has a positive effect on IU.
C	Degree to which playing VR exergames gives the user the following two types of cybersickness symptoms: nausea (e.g., stomach awareness) and oculomotor (e.g., eyestrain) (Kennedy et al., 1993).	**H7:** C has a negative effect on IU.
PIM	The sense of being "in the game" (Brown & Cairns, 2004).	**H8:** PIM has a positive effect on IU.
PI	The willingness of an individual to try out any new technology (Agarwal & Prasad, 1998).	**H9.1–9.2:** PI has a positive effect on PEOU and PU.

Note. VREAMCOA: VR Exergame Acceptance Model for Chinese Older Adults; *IU*: Intention to Use; *PU*: Perceived Usefulness; *PEOU*: Perceived Ease of Use; *FC*: Facilitating Conditions; *SS*: Self-Satisfaction; *CT*: Costs Tolerance; *PE*: Perceived Enjoyment; *C*: Cybersickness; *PIM*: Perceived Immersion; *PI*: Personal Innovativeness.

used (Nichols & Patel, 2002). Studies have suggested that between 60% (Regan, 1997) and 80% (Cobb et al., 1999) of participants exposed to VR will experience an increase in cybersickness symptoms (e.g., headache, disorientation, vertigo (Cobb et al., 1999; LaViola, 2000)). However, these symptoms are short-lived, as most participants recover in an hour, but some effects (such as disorientation) can linger for several hours (Rebenitsch & Owen, 2016). Cybersickness may stop users from using a particular technology again (Biocca, 1992; Diels & Howarth, 2013; Lin & Parker, 2007), hindering both the broader adoption of VR and its overall perceived usability (Stauffert et al., 2020). Prior work suggests that Cybersickness has a significant negative effect on the Intention to Use VR for aeronautical assembly learning (Sagnier et al., 2020). Therefore, based on this research, we propose the following hypothesis:

H7: Cybersickness has a negative effect on Intention to Use VR exergames.

2.7. Perceived immersion

Immersion is a unique characteristic of VR. For gaming applications, immersion is the feeling of being "in the game" (Brown & Cairns, 2004). To our knowledge, there are limited studies on investigating the effect of immersion on user acceptance of virtual environments. Shin et al. (2013) have proposed a modified technology acceptance model with constructs from the Expectation-Confirmation Theory and found that immersion has a positive influence on user acceptance through the confirmation of users' expectations. In addition, Disztinger et al. (2017) have found that immersion has a significant positive effect on using VR travel planning applications. Therefore, the hypothesis related to Perceived Immersion is:

H8: Perceived Immersion has a positive effect on Intention to Use VR exergames.

2.8. Personal innovativeness

Personal Innovativeness is the foundation of a technological culture among individuals, and it is conceptualized as a psychological sign of a potential user. Personal Innovativeness is defined as "the willingness of an individual to try out any new information technology (IT)" (Agarwal & Prasad, 1998) and has been found to have a positive impact on Perceived Usefulness, Ease of Use, and Intention to Use IT-based innovations (Yi et al., 2006). Similarly, Kim and Forsythe (2010) have indicated that Personal Innovativeness has a direct positive effect on Perceived Usefulness and Perceived Ease of Use in the context of virtualization technologies.

In addition, Personal Innovativeness has been found to impact VR adoption positively among young individuals. For instance, Fagan et al. (2012) suggest that Personal Innovativeness can directly affect Perceived Usefulness, Perceived Ease of Use, and Intention to Use a VR simulation designed to teach nursing students how to use a medical emergency crash cart. Recently, Sagnier et al. (2020) have found that Personal Innovativeness can positively affect individuals' perceived usefulness of using VR for aeronautical assembly learning tasks. However, older adults do not tend to use new technology just to use it. Instead, the technology must be perceived as filling a need in their lives and must be perceived as being usable (Hanson, 2010). Therefore, we hypothesize that:

H9.1: Personal Innovativeness has a positive effect on Perceived Ease of Use.

H9.2: Personal Innovativeness has a positive effect on Perceived Usefulness.

Table 1 summarizes the definitions of the constructs and corresponding hypotheses used in the proposed VR Exergame Acceptance Model for Chinese Older Adults (VREAMCOA).

Table 2. Items and sources of hypothesized constructs.

Constructs	Items	Contents
Intention to Use (Fishbein & Ajzen, 1975)	IU1	I would probably play VR exergames in the future.
	IU2	It is likely for me to play VR exergame in the future.
Perceived Usefulness (Davis, 1989)	PU1	Playing VR exergames could improve my fitness.
	PU2	I find VR exergames to be a good product to improve my health.
	PU3	I find playing VR exergame useful for my health.
Perceived Ease of Use (Davis, 1989)	PEOU1	Learning how to play VR exergames is easy for me.
	PEOU2	I am or can be skillful at playing VR exergames.
Facilitating Conditions (Venkatesh et al., 2003)	FC1	It is important to have someone who can help me with any problems when I use VR technology.
	FC2	Having some training is useful for me before playing VR exergames.
	FC3	Having some training is important for me before playing VR exergames.
Self-Satisfaction (Park et al., 2013)	SS1	Playing VR exergames can help me feel or look younger.
	SS2	Playing VR exergames can increase my sense of achievement.
	SS3	Playing VR exergames can help keep pace with current developments.
Costs tolerance (Ma et al., 2016)	CT1	The cost of the VR exergames should be economical.
	CT2	I have no issues paying RMB 3000 to buy a VR device.
Perceived Enjoyment (Disztinger et al., 2017)	PE1	I would find playing VR exergames enjoyable.
	PE2	I would have fun playing VR exergames.
	PE3	The process of playing VR exergames is pleasant.
Cybersickness (Kennedy et al., 1993)	C1	I might suffer increased salivation, sweating, stomach awareness, burping when playing VR exergames.
	C2	I might suffer fatigue, headache, eyestrain when playing VR exergames.
	C3	I might suffer fullness of head, dizzy (eyes open), dizzy (eyes closed), vertigo when playing VR exergames.
Perceived Immersion (Disztinger et al., 2017)	PIM1	When playing VR exergames, I could easily stop thinking of my real-world problems.
	PIM2	When playing VR exergames, I would forget the world around me.
	PIM3	When playing VR exergames, I would feel immersive in the game.
	PIM4	When playing VR exergames, I felt like I am inside that world.
Personal Innovativeness (Agarwal & Prasad, 1998)	PI1	If I heard about a new technology, I would look for ways to experiment with it.
	PI2	Among my peers, I am usually the first to try out new technologies.
	PI3	In general, I am hesitant to try out new technologies.
	PI4	I like to experiment with new technologies.

Note. IU: intention to use; *VR*: virtual reality; *PU*: perceived usefulness; *PEOU*: perceived ease of use; *FC*: facilitating conditions; *SS*: self-satisfaction; *CT*: costs tolerance; *PE*: perceived enjoyment; *C*: cybersickness; *PIM*: perceived immersion; *PI*: personal innovativeness.

3. Methodology

3.1. Research design

We used a quantitative method with structured questionnaires to determine the significant constructs in our model, VREAMCOA. To develop a sophisticated measurement tool, a confirmatory study was used to test our proposed theoretical model for predicting the acceptance of VR exergames by Chinese older adults. The structured questionnaire was conducted in person, where a researcher was in the presence of the participants when they were completing the questionnaire to ensure the quality and accuracy of the results. This way, if there were any unclear statements, the researcher could clarify them. Participants were asked to answer as accurately as possible and were told their responses would be anonymized and aggregated for later analysis.

This research falls under the low-risk research category. It was reviewed and approved by Xi'an Jiaotong-Liverpool University's University Ethics Committee. All participants signed an informed consent form before taking part in the study on a voluntary basis.

3.2. Measurement development

The questionnaire consisted of two main parts: (a) demographic characteristics of the older adult participants, and (b) the exploration of acceptance constructs (Perceived Usefulness, Perceived Ease of Use, Intention to Use, Facilitating Conditions, Self-Satisfaction, Costs Tolerance, Perceived Enjoyment, Cybersickness, Perceived Immersion, Personal Innovativeness). In addition, we asked participants about their opinions of the three selected games (e.g., "*Overall, what did you think about the game*?", "*What did you like about the game*?", "*What did you not like about the game*?", "*Was there anything more difficult than you expected in the game*?", and "*Was there anything more confusing than you expected in the game*?" Drachen et al. (2018). Table 2 presents the measurement scales and items adopted for the present survey. All items have been used and validated in previous empirical studies. We used a 7-point Likert scale for the items in each construct, where "1" indicated "strongly disagree," "4" meant "neutral," and "7" indicated "strongly agree."

3.3. Procedure

Since VR exergames were relatively new to the market and these participants, we first asked them to watch an introduction video to help them understand what VR exergames were. Then, they were given opportunities to play three selected VR exergames (i.e., FitXR, Beat Saber, and Dance Central) on an Oculus Quest 1 (see Figure 1 for the experiment setup and Figure 2 for screenshots of each game), where each game level lasted about 4 min. In the end, as stated earlier, we conducted an individual face-to-face interview to ensure the quality and accuracy of the results. All participants who completed the experiment and the survey were rewarded ¥50 for their time and were given a chance to play the games again if they wanted to at the end of the experiment.

4. Participants

The inclusion criteria were (1) Chinese residents aged 65 and above, and (2) they could communicate well with the interviewer. The exclusion criteria were (1) answering "yes" to any of the questions from the Physical Activity Readiness Questionnaire (Adams (1999) because our experiment would require participants to play three VR exergames and (2) to have a resting blood pressure higher than 140/90 mmHg. All participants were recruited from elderly centers with the permission of the management and residents. As their participation was voluntary, a participant could stop the experiment at any time.

Figure 1. A picture of a Chinese older adult participant playing a virtual reality exergame in an open ground with no risks of hitting other objects.

5. Data analysis method

This research employed partial least squares structural equation modeling (PLS-SEM) with SmartPLS 3. PLS-SEM is used because it can be applied in a wide range of situations (Hair et al., 2016), and its requirements for sample size (Haenlein & Kaplan, 2004) and distribution (Chin, 1998) are less restrictive than other modeling approaches. It is suitable for dealing with a complex model (6+ constructs) (Hair et al., 2017), is now widely applied in many social sciences and related disciplines (Hair et al., 2019), and has been used in several studies involving TAM (Raaij & Schepers, 2008; Sagnier et al., 2020; Yeou, 2016). As recommended, the data analysis was conducted in two stages (Hair et al., 2016). First, we assessed the internal consistency, the convergent validity, and the discriminant validity of the measurement model. While there is no need to report the goodness of fit metrics (Hair et al., 2017), we reported standardized root-mean-square residual (SRMR) because it has been suggested that it could be used to avoid model misspecification (Henseler et al., 2014). Second, after the first stage results were satisfactory, we used the structural model to test our hypotheses.

Feedback data from the semi-structured interview were recorded and transcribed in text and later analyzed by two researchers following an informal, simplified inductive open coding approach (Sanders & Stappers, 2013). Themes were concluded by the two researchers independently and agreed upon in a post-coding meeting with a third researcher.

6. Results

6.1. Demographics

Fifty-one participants completed the study. The characteristics of the participants are shown in Table 3.

Figure 2. Screenshots of the virtual reality exergames that are used in our experiment: (a) FitXR[4], (b) BeatSaber[5], (c) Dance Central[6].
Notes.
[4]https://fitxr.com/
[5]https://beatsaber.com
[6]https://www.dancecentral.com/

Table 3. Demographic profile of the participants.

Items	Frequency	Percentage (%)
Age		
65–69	37	72.5
70–74	8	15.7
75+	6	11.8
Gender		
Male	22	43.1
Female	29	56.9
Living Arrangement		
With family	48	94.1
Living alone	3	5.9
In nursing home	0	0
With friends	0	0
Education		
Primary school	8	15.7
Secondary	12	23.5
Post-secondary	18	35.5
Bachelor's degree	9	17.6
Postgraduate degree	4	7.8
Marital status		
Married	49	96.1
Divorced/separated	0	0
Widowed	2	3.9
Never married	0	0
Work status		
Full-time	1	2.0
Part-time	0	0
Retired	50	98.0
Source of income		
Salary/wage	1	2.0
Pension	39	76.5
Property	0	0
Families support	0	0
Government subsidy	11	21.6
Economic status		
Very rich	0	0
Rich	1	2.0
Average	46	90.2
Poor	4	7.8
Very poor	0	0
Health status		
Very good	7	13.7
Good	15	29.4
Average	28	54.9
Poor	1	2.0
Very poor	0	0
Experience with VR		
Yes	3	5.9
No	48	94.1
Experience with exergames		
Yes	10	19.6
No	41	80.4

Note. VR: virtual reality.

6.2. Measurement model

Instead of using Cronbach's alpha, we used Composite Reliability (CR) to assess internal consistency. Cronbach's alpha is considered a conservative measure of internal consistency reliability because it is sensitive to the number of items and assumes that each item is equally reliable (Hair et al., 2016). In contrast, CR considers the different outer loadings of the items. It is recommended that CR values are above. 70 (Hair et al., 2011). We used factor loading values and the average variance extracted (AVE) to assess the convergent validity of the constructs. It is recommended that factor loading values be above 0.7 and AVE values above 0.5 (Hair et al., 2016). We used the heterotrait-monotrait ratio of correlations (HTMT) (Henseler et al., 2015) to examine the discriminant validity of the constructs, which is recommended by SmartPLS where the HTMT should be significantly lower than 0.90.

Table 4. Psychometric properties of the measurement model.

Constructs	Items	Mean	SD	Loading	AVE	CR
IU	IU1	5.94	1.17	0.943	0.895	0.944
	IU2	5.73	1.34	0.949		
PU	PU1	5.63	1.30	0.967	0.851	0.945
	PU2	5.55	1.42	0.946		
	PU3	5.41	1.36	0.850		
PEOU	PEOU1	5.37	1.61	0.971	0.942	0.970
	PEOU2	5.29	1.58	0.970		
FC	FC1	5.53	1.55	0.893	0.833	0.937
	FC2	5.59	1.46	0.938		
	FC3	5.73	1.23	0.907		
SS	SS1	6.04	1.00	0.932	0.794	0.920
	SS2	5.90	0.98	0.895		
	SS3	5.98	1.07	0.845		
CT	CT1	4.98	1.52	1.000	1.000	1.000
PE	PE1	5.33	1.32	0.890	0.828	0.935
	PE2	5.75	1.09	0.941		
	PE3	5.78	1.10	0.898		
C	C1	2.02	1.54	0.857	0.767	0.908
	C2	2.51	1.77	0.900		
	C3	2.76	1.85	0.870		
PIM	PIM1	5.35	1.53	0.949	0.893	0.962
	PIM2	5.47	1.47	0.962		
	PIM3	5.27	1.65	0.924		
PI	PI1	4.61	1.94	0.863	0.770	0.910
	PI2	4.41	1.87	0.894		
	PI4	5.06	1.55	0.876		

Note. SD: standard deviation; *AVE*: average variance extracted; *CR*: composite reliability; *IU*: intention to use; *PU*: perceived usefulness; *PEOU*: perceived ease of use; *FC*: facilitating conditions; *SS*: self-satisfaction; *CT*: costs tolerance; *PE*: perceived enjoyment; *C*: cybersickness; *PIM*: perceived immersion; *PI*: personal innovativeness.

We removed CT2 and PI3 because of their low loadings (loading value <.70) to ensure convergent validity. In addition, we further removed PIM4 to improve the model fit. All items have a CR value higher than the recommended threshold value of.70. Meanwhile, their AVE values were above the recommended value of 0.5 (Hair et al., 2016). Table 4 presents CR and AVE values for all the constructs. Table 5 shows the HTMT results. All of the HTMT values were lower than 0.9 for all the constructs, suggesting an acceptable discriminant quality. The final model shows a SRMR value of 0.077 (< 0.080), which indicates that our model is acceptable (Hu & Bentler, 1999; Kline, 2015).

6.3. Structural model

We used bootstrapping to test the relationships hypothesized in our model. Path significance was tested using a bootstrapping technique for the 51 cases with 5000 samples (Hair et al., 2011). Table 6 lists all path coefficients and their significance. To assess the predictive strength of the model, we reported R^2 values for each endogenous variable. As a rule of thumb, we followed (Hair et al., 2011) to report the R^2 values where R^2 of 0.25, 0.50, and 0.75 are considered weak, moderate, and substantial, respectively. Results suggest that our model can explain 61.6% of the variance in Intention to Use (moderate), 51.5% of the variance in Perceived Ease of Use (moderate), and 28.1% of the variance in Perceived Usefulness (weak). These R^2 values are comparable to those

Table 5. HTMT (heterotrait-monotrait ratio of correlations) results.

Constructs	IU	C	CT	FC	PE	PEOU	PI	PIM	PU	SS
IU										
C	0.24									
CT	0.19	0.10								
FC	0.14	0.13	0.12							
PE	0.74	0.45	0.10	0.12						
PEOU	0.66	0.39	0.11	0.41	0.68					
PI	0.64	0.20	0.11	0.04	0.65	0.47				
PIM	0.28	0.15	0.17	0.20	0.50	0.38	0.20			
PU	0.69	0.32	0.31	0.11	0.61	0.38	0.45	0.24		
SS	0.75	0.23	0.07	0.11	0.84	0.64	0.43	0.36	0.53	

Note. IU: intention to use; *PU*: perceived usefulness; *PEOU*: perceived ease of use; *FC*: facilitating conditions; *SS*: self-satisfaction; *CT*: costs tolerance; *PE*: perceived enjoyment; *C*: cybersickness; *PIM*: perceived immersion; *PI*: personal innovativeness.

Table 6. Structural model results.

Hypothesis	Path	Path coefficient	t	Support or not
H1	PU → IU	0.377	3.018**	Yes
H2.1	PEOU →PU	0.043	0.214	No
H2.2	PEOU → IU	0.348	2.761**	Yes
H3	FC → PEOU	−0.350	3.873***	No
H4.1	SS → PEOU	0.479	4.140***	Yes
H4.2	SS → PU	0.348	1.971*	Yes
H5	CT → IU	−0.005	0.062	No
H6	PE → IU	0.341	1.990*	Yes
H7	C → IU	0.149	1.469	No
H8	PIM → IU	−0.092	0.830	No
H9.1	PI → PEOU	0.238	1.540	No
H9.2	PI → PU	0.252	1.602	No

Note. PU: perceived usefulness; *IU*: intention to use; *PEOU*: perceived ease of use; *FC*: facilitating conditions; *SS*: self-satisfaction; *CT*: costs tolerance; *PE*: perceived enjoyment; *C*: cybersickness; *PIM*: perceived immersion; *PI*: personal innovativeness. All t tests are two-tail t-tests, where $p < 0.05$ are shown with *, $p < 0.01$ are shown with **, $p < 0.001$ are shown with ***.

reported in the literature (see, for example Sagnier et al. (2020).

Perceived Usefulness had a significant positive effect on the Intention to Use VR exergames, which supported **H1**. Perceived Ease of Use had a significant positive effect on Intention to Use VR exergames but not Perceived Usefulness of VR exergames, meaning that **H2.2** was supported but not **H2.1**. Facilitating Conditions had a significant negative effect on Perceived Ease of Use, meaning that **H3** was not supported. Self-Satisfaction had a significant positive effect on both Perceived Ease of Use and Perceived Usefulness, supporting **H4.1** and **H4.2**.

Cost Tolerance had no effect on Intention to Use VR exergames, meaning **H5** was not supported. Perceived Enjoyment had a significant positive effect on Intention to Use VR exergames, meaning that **H6** was supported. We did not find a significant effect of Cybersickness on Intention to Use VR exergames, meaning that **H7** was not supported. In addition, Perceived Immersion had no significant effect on Intention to Use, meaning that **H8** was not supported. Personal Innovativeness had no significant impact on Perceived Ease of Use nor Perceived Usefulness, meaning that **H9.1** and **H9.2** were not supported. The results are summarized in Table 6. Figure 3 shows the relationships in the model, along with path coefficients and p values.

We conducted a Pearson correlation analysis between the model constructs and participants' demographic data to understand better how their characteristics influenced both attitudinal constructs (i.e., Perceived Usefulness, Perceived Ease of Use, Intention to Use) and external factors (i.e., Facilitating Conditions, Self-Satisfaction, Cost Tolerance, Perceived Enjoyment, Cybersickness, Perceived Immersion, Perceived Innovativeness). The score of each construct was computed based on the mean values of their corresponding items.

Table 7 shows the correlation results between VR exergame constructs and participants' demographics. *Age* was negatively correlated with Intention to Use, Self-Satisfaction, and Perceived Enjoyment. This result indicates that (1) "younger" participants were more likely to accept VR exergames, and (2) they had a higher Self-Satisfaction and Perceived Enjoyment than "older" participants. *Education* was positively correlated with Perceived Ease of Use, Intention to Use, and Self-Satisfaction, which indicates that people with higher education levels found it is easier to play VR exergames than those with a lower education level. They were also more willing to play VR exergames and had a higher Self-Satisfaction than those with a lower education level.

Results show that *working status* positively correlated with Perceived Ease of Use and Personal Innovativeness, suggesting that retired people are more willing to try new things like VR exergames, and believe that VR exergames are easy to use. *Economic status* had a negative effect on the Intention to Use and Self-Satisfaction, suggesting older adults with better financial situations had a higher Intention to Use VR exergames and had a higher Self-Satisfaction. Finally, *health conditions* negatively correlated with Intention to Use, indicating that healthier older adults were more likely to accept VR exergames. In summary, older adults who were younger, attained higher education, were retired, and possessed good economic status and health conditions had a more positive view of VR exergames.

6.4. Comments

Overall, participants perceived VR exergames to be enjoyable ($N = 50$). Their interaction style was perceived as simple and easy to learn ($N = 32$). Many participants were willing to try more VR games in the future ($N = 36$). Meanwhile, they also commented that several features of VR exergames would need to be improved or added ($N = 45$). Below, we list the feedback provided by our participants that are essential to make VR exergames more feasible and suitable for them. From the coded transcripts, three main domains emerged (*social interaction*, *difficulty*, and *demographics of the population*) from the two researchers, who first reviewed the transcripts independently. They were agreed upon by a third researcher after a second discussion.

6.4.1. Social interaction

Many participants ($N = 42$) expressed the need to involve their friends in the game, "*It would be good if I could play this game (Beat Saber/Dance Central) with my friends.*" For

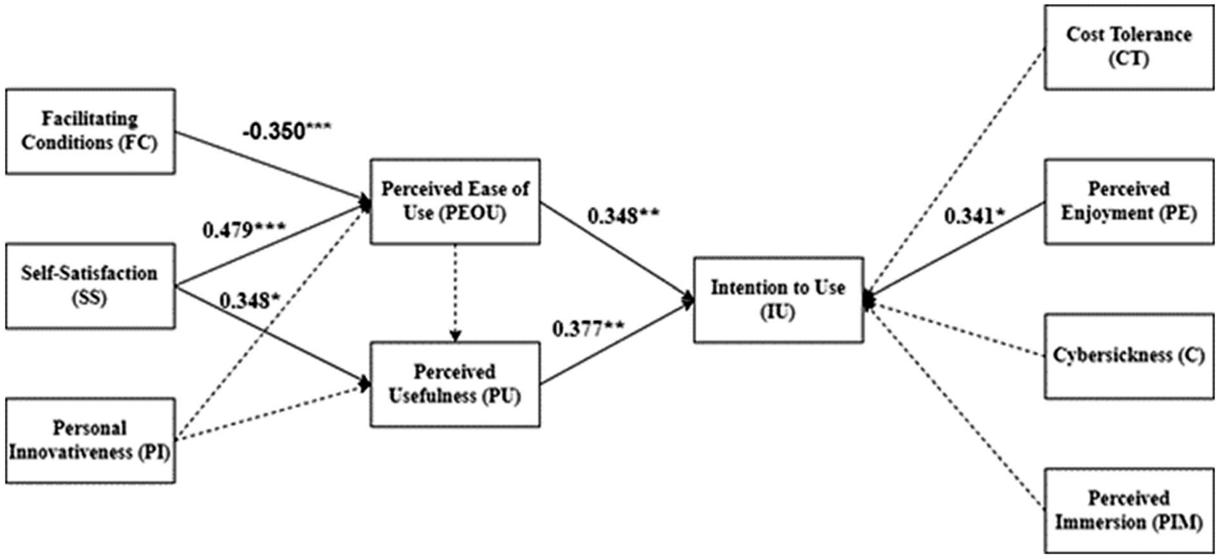

Figure 3. Results of VR exergames acceptance model for Chinese older people (dotted lines indicate non-significance).

Table 7. Correlation between VR exergame constructs and demographics.

	Age	Education	Marital status	Working status	Economic status	Health status
Age	1	−.084	−.156	.192	−.081	.098
Education	−.084	1	.038	−.027	−.410**	−.138
Marital status	−.156	.038	1	.029	−.039	.148
Working status	.192	−.027	.029	1	.027	.085
Economic status	−.081	−.410**	−.039	.027	1	.140
Health	.098	−.138	.148	.085	.140	1
PU	−.234	.210	−.168	−.168	−.013	−.194
PEOU	−.247	.427**	.022	.308*	−.187	−.191
IU	−.298*	.446**	−.100	−.080	−.298*	−.281*
FC	−.115	.064	.061	−.153	.108	.243
SS	−.354*	.479**	.043	−.109	−.350*	−.187
CT	−.013	.078	.003	.092	.045	−.166
PE	−.301*	.263	−.087	.039	−.193	−.148
C	−.085	−.129	.167	−.117	.087	−.016
PIM	−.232	−.019	−.074	.036	.010	.065
PI	−.081	.172	−.090	.336*	−.126	−.184

Note. PU: perceived usefulness; *IU*: intention to use; *PEOU*: perceived ease of use; *FC*: facilitating conditions; *SS*: self-satisfaction; *CT*: costs tolerance; *PE*: perceived enjoyment; *C*: cybersickness; *PIM*: perceived immersion; *PI*: personal innovativeness. $p < 0.05$ are shown with *. $p < 0.01$ are shown with **.

example, for Beat Saber, they wanted to compete with others and share tips for how to play the game ($N = 30$). Participants asked for a multiplayer feature in Dance Central because they wished to have their friends be part of the virtual environment to help them follow up, correct their movements, and improve their dance moves ($N = 22$).

6.4.2. Difficulty

The free trial level of Beat Saber was perceived to be too simple by those participants who regularly do exercise, "*The game is not so difficult, I would like to challenge myself for a harder level*" ($N = 19$), while some participants ($N = 11$) who were relatively more inactive commented that "*I can't follow the rhythm,*" "*I felt sick when cubes are moving faster,*" and "*It is difficult for me to slice with the corresponding color (the correct saber) and slice with the correct direction*". In addition, both male and female participants could not follow the flow of Dance Central; however, female participants were observed to have a better performance than male participants. These participants suggested that it would be good if the flow speed could be adjusted by themselves to fit their abilities and playing preferences better ($N = 45$).

6.4.3. Demographics of the population

Participants played the free trial level of Dance Central and found the dancing style did not match their demographics and cultural background that well. Some of them ($N = 35$) mentioned that "*I have never tried hip-pop, it would be good if they could provide traditional Chinese dance*". Some ($N = 30$) believed that it was acceptable to try new styles, but more consideration should be taken, "*I could not follow the flow because I am not familiar with this type of dancing*". They ($N = 45$) suggested that "*I wish they would allow us to adjust the speed*". In addition, participants requested the game should add Chinese songs ($N = 30$). Gender could also affect participants' choice of exergames. In general, all participants like Beat Saber, but their opinions about Dance Central and FitXR varied. Male participants disliked Dance Central but found FitXR very enjoyable, while female participants who liked dancing preferred Dance Central over FitXR.

7. Discussion and conclusion

This study investigated the factors that could influence the acceptance of VR exergames, a technology-supported solution that could enhance older adults' physical performance, mental well-being, and independent living among Chinese older adults. We conducted an in-person experiment where participants first played three VR exergames (FitXR, Beat Saber, and Dance Central) and were then asked to fill in a structured questionnaire and participate in a semi-structured interview. The questionnaire combined variables from an acceptance model of smartphones for the Chinese elderly (Facilitating Conditions, Self-Satisfaction, Cost Tolerance) (Ma et al. (2016) with variables specific to the experience with VR (new IT-based innovation) and VR exergames (i.e., Personal Innovativeness, Immersion, Cybersickness, Enjoyment) (Disztinger et al., 2017; Sagnier et al., 2020). In addition, the study demonstrated the importance of a series of mediating variables, such as age, economic status, and education level, in understanding the acceptance of VR exergames by Chinese older adults.

Our results show that there seems to be a general tendency to accept VR exergames among these Chinese older adults. Those who are younger, have higher education, are retired, and have better financial situation and good health condition are more likely to accept VR exergames. Age and education are the most significant personal factors influencing the acceptance of VR exergames by these older adults.

Regarding the structural model and constructs, Perceived Usefulness is the most critical factor that needs to be considered since it directly impacts Chinese older adults' intention toward playing VR exergames. This observation suggests that it is crucial (1) to provide VR exergames that effectively improve older adults' health status, and (2) for VR exergame providers to convince older adults that their VR exergames can enhance their health—or at least increase their perception of this.

Unlike prior work focusing on younger adults' intention to use VR (Sagnier et al., 2020), we find a significant positive effect of Perceived Ease of Use on Intention to Use VR exergames, and this result suggests that VR exergames that are easy to use would be more acceptable by Chinese older adults. The VR exergames included in our study are relatively natural to play (based on body motions) (Bowman et al., 2012) and very easy to play (these VR exergames mainly relied on simple movements—e.g., punching for FitXR, hand sliding for Beat Saber, and dancing for Dance Central).

In line with previous studies (Ma et al., 2016), our results suggest that older adults who have higher Self-Satisfaction are more likely to have a higher degree of Perceived Ease of Use and Perceived Usefulness. Therefore, this would imply that VR exergames should provide user satisfaction with their achievements within the games. In addition, we also observed that Enjoyment is a positive predictor of Intention to Use VR exergames, which supports the statement that older adults are more motivated by exergames that are fun to play (i.e., higher enjoyment) (Subramanian et al., 2020).

Many studies suggest that proper training before using an unfamiliar technology is needed and can be helpful for older adults (Lagana, 2008; Sharit et al., 2004), including Chinese older adults (e.g., similar to smartphones (Ma et al., 2016). However, this seems unnecessary for VR exergames since our results indicate that Facilitating Conditions have a negative influence on the ease of use of VR exergames. One possible explanation is that, as mentioned earlier, the VR exergames included in our study are natural and easy to play; hence, they do not need any prior training, which should be the case for motion-based exergames in general.

The qualitative analysis of older adults' comments provided additional insights into their intention to use VR exergames. For instance, the following two social features should be added to future VR exergames ($N = 42$): (1) a *multiplayer mode* to allow Chinese older adults to play with their friends or watch their friends' gameplay, and (2) a *live chat component* to allow them to discuss and share their experiences. In addition, as suggested by 45 participants, there is a need to allow adjusting the difficulty level in the game to make sure the game difficulty fits their current ability. Furthermore, participants highlighted that there is a need to have game content match their demographics and cultural background (e.g., difficulty ($N = 45$), dance style ($N = 35$), and background music ($N = 30$)).

7.1. Recommendations

Based on the above findings from our study, we present the following five recommendations for VR exergames producers to design more acceptable VR exergames that are tailored for Chinese older adults.

1. As Perceived Usefulness had a positive effect on Chinese older adults' intention towards VR exergames, providers of these games should (1) make sure a game is sufficient to provide health benefits to these older adults, and (2) highlight the health benefits these older players could obtain and how effective the game could provide these benefits to the elderly users.
2. Use natural and simple motions (e.g., punching, slicing, dancing) for VR exergames as these motions are easy to use–Perceived Ease of Use is a positive predictor of Chinese older adults' intention to use VR exergames. In addition, no additional facilitation conditions are needed by default when the game only uses easy-to-learn, straightforward, and natural motions.
3. VR exergame producers should provide various in-game achievements to encourage further gameplay. One way to achieve this is to use a badge system (Farzan et al., 2008; Xu, Liang, He, et al., 2020).
4. In line with previous studies (e.g., Aarhus et al., 2011), VR exergames should enable social interaction within these games and encourage older adults to play together in groups or at least with another friend since many

participants ($N = 42$) have expressed the need to play with other players or for others to watch them play. Studies suggest that social interaction could help older adults exchange tips for better performance and, as such, could make them more engaged in a game (Aarhus et al., 2011; Graves et al., 2010; Nawaz et al., 2014).

5. Consideration should be given to the demographics of the population. For instance, dancing games should involve some type of Chinese style dances. Chinese songs can also be provided in rhythmic-based and dancing games. Multiplayer features should be supported since the Chinese elderly are quite social and prefer to play with their peers. Overall, games targeted at Chinese older adults should consider the demographics of this population and adapt the games to them. This can be done with surveys or playtesting while developing the exergames.

7.2. Limitations and future work

Although our findings provide meaningful implications for the Chinese older adults' acceptance of VR exergames, we have identified some limitations that need to be addressed in future research. One limitation of our study is the sample size. Future work could include more participants to determine if further insights can be extracted. In addition, future work could also focus on exploring technology acceptance models among other age groups. For instance, a major player group would be the younger generation of users in China and nearby areas. To do this, modifications to our model would need to be made so that the model is more tailored to the characteristics of these younger users. For instance, one new construct could be about the level of competitiveness, as previous research has suggested that younger users tend to be more competitive than older users when playing exergames (Subramanian et al., 2020).

Other factors such as social influence have been used in the TAM literature but were not included in our study. We did not include social factors as constructs in this study because (1) current VR exergames have relatively limited multiplayer features and, therefore, were not able to show this aspect in a practical and meaningful way to participants; and (2) we want to control the length of the questionnaire to minimize the workload of our participants when answering the questions. It will be helpful to include these constructs in future exploratory models, which we plan to conduct. For instance, they could have the social factor as a construct when VR exergames have enhanced and mature multiplayer features where older adults can play together and chat in real-time because many participants ($N = 42$) expressed the need to involve their friends in not only VR exergames but also other types of games, especially those dealing with cultural artifacts such as Liu et al.'s RelicVR (2021).

In addition, our participants played the three VR exergames for a relatively short time and in the process they received a brief introduction to how these VR games could bring benefits to their physical health. As we did not explore the benefits to their mental health in detail, it would be helpful to have a model to assess older adults' acceptance of playing VR exergames via a long-term study focused on their mental health, similar to Xu et al.'s study with university students (Xu, Liang, et al., 2021). This direction is particularly important given that recent research has shown that VR is effective in supporting the treatment of anxiety or depression for the general population (Baghaei, Ahmadi, et al., 2021); Baghaei, Chitale, et al., 2021); Baghaei, Stemmet, et al., 2021). As such, it will be helpful to explore whether the same effect is found in older adults and whether they would adopt VR as a long-term tool to help enhance their mental health.

Despite these limitations, our study, as the first to explore Chinese older adults' acceptance of VR exergames, presents meaningful findings and insights about the salient factors and aspects of these exergames and VR technology that can determine their acceptance by this population group that is growing rapidly and would likely become a dominant group within China and other places.

7.3. Conclusion

Exergame has long been proposed as a technology-based solution to support older adults in enhancing their physical abilities, maintaining their cognition level, and living independently. This research investigated user acceptance of virtual reality (VR) exergames among older adults in mainland China. Our questionnaire uses the original technology acceptance model and combines variables specific to the Chinese older adults and VR exergames. In addition, the study explored several mediating variables (e.g., age, economic status, education level) in understanding the acceptance of VR exergames by the target population. Our results suggest that (1) Perceived Usefulness, Perceived Ease of Use, and Perceived Enjoyment have a positive effect on their intention to play VR exergames; (2) Self-Satisfaction has a positive impact on Perceived Ease of Use and Perceived Usefulness; (3) Facilitating Conditions have a negative effect on Perceived Ease of Use; and (4) Chinese older adults who are younger, have higher education, are retired, and come with better economic status and health conditions have a more positive view of VR exergames. These results and feedback from our participants led to five design recommendations that could help pave the way for improving the acceptability of VR exergames among Chinese older adults and make them more enjoyable, fitting, and valuable.

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Appendix A. Elderly demographic information.

1. Age.
2. Gender: (a. male, b. female)
3. Living Arrangement: (a. With family, b. Living alone, c. In nursing home, d. With friends)
4. Education: (a. Primary school, b. Secondary, c. Post-secondary, d. Bachelor's degree, e. Graduate degree)
5. Marital status: (a. Married, b. Divorced/separated, c. Widowed, d. Never married)
6. Work status: (a. Full-time, b. Part-time, c. Retired)
7. Source of income: (a. Salary/wage, b. Pension, c. Property, d. Families support, e. Government subsidy)
8. Economic status: (a. Very rich, b. Rich, c. Average, d. Poor, e. Very poor)
9. Health status: (a. Very good, b. Good, c. Average, d. Poor, e. Very poor)
10. Experience with VR: (a. Yes, b. No)
11. Experience with exergame: (a. Yes, b. No)

Appendix B. TAM questionnaire

7-point Likert scale, "1" indicated "strongly disagree", "4" indicated "neutral", "7" indicated "strongly agree".

1. I am likely to play VR exergames in the future.
2. It is possible for me to play VR exergame in the future.
3. Playing VR exergames could improve my fitness.
4. I find VR exergame is a good product to improve my health.
5. I find playing VR exergame useful for my health.
6. Learning how to play VR exergames is easy for me.
7. I am or can be skillful at playing VR exergames.
8. It is important to have someone who can help me with any problems when I use VR technology.
9. Having some training is useful for me before playing VR exergames.
10. Having some training is important for me before playing VR exergames.
11. Playing VR exergames can help me feel or look younger.
12. Playing VR exergames can increase my sense of achievement.
13. Playing VR exergames can help keep pace with current developments.
14. The cost of the VR exergames should be economical.
15. I have no issues paying RMB 3000 to buy a VR device.
16. I would find playing VR exergames enjoyable.
17. I would have fun playing VR exergames.
18. The process of playing VR exergames is pleasant.
19. I might suffer nausea-related symptoms increased salivation, sweating, stomach awareness, burping when playing VR exergames.
20. I might suffer fatigue, headache, eyestrain when playing VR exergames.
21. I might suffer fullness of head, dizzy when eyes open or eyes closed, vertigo when playing VR exergames.
22. When playing VR exergames, I could easily stop thinking of my real-world problems.
23. When playing VR exergames, I forgot the world around me.
24. When playing VR exergames, I would feel immersive in the game.
25. When playing VR exergames, I felt like I am inside that world.
26. If I heard about a new technology, I would look for ways to experiment with it.
27. Among my peers, I am usually the first to try out new technologies.
28. In general, I am hesitant to try out new technologies.
29. I like to experiment with new technologies.