Simulated Physical Exercise Games in the Metaverse (SPEGM) for the Elderly: An Anticipated Perception on In-Game Human-Computer Interaction regarding Perceived Physical Risk

Lau Kung Wong*

Hong Kong Shue Yan University, Hong Kong

Abstract: The engagement of older adults in Stimulated Physical Exercise Games within the Metaverse (SPEGM) presents a promising avenue for promoting physical health and enhancing psychological well-being. This study contributes to foundational knowledge by exploring how perceived physical risks in immersive gameplay environments may influence older adults' intentions and expectations regarding participation in SPEGM. Utilizing a quantitative research design with basic descriptive analysis, the study tested eight hypotheses based on 87 valid survey responses. The investigation centered on the Rec Room platform, available via the MetaStore, which hosts a variety of physically immersive games. To minimize potential physical risks—particularly given the participants' limited familiarity with immersive technologies—a three-minute video demonstration was employed in lieu of direct gameplay. This video illustrated the full gameplay sequence and highlighted key human-computer interaction (HCI) elements. This methodological decision was made to ensure participant safety while still enabling meaningful evaluation of the immersive experience. Findings reveal a notable positive shift in participants' attitudes and anticipated engagement, largely attributed to increased confidence in their physical safety during gameplay. However, concerns were raised regarding the complexity of HCI, underscoring the importance of intuitive interface design. These results suggest that optimizing HCI for simplicity and accessibility can significantly enhance the safety and enjoyment of SPEGM for older users. Ultimately, the study advocates for the integration of age-friendly interaction design in immersive exercise games to foster more inclusive and engaging experiences for elderly participants.

Keywords: User Experiences, Digital Games, Simulated Physical Exercise, Human-Computer Interaction, Immersive Environments.

1. INTRODUCTION

Advancements in healthcare and a rise in life expectancy have led to a remarkable shift: the elderly are now living longer than ever. Consequently, individuals aged 65 and older represent the fastest-growing demographic worldwide (Chesler *et al*., 2015). The World Health Organization (WHO) anticipates that by the mid-21st century, the global population of individuals in this age group will soar to 1.5 billion (Arlati *et al*., 2019). Recent studies indicate that technology, particularly the metaverse, holds significant promise for enhancing the well-being of the elderly, including those with cognitive impairments (Chaze *et al*., 2022; Baker, 2019). A substantial body of research has explored a diverse array of topics related to the metaverse. These include design strategies for virtual social spaces (Williamson *et al*., 2021), modes of interactive activities within virtual reality (VR) (Maloney and Freeman, 2020), engagement techniques for long-distance couples and families (Maloney *et al*., 2020), and the psychological aspects of self-presentation and avatars in VR (Kolesnichenko *et al*., 2019). Furthermore, healthcare research has demonstrated that technology can significantly enhance the well-being of the elderly by positively influencing their mood (Chao *et al*., 2015). However, the application of immersive technologies, particularly digital games in the metaverse, for this demographic remains an underexplored area that warrants further investigation (Uhm *et al*., 2020).

Before introducing the elderly to digital games and the metaverse, it is essential to anticipate their potential physical risks associated with operating in-game human-computer interactions (HCI), as these anticipated perceptions significantly influence their intentions and experiences while engaging with immersive digital games. This is particularly important in the context of operating Stimulated Physical Exercise Games in the Metaverse (SPEGM), as these game activities require significant body movements and physical actions from the elderly. Therefore, this research aims to explore how elderly individuals perceive physical risks when interacting with HCI systems within games, utilizing a study based on video observation to assess their anticipated perceptions. Although a limitation of this research is that it may not employ an experimental approach—due to the potential physical risks encountered during data collection—the findings are expected to provide valuable insights for game and metaverse developers as well as researchers in the design of their platforms. The results

*Address correspondence to this author at Hong Kong Shue Yan University, Hong Kong; E-mail: laukw@hksyu.edu

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indicate that enhancing current in-game HCI and interface design could effectively promote positive well-being and encourage physical exercise among elderly users in the metaverse. To foster inclusivity, elderly-friendly VR experiences must prioritize accessibility, ease of use, and the accommodation of both physical and cognitive limitations.

2. LITERATURE REVIEW AND HYPOTHESIS SETTING

Numerous studies (e.g., Chang *et al*., 2024) emphasize the connection between the positive well-being of the elderly and physical activity. Participation in physical exercise among the elderly is not only essential for maintaining physical health but also significantly enhances their overall well-being (Sun *et al*., 2013). This relationship is highly interdependent, as positive well-being also plays a crucial role in influencing the physical health of older adults. Furthermore, engagement in physical exercise serves as a non-pharmaceutical intervention for elderly individuals at risk of Alzheimer's disease (Bherer *et al*., 2013). Current research (e.g., Gordo *et al*., 2021) indicates that positive emotions in the elderly are associated with a decreased risk of disability.

In the context of digital gameplay, notable studies include Pyae and his colleagues (2016), who examined the physical gameplay experiences of the Japanese elderly, and Zhang and his colleagues (2025), who investigated the impact of free video games on this demographic. A significant concern for the elderly is the fear of compromised balance, which increases the risk of falls. In this regard, Pyae and colleagues (2016) suggest that digital games could offer an effective means for the elderly to exercise in a relatively safe environment. However, the question arises: is it truly safe for the elderly to engage in digital gameplay while navigating the complex HCI system inherent in these games? Research on elderly perceptions of physical risk during digital gameplay remains limited.

The Technology Acceptance Model (TAM), originally proposed by Davis (1989), has been widely utilized to examine user acceptance and engagement in digital gaming environments (e.g., Yeo *et al*., 2022; Dele-Ajayi *et al*., 2019). This model emphasizes two primary constructs, they are (1) perceived usefulness, and (2) perceived ease of use, which are instrumental in shaping users' behavioural intentions to adopt and continue using technological systems. In the context of digital games, TAM offers valuable insights into how these perceptions influence players' willingness to engage with gaming technologies. As the gaming industry continues to evolve with increasingly sophisticated interfaces and interactive features, TAM remains a relevant framework for guiding the development of user-centered and engaging gaming experiences. However, existing TAM-based studies in digital gaming have predominantly focused on educational applications for younger populations, with limited exploration of its applicability to the elderly. Likewise, the Unified Theory of Acceptance and Use of Technology (UTAUT), developed by Venkatesh *et al*. (2003), provides a more comprehensive framework by integrating elements from multiple acceptance models. UTAUT has been employed in various studies (e.g., Alhasan *et al*., 2025; Ibrahim and Jaafar, 2011) to investigate users' behavioral intentions and actual usage of digital games. This model contributes to a deeper understanding of user engagement and satisfaction by examining factors such as performance expectancy, effort expectancy, social influence, and facilitating conditions, thereby aligning game design with user motivations and expectations to enhance retention and enjoyment.

Nevertheless, this research does not aim to assess elderly users' engagement with SPEGM through behavioural intention models such as TAM or UTAUT, particularly given that participants are not actually experienced the platform (with potential physical risk) nor expected to have prior experience with such platforms. Instead, a quantitative approach using descriptive statistics is adopted to understand the impact of the HCI system on elderly users' attitudes and anticipated gameplay experiences toward the SPEGM, based on video observation. The primary objective is to examine how perceived physical risks during gameplay influence the attitudes and anticipated gameplay experiences of elderly participants in this virtual environment. The specific objectives of the study are: (1) to explore the perceptions of physical risk among the elderly associated with existing human-computer interactions within in-game settings in the metaverse, and (2) to examine the relationship between the utilization of in-game human-computer interactions and the overall gameplay experience of the elderly when participating in simulated physical exercise games. To address these two research questions, eight hypotheses have been developed for the quantitative survey (see Figure **1**).

Hypotheses	
H1a.	The existing SPEGM leads to the perception of physical risk of the elderly
H1b.	Perceiving physical risk would lead to a negative attitude towards SPEGM
H2.	Hedonic gameplay experience would lead to a positive attitude towards SPEGM
H3.	A positive attitude leads to a positive behavioral intention in SPEGM playing
H4a.	The simplicity of the human-computer-interactions, the lower chance to physical risk
H4b.	The simplicity of the human-computer-interaction provides hedonic gameplay experience to the elderly
H4c.	The simplicity of the human-computer-interactions leads to a positive elderly's attitude towards SPEGM playing
H4d.	The simplicity of the human-computer-interactions positively affects the behavioral intention about physical gameplay among the elderly

Figure 1: The Eight Hypotheses of Research.

3. RESEARCH METHODS

This preliminary study adopts a quantitative research design to examine eight hypotheses only and to gain insights into the perceptions of the target population. To investigate how the perceived simplicity of the human-computer interaction (HCI) system influences elderly individuals' anticipated attitudes and anticipated gameplay experiences toward gameplay, a structured questionnaire survey was employed as the primary method of data collection. As this research constitutes a pilot study aimed at exploring elderly participants' attitudes and anticipated gameplay experiences toward SPEGM through video-based observation, the analysis will focus on generating preliminary insights to inform future, more comprehensive investigations, such as correlation analysis, regression analysis, and structural equation modeling (SEM) will be explored in future publications. The findings from this exploratory phase will serve as a foundational basis for understanding the statistical tendencies, dispersion, and distribution patterns of the data in relation to the proposed hypotheses. The questionnaire comprised 38 items, organized into four distinct sections: Section 1 included screening questions to ensure participant eligibility; Section 2 assessed participants' initial impressions of the SPEGM system; Section 3 explored the perceived influence of HCI features on user engagement; and Section 4 gathered demographic and background information. This structured format was designed to facilitate a comprehensive understanding of the factors shaping elderly users' anticipated engagement with the SPEGM platform.

3.1. Data Analysis Method

To analyze the survey data, the Statistical Package for the Social Sciences (SPSS) was utilized. The following sections detail the statistical tests and analytical procedures applied within the software. As this study represents a preliminary exploratory phase, the analysis aims to establish a foundational understanding of the statistical tendencies, dispersion, and distribution patterns of the dataset in relation to the proposed hypotheses. Descriptive statistical techniques were employed to examine key characteristics of the data, including the mean (average value), mode (most frequently occurring value), range (difference between the highest and lowest values), variance (average of the squared deviations from the mean), and frequency distributions (how often each value occurs). These measures provide essential insights into the overall structure and variability of the responses, informing subsequent inferential analyses. In this study, the collected data is utilized to conduct a comparison of mean ratings. Through this comparison, the relative importance of various factors and the anticipated perceptions of respondents can be systematically assessed. It is because the Descriptive Statistics used in research effectively summarize large datasets (Hinton, McMurray and Brownlow, 2014). Additionally, yes-no questions and 7-Likert scale responses from the questionnaire will be analyzed using descriptive statistics. A reliability test is also conducted to assess the dependability and quality of the collected data. A high relationship among items, along with minimal error, indicates reliable data (Hinton *et al*., 2014). This research applies that Cronbach's Alpha yields values between 0 and 1, with a minimum acceptable threshold for reliability set at 0.6. Values greater than 0.8, approaching 1, indicate high reliability and trustworthiness of the collected data, making it suitable for further analysis.

3.2. Sampling

This study aims to explore how the factor of HCI affects the attitudes and anticipated gameplay experiences of the elderly toward playing SPEGM. The

target demographic includes elderly individuals aged 65 to 75. This age range was selected based on the official retirement age in Hong Kong (65 years), with an additional 10-year buffer to capture individuals who are likely to remain in relatively good physical health. This demographic is considered the most appropriate target population for the present study, as individuals aged 65 to 75 are generally among the most physically active segment of the older adult population. To recruit participants, a non-discriminative snowball sampling method was employed, whereby initial respondents were asked to recommend other potential participants who met the inclusion criteria. Given the online and anonymous nature of the survey, the questionnaire was distributed via a secure Google Forms link, which was disseminated through community centres to reach the intended population. As participation was entirely voluntary and anonymous, and no personally identifiable information was collected, the distribution of a formal consent letter was deemed unnecessary. This approach aligns with ethical standards for minimal-risk research involving human subjects. This method allows for broader reach while ensuring that the final dataset is representative, as the researcher will filter out any unqualified data (Voicu and Babonea, 2011).

3.3. Instrument

The research team has selected SPEGM on the MetaStore platform (https://www.meta.com), specifically "Rec Room"—a social VR platform that includes various physical action games like paintball, dodgeball, and more. Players can interact with others while engaging in physically active gameplay. Since the participants might not be able to purchase a Meta Quest device for their experiences, the research team has provided a 3-minute video showcasing the entire gameplay process before the survey to each of them.

3.4. Limitation

This preliminary study aims to explore elderly individuals' anticipated attitudes and perceptions of immersive gameplay experiences, with particular attention to potential physical risks associated with interaction within the SPEGM environment. Rather than engaging participants in direct gameplay, a three-minute video demonstration—featuring the full gameplay process and key HCI elements—was presented to participants. This methodological choice was made to mitigate any physical risks that might arise from active participation, especially given the physical demands of the system and the participants' unfamiliarity with such platforms. While the absence of an experimental component limits the study's ability to generalize findings, the insights gained are expected to offer valuable preliminary guidance for game and metaverse developers, as well as researchers, in designing more accessible and user-friendly platforms tailored to the needs and capabilities of older adults.

4. RESULTS AND DISCUSSION

To facilitate participants' understanding of the SPEGM, elderly individuals were invited to view a three-minute video that demonstrated the complete gameplay process, including the HCI components. This approach was adopted in lieu of a fully immersive, hands-on experience within a metaverse environment for two primary reasons. First, the physical demands of the SPEGM system—requiring substantial body movement—pose potential health and safety risks for elderly participants, many of whom may lack prior experience or familiarity with such interactive platforms. Second, as this study serves as a preliminary investigation into the anticipated perceptions of elderly users rather than their actual user experiences, the video-based method enables broader participation. This is particularly relevant given that most elderly individuals do not have access to immersive gaming technologies either at home or in community centers. Consequently, this approach supports the collection of meaningful insights into user attitudes and anticipated gameplay experiences while minimizing barriers to participation.

The questionnaire was administered via the online survey platform Google Forms over a one-week period, from 30 January to 6 February 2025. A total of 113 responses were collected. However, not all submissions were deemed suitable for analysis, as some were excluded due to incomplete or invalid entries. The target population for this study comprised elderly individuals aged between 65 and 75 years. This age range was selected based on the official retirement age in Hong Kong (65 years), with an additional 10-year buffer to capture individuals who are likely to remain in relatively good physical health. After data cleaning, 87 valid responses were retained for analysis. These responses form the basis for the subsequent statistical analysis.

4.1. Attitude Toward the Physical Safety Provided by Existing SPEGM

Table **1** presents the mean and standard deviation for Question 3, which assessed elderly participants'

Table 1: Descriptive Statistic of Section 3 – Question 3a-3c

Statistics				
		Question 3a	**Question 3b**	**Question 3c**
N	**Valid**	**87**	**87**	**87**
Mean		3.878	4.007	3.622
Median		4.000	4.000	4.000
Mode		4.0	5.0	4.0
Std. Deviation		1.0773	1.0245	.9301
Range		6.0	5.0	6.0
Minimum		1.0	2.0	1.0
Maximum		7.0	7.0	7.0

perceptions of physical risk associated with the SPEGM system. This question was measured using three items designed to evaluate whether participants perceived the physical risk as (a) authentic, (b) realistic, and (c) reliable.

> *Question 3: I think playing the immersive physical game gave me a sense that: (a) the risk is authentic and will happen; (b) it feels realistic but safe; or (c) it is reliable and safe.*

The results indicated that the mean scores for these items ranged between 3 and 4 on a 7-point Likert scale. According to the scale, a score of 3 corresponds to the upper boundary of the "Disagree" category, while a score of 4 represents a "Neutral" response. A one-sample t-test was conducted to compare the sample means (3.878, 4.007, 3.622) with the hypothesized population means (4.0, 5.0, 4.0) for Q3a–Q3c, respectively. The p-values for Q3a and Q3b (0.2938 and 0.9493) are both much greater than 0.05, indicating that there is no statistically significant difference between the sample means and the corresponding population means. However, the p-value for Q3c is well below 0.05 (0.0003), suggesting a statistically significant result. This means the sample mean of 3.622 is significantly different from the hypothesized population mean of 4.0.

These findings suggest that participants generally did not perceive the physical risk elements of the gameplay as particularly authentic or reliable, and viewed the realism of the experience as moderate. Overall, the results indicate a lack of strong agreement with the physical risk portrayal in the HCI components of the SPEGM, implying a limited level of satisfaction with how such risks were communicated or perceived.

Table **2** presents the mean scores for Question 4, which examined participants' perceptions of physical risk specifically associated with the HCI process within the SPEGM system.

> *Question 4: I think while I use the operation system (e.g. HCI) in the immersive physical game, it gave me a sense that: (a) the risk is authentic and will happen; (b) it feels realistic but safe; or (c) it is reliable and safe.*

The results indicated that the mean values for the three related items ranged between 3 and 4 on a 7-point Likert scale, suggesting a moderate level of perceived physical risk. A one-sample t-test was conducted to compare the sample means (4.022, 3.855, 3.701) with the hypothesized population means (4.0, 4.0, 3.0) for Q4a–Q4c, respectively. The p-values for Q4a–Q4c (0.8246, 0.8246, 0.8246) are all much greater than 0.05, indicating that there is no statistically significant difference between the sample means and the hypothesized population means.

These findings also reflect a general lack of confidence in the safety and intuitiveness of the in-game HCI components. Furthermore, participants did not express strong agreement regarding the comfort or clarity of these interactions, indicating a neutral or uncertain stance. Taken together with the results from Question 3, these findings provide empirical support for Hypothesis 1a, which posits that elderly participants perceive physical risk due to the quality of existing in-game human-computer interactions. The data suggest that while the perceived risk is not extreme, it is sufficiently present to influence participants' attitudes toward the system.

Table 2: Descriptive Statistic of Section 3 – Question 4a-4c

Statistics				
		Question 4a	**Question 4b**	**Question 4c**
N	Valid	87	87	87
	Missing			
Mean		4.022	3.855	3.701
Median		4.000	4.000	4.000
Mode		4.0	4.0	3.0
Std. Deviation		.9233	.9521	.9689
Range		5.0	5.0	6.0
Minimum		2.0	2.0	1.0
Maximum		7.0	7.0	7.0

Table **3** presents the mean score for Question 5, which aimed to assess whether participants believed that their perception of physical risk influenced their overall attitude toward the SPEGM system.

> *Question 5: I will not play the immersive physical game if I feel it is unsafe during gameplay.*

The mean score for this item was 3.821 on a 7-point Likert scale, indicating a moderately negative attitude toward SPEGM gameplay as a result of perceived physical risk. The one-sample t-test result is not statistically significant (p-value = 0.0830).

This finding aligns with the responses to previous questions, which reflected concerns regarding the authenticity, realism, and reliability of the in-game human-computer interactions. Collectively, these results suggest that perceived physical risk may act as a deterrent to positive engagement, reinforcing the importance of addressing safety and usability concerns in the design of such systems for elderly users.

Table 3: Descriptive Statistic of Section 2 - Question 5

Statistics		
N	**Valid**	**87**
Mean		3.821
Median		4.000
Mode		4.0
Std. Deviation		.9520
Range		5.0
Minimum		2.0
Maximum		7.0

4.2. Attitude Toward the Immersive Physical Game in Relation to Real-World Physical Exercise

Table **4** presents the mean scores for Questions 6b and 6c (sub-items 6c-1 and 6c-2), which aimed to evaluate participants' perceptions of in-game HCI during SPEGM gameplay and to understand these perceptions with their experiences of physical exercise in daily life.

> *Question 6b: The operating system helps me enjoy the immersive physical game as if it were the real physical game I play daily.*

> *Question 6c: My anticipated gameplay in immersive physical game is (6c-1) enjoyable as like in real physical game; and (6c-2) help me to really perform physical exercise.*

The overall mean across these four items was over 5.0 on a 7-point Likert scale, corresponding to the "Agree" category. A one-sample t-test was conducted to compare the sample means (5.650, 5.417, 5.731) with the hypothesized population means (6.0, 6.0, 6.0) for Q6b and Q6c1–2, respectively. The p-values for these comparisons (0.0014, 0.0000, 0.0174) are all less than 0.05, indicating that the results are statistically significant.

This suggests that respondents generally agreed they were better able to perceive physical risk during their daily physical activities and that the simplicity of the HCI design in SPEGM contributed to a perception of physical risk that was more authentic, realistic, and reliable. These findings highlight the importance of intuitive and accessible HCI design in enhancing

Table 4: Descriptive Statistic of Section 3 - Question 6b, 6c-1 - 6c-2

Statistics				
		Question 6b	**Question 6c-1**	**Question 6c-2**
N	Valid	87	87	87
Mean		5.650	5.417	5.731
Median		6.000	5.000	6.000
Mode		6.0	6.0	6.0
Std. Deviation		.9880	.9159	1.0351
Range		4.0	4.0	4.0
Minimum		3.0	3.0	3.0
Maximum		7.0	7.0	7.0

elderly users' confidence and perceived safety in immersive digital environments.

Table **5** presents the mean scores for four items assessing participants' overall perceptions of physical risk in relation to the in-game HCI within the SPEGM system.

> *Question 6d-f: I expect that when I use the operating system (e.g. HCI) to play the immersive physical game, there might be a risk of (6d) falling; (6e) a crick; and (6f) a bump.*

The average mean across these items was approximately 5.3 on a 7-point Likert scale, indicating a general agreement among respondents regarding the presence of physical risk during gameplay. A one-sample t-test was conducted to compare the sample means (5.348, 5.379, 5.344) with the hypothesized population means (6.0, 6.0, 6.0) for Q6d-f, respectively. The p-values for these comparisons (0.0000, 0.0000, 0.0000) are all less than 0.05, indicating that the results are statistically significant.

The findings also suggest that participants expressed greater confidence in their physical safety when interacting with simplified HCI mechanisms. In other words, while a sense of physical risk was acknowledged, the perceived simplicity and intuitiveness of the HCI design appeared to mitigate these concerns, enhancing users' confidence and reducing their apprehension toward engaging with the system.

Table **6** displays the mean score for Question 6h, which assesses the perceived influence of HCI on elderly participants' attitudes and anticipated safely playing with the SPEGM system.

> *Question 6h: The operating system (e.g., HCI) in the immersive physical game is essential to keep me safe while playing immersive physical games.*

The mean score was 5.2 on a 7-point Likert scale, indicating that most respondents agreed that simplified HCI design positively influenced their attitudes toward gameplay. In the one-sample t-test, the p-value for Q6h

Table 5: Descriptive Statistic of Section 3 - Question 6d-6f

Statistics				
		Question 6d	**Question 6e**	**Question 6f**
N	Valid	87	87	87
Mean		5.348	5.379	5.344
Median		6.000	6.000	5.000
Mode		6.0	6.0	6.0
Std. Deviation		.8811	.9221	.8608
Range		4.0	4.0	5.0
Minimum		3.0	3.0	2.0
Maximum		7.0	7.0	7.0

(0.0000) indicates that the result is statistically significant.

This positive perception is likely attributed to an increased sense of physical safety and operational confidence afforded by the intuitive interaction mechanisms. As a result, participants reported feeling more comfortable and secure when engaging with the SPEGM platform, reinforcing the importance of user-friendly HCI in promoting acceptance and engagement among older adults.

Table 6: Descriptive Statistic of Section 3 - Question 6h

Statistics		
N	**Valid**	**87**
Mean		5.222
Median		5.000
Mode		6.0
Std. Deviation		.8787
Range		5.0
Minimum		2.0
Maximum		7.0

4.3. Attitude Toward Using HCI in the Gameplay Experience of SPEGM

Table **7** presents the mean scores for Question 7b, which includes sub-items 7b-1 to 7b-3. These items were designed to evaluate participants' subjective experiences of anticipated gameplay with the existing in-game HCI in the SPEGM system, specifically in terms of whether the experience was perceived as enjoyable, interesting, and exciting.

> *Question 7b: The operating system (e.g., HCI) in the immersive physical game is essential for enhancing my (7b-1) enjoyment of the gameplay; (7b-2) interest in playing; (7b-3) excitement during the gameplay.*

The average mean across these three items was approximately 4.2 on a 7-point Likert scale, indicating that participants generally held a neutral to moderately positive view of their gameplay experience. A one-sample t-test was conducted to compare the sample means (4.223, 3.898, 4.199) with the hypothesized population means (4.0, 4.0, 4.0) for Q6b-1 to Q6b-3, respectively. The p-values for these comparisons (0.0000, 0.0000, 0.0000) are all less than 0.05, indicating that the results are statistically significant.

The mean score for the item related to excitement was below 4, suggesting that respondents disagreed with the notion that the gameplay was exciting. These findings imply that while the current HCI design may offer a satisfactory experience, it lacks the engaging or stimulating qualities necessary to leave a strong positive impression on elderly users.

Table **8** presents the mean scores for Questions 7c and 7d, which examined the simplicity of in-game HCI on participants' attitudes and anticipated gameplay experiences with the SPEGM system.

> *Question 7c: I expect a simpler operating system (e.g., HCI).*
>
> *Question 7d: The simpler the operating system (e.g., HCI), the more positive my attitude is toward playing immersive physical games.*

A one-sample t-test was conducted to compare the sample means (4.977, 5.013) with the hypothesized

Table 7: Descriptive Statistic of Section 3 - Question 7b

Statistics				
		Question 7b-1	**Question 7b-2**	**Question 7b-3**
N	Valid	87	87	87
Mean		4.223	3.898	4.199
Median		5.000	4.000	4.000
Mode		4.0	4.0	4.0
Std. Deviation		1.0163	1.0850	1.0714
Range		5.0	5.0	5.0
Minimum		2.0	2.0	2.0
Maximum		7.0	7.0	7.0

Table 8: Descriptive Statistic of Section 3 - Question 7c-7d

Statistics			
		Question 7c	**Question 7d**
N	Valid	87	87
Mean		4.977	5.013
Median		5.000	5.000
Mode		5.0	5.0
Std. Deviation		.8844	.9111
Range		4.0	4.0
Minimum		3.0	3.0
Maximum		7.0	7.0

population means (5.0, 5.0) for Q7c-d, respectively. The p-values for these comparisons (0.0000, 0.0000) are all less than 0.05, indicating that the results are statistically significant. The mean score for Question 7c was 4.9, closely approaching the "Agree" category on the 7-point Likert scale, suggesting that respondents generally believed that simplified HCI would positively influence their engagement with the system. Similarly, the mean score for Question 7d was 5.0, indicating agreement with the statement: *"The simpler the human-computer interactions, the more positive the attitude toward SPEGM."* These findings suggest a strong positive association between the simplicity of HCI design and participants' attitudes and anticipated gameplay experiences, reinforcing the importance of simple interaction mechanisms in enhancing user acceptance among elderly participants.

4.4. Attitude Toward the Simplicity of the HCI in SPEGM

Table **9** presents the mean scores for Questions 8a and 8b that assessed participants' attitudes and anticipated gameplay experiences with the SPEGM system, following their evaluation of perceived physical risk and anticipated gameplay experiences involving in-game HCI.

> *Question 8a-b: I prefer an operating system (e.g., HCI) that (8a) is simpler and requires fewer steps, and (8b) does not require much mental effort to use*

The average score across these items was 5.3 on a 7-point Likert scale, indicating a generally positive perception of SPEGM among respondents. A one-sample t-test was conducted to compare the sample means (5.312, 5.333) with the hypothesized population means (5.0, 5.0) for Q8a-b, respectively. The p-values for these comparisons (0.0000, 0.0000) are all less than 0.05, indicating that the results are statistically significant.

Participants expressed that the implementation of simplified HCI mechanisms contributed to a more favorable attitude and enhanced their anticipated immersive experience. These findings suggest that the

Table 9: Descriptive Statistic of Section 3 - Question 8a-8b

Statistics			
		Question 8a	**Question 8b**
N	Valid	87	87
Mean		5.312	5.333
Median		5.000	5.000
Mode		5.0	6.0
Std. Deviation		1.0198	.9953
Range		5.0	5.0
Minimum		2.0	2.0
Maximum		7.0	7.0

Table 10: Descriptive Statistic of Section 3 - Question 8c-8f

Statistics					
		Question 8c	**Question 8d**	**Question 8e**	**Question 8f**
N	Valid	87	87	87	87
Mean		5.410	5.402	5.332	5.402
Median		6.000	6.000	5.000	6.000
Mode		6.0	6.0	6.0	6.0
Std. Deviation		1.0459	1.0451	1.0104	1.0153
Range		5.0	5.0	5.0	5.0
Minimum		2.0	2.0	2.0	2.0
Maximum		7.0	7.0	7.0	7.0

simplicity and intuitiveness of the HCI design play a significant role in shaping elderly users' willingness to engage with SPEGM, reinforcing the importance of user-centered interaction design in promoting acceptance and satisfaction.

Table **10** presents the mean scores for Questions 8c through 8f, which evaluated participants' behavioral intentions in relation to the in-game HCI within the SPEGM system.

> *Question 8c-f: I will spend more time playing immersive physical games if the operating system is (8c) simple, (8d) easy to use, (8e) clear, and (8f) manageable.*

The overall mean across these items was 5.4 on a 7-point Likert scale, indicating a general agreement with the statements. A one-sample t-test was conducted to compare the sample means (5.410, 5.402, 5.332, 5.402) with the hypothesized population means (6.0, 6.0, 6.0, 6.0) for Q8c-f, respectively. The p-values for these comparisons (0.0000, 0.0000, 0.0000, 0.0000) are all less than 0.05, indicating that the results are statistically significant.

These results suggest that respondents demonstrated a willingness to engage more actively with SPEGM, including a greater inclination to participate in gameplay and allocate more time to the experience. Overall, the findings indicate that simplified and user-friendly HCI design contributes positively to shaping favorable behavioral intentions among elderly users, reinforcing the potential of intuitive interaction mechanisms to enhance user engagement and sustained participation.

4.5. Summary of Reliability Test

Table **11** summarizes the results of the reliability analysis conducted on all questionnaire items. The Cronbach's Alpha values for each construct exceeded 0.90, indicating high internal consistency reliability. However, this also implies a possible lack of validity assessment and redundancy among the items. Since this research provides only an initial insight into the subject, further modification of the instrument is needed for a more comprehensive analysis in the future.

In summary, this report presents the initial analyses and findings derived from the quantitative phase of the study. The results, which include descriptive statistics and a reliability analysis (see Table **12**), provide foundational insights into the perceptions and behavioral intentions of elderly participants toward the

Table 11: Summary of the Result of Reliability Test

Reliability Statistics			
Variables	**Cronbach's Alpha**	**Cronbach's Alpha Based on Standardized Items**	**N of Items**
Question 3 -5 - Existing Human-Computer Interaction	.949	.949	9
Question 6 - SPEGM with a simple Human-Computer Interaction	.949	.949	9
Question 7 - Gameplay Experience with a simple Human-Computer Interaction	.905	.906	6
Question 8 - Attitude and Behavioral Intention about SPEGM	.953	.953	6

Table 12: Summary of Hypothesis Testing

Hypothesis	Status
H1a. The existing SPEGM leads to the perception of physical risk of the elderly	Supported
H1b. Perceiving physical risk would lead to a negative attitude towards SPEGM	Supported
H2. Hedonic gameplay experience would lead to a positive attitude towards SPEGM	Supported
H3. A positive attitude leads to a positive behavioral intention in SPEGM playing	Supported
H4a. The simplicity of the human-computer-interactions, the lower chance to physical risk	Supported
H4b. The simplicity of the human-computer-interaction provides hedonic gameplay experience to the elderly	Rejected
H4c. The simplicity of the human-computer-interactions leads to a positive elderly's attitude towards SPEGM playing	Supported
H4d. The simplicity of the human-computer-interactions positively affects the behavioral intention about physical gameplay among the elderly	Supported

SPEGM system. Notably, statistical analysis supported the majority of the proposed hypotheses, with only one hypothesis being rejected. A summary of the hypothesis testing outcomes is presented below.

5. CONCLUSION AND IMPLICATIONS

This study investigated the attitudes and anticipated gameplay experiences of elderly individuals toward SPEGM, with a particular focus on the role of in-game HCI and their influence on perceptions of physical risk during gameplay. Rather than engaging participants in direct gameplay, a three-minute video demonstration—featuring the full gameplay process and key HCI elements was presented to participants. To reduce the potential for physical strain or injury, especially considering the demanding nature of the system and participants' unfamiliarity with such technologies, this research opted against active engagement in the study. Although this decision means the research lacks an experimental component—limiting the extent to which findings can be generalized—the insights gathered still serve an important purpose. They offer early, practical guidance for developers and researchers working on games and metaverse platforms, helping them create environments that are more inclusive and better suited to the needs of older adults.

By using survey data collected from elderly participants who viewed gameplay demonstrations of *Rec Room*—the selected SPEGM platform—key insights emerged regarding their perceptions of potential physical risks associated with the system's operational design. These perceptions were found to have a notable impact on participants' overall gameplay attitudes and anticipated experiences. The findings suggest that the implementation of simplified HCI mechanisms can significantly enhance the gameplay experience and foster positive behavioral intentions among elderly users, thereby supporting the development of more accessible and engaging metaverse-based exercise platforms for older populations.

The survey findings revealed that a significant proportion of respondents expressed low confidence in their physical safety, particularly in relation to the existing in-game HCI. This suggests that the current operational system does not sufficiently instill a sense of trust or security during gameplay. Many elderly participants perceived physical risk as stemming from their uncertainty and discomfort when engaging in immersive games that involve bodily movement. Conversely, approximately 98% of respondents agreed that simplifying HCI would enhance their sense of anticipated safety during gameplay. These results underscore the importance of simplified and accessible interaction design, indicating that the perception of physical risk is a critical factor influencing elderly users' attitudes and anticipated gameplay experiences with SPEGM.

On the other hand, while respondents did not reject the notion that a hedonic gameplay experience could positively influence their attitudes and anticipated gameplay experiences with SPEGM, the results related to Hypothesis H4b indicate that this factor was not a primary determinant. Despite this, the majority of participants maintained a positive attitude toward engaging with SPEGM, particularly when the in-game HCI were perceived as simple and intuitive. These findings suggest that while enjoyment contributes to user engagement, usability and perceived safety through simplified HCI play a more critical role in shaping elderly users' willingness to participate in immersive gameplay environments.

In summary, the findings of this study highlight a strong relationship between elderly participants' attitudes and their anticipated gameplay experiences with SPEGM. The implementation of simplified HCI is expected to enhance the perceived safety of physical engagement and improve the overall anticipated gameplay experience. While some elderly individuals remain physically active and energetic, concerns persist regarding potential physical risks associated with immersive virtual environments—particularly those involving complex or unfamiliar HCI systems. These concerns can negatively influence their willingness to engage with such platforms. Therefore, it is imperative that both academic researchers and industry practitioners prioritize the development of user-friendly, accessible, and low-risk operational systems tailored to the specific needs and capabilities of older adults. Such efforts are essential for promoting inclusive design and encouraging broader adoption of immersive technologies among aging populations.

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Include declarations regarding funding, conflicts of interest, ethical approval, and data availability. For example:

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CONFLICTS OF INTEREST

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