EFFICACY OF THE VOICE-ACTIVATED INTELLIGENT PERSONAL ASSISTANCE (VIPA) INTERVENTION ON PSYCHOSOCIAL WELL-BEING AMONG PEOPLE WITH PARKINSON’S DISEASE: A PILOT RANDOMIZED CONTROLLED TRIAL

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Efficacy of the Voice-activated Intelligent Personal Assistance (VIPA) intervention on psychosocial well-being among people with Parkinson's Disease: A pilot randomized controlled trial

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CERTIFICATE OF ORIGINALITY

I hereby declare that this thesis is my own work and that, to the best of my knowledge and belief, it reproduces no material previously published or written, nor material that has been accepted for the award of any other degree or diploma, except where due acknowledgement has been made in the text.

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Abstract

Background:

The increasing prevalence of Parkinson’s disease (PD) underscores the need for tailored interventions. Despite their importance, positive health strategies and psychosocial well-being in PD remain understudied, requiring more empirical evidence to evaluate their effectiveness. This study used a two-stage sequential research process to develop a salutogenic-based voice-activated intelligent personal assistant (VIPA) user protocol and assess its feasibility and preliminary effects in people with PD (PWP).

Method:

Phase 1: Fourteen participants with varying degrees of daily technical use were recruited via purposive sampling from local NGOs to participate in three exploratory, semi-structured focus groups. An interpretive description approach with inductive content analysis was employed to formulate the VIPA user protocol. Three other cognitive interviews were held to assess the protocol’s feasibility and face validity. Five experts specialising in psychology and information technology examined its content validity.

Phase 2a: The Parkinson’s Disease Questionnaire (PDQ-8) was localised in collaboration with the copyright holder, Oxford University Innovation Limited (OUI). Four independent translators and the linguistic manager from OUI were involved in the dual front and back translation, with an expert panel of five healthcare professionals examining the translated scale’s linguistic equivalence and content validity. The face validity was examined through five cognitive inteviews with PWP. Fifty-one PWP were recruited with convenience sampling from local NGOs to complete the PDQ-8, the EuroQol-5d-5L (EQ-5D-5L), the 13-item Sense of

Coherence scale (SOC-13), the Mental Health Continuum Short Form (MHCSF), the UCLA 3-item loneliness scale (UCLA-3), and the Brief Resilient Coping Scale (BRCS).

The 8-week VIPA pilot randomised controlled trial (RCT) recruited 48 PWP. The intervention group (IG) participants received the VIPA user protocol, a training session, and were instructed to use the VIPA 10 times a day, along with access to a tele-support hotline. When control group (CG) participants received their usual care. The primary outcome was the SOC-13. The secondary outcomes were the MHCSF, UCLA-3, BRCS, PDQ-8, System Usability Scale (SUS), and self-reported VIPA usage.

Phase 2b: Seven PWP were selected using extreme case sampling based on their SOC-13 score differences and participated in in-depth interviews exploring their VIPA user experiences. A hybrid thematic analysis, guided by the salutogenic framework, used both inductive and deductive coding approaches.

Results:

Phase 1: A VIPA user protocol with satisfactory face and content validity was formulated based on the overarching theme of *Desirable design of psychosocial-oriented VIPA for PD*, with three sub-themes: *Versatile role of VIPA*, *All-in-one information hub*, and *Desirable designs in VIPA*. The majority of participants valued the health-informative and assistive domains of the VIPA and identified secretarial and caregiving roles as the most helpful in managing PD symptoms, which could also connect PWP with readily available community and online resources.

Phase 2a: The PDQ-8 demonstrated satisfactory internal reliability (Cronbach's alpha= 0.79), mean inter-item correlation (0.32), and item-total correlation (all items > 0.3, except for *stigma*). Significant correlations with the EQ-5D-5L index score ($r = -0.63$, $p <. 01$) and visual analogue score ($r = -0.36$, $p < .05$), SOC-13 ($r = -0.51$, $p < .01$), MHC-SF ($r = -0.50$, $p < .01$), and UCLA-3 ($r = 0.34$, $p < .05$) scores were identified. No floor or ceiling effects were detected.

In the pilot RCT, the IG participants reported fair adherence (30%) and high retention (83%) with the VIPA intervention, with an average VIPA usage of 6.2 successful commands per day. The average SUS score was 60.25/100, indicating moderate usability. No significant mean differences or group*time effects were identified between the IG and CG participants on SOC-13 ($\beta = -2.42$, $p = 0.36$), BRCS ($\beta = 0.59$, $p = 0.34$), MHCSF ($\beta = 0.20$, $p = 0.94$), PDQ-8 ($\beta =0.60$, $p = 0.59$), and UCLA-3 ($\beta =-0.12$, $p = 0.84$). A significant group*time effect for emotional well-being of MHCSF, indicating a decrease in positive emotion, was identified in the post-test ($\beta =-1.77$, $p < 0.05$) but not in the follow-up test ($\beta = -1.06$, $p = 0.25$).

Phase 2b: The overarching theme was identified as *A promising tool to regain control over PD*. Four main themes emerged from the explanatory qualitative interviews: *Symptoms severity as motivation to comprehend PD via the VIPA*; *An auxiliary home-alone remedy to manage PD symptoms*; *Regaining control over PD*; and *Calling for a 'motherly' voice*. The intervention was likened it to an electric wheelchair in bypassing their once disabling motor symptoms. Other participants reported with a suboptimal PD-friendliness user experience, with a sense of abandonment induced if they were unable to initiate a conversation with the VIPA.

Conclusion:

The VIPA demonstrated satisfactory applicability, acceptability, and feasibility on the participants during the intervention period and could serve as participants' Generalized Resistance Resources in accessing assistive functions to facilitate their daily lives.

The qualitative data suggested VIPA could nurture PWP's sense of control and autonomy within the SOC meaningfulness domain and address both of their problem-focused and emotion-focused needs. Participants recommended the VIPA to PWP with higher impairment levels or if those who were homebound to support their caregivers. Unsuccessful attempts at interaction sometimes resulted in feelings of abandonment, and were reflected in a temporary adverse effect on participants in the GEE model, but typically subsided after successful interactions. Participants offered suggestions for improving the VIPA's PD-friendliness and for minimising undesirable emotions.

This study also validated an international QOL scale for local PD research and introduced a novel salutogenic technological intervention, a VIPA. This technological implementation was noted shifting the coping strategies of the participants towards a problem-focused approach for managing their motor symptoms and promoting their psychological well-being and meaningfulness domains.

Publications, Conference Presentations and Patents

Publications related to thesis study

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1. Lau, T. K., Tse, M. K., Liu, Y., & Leung, A. Y. (2025). Effectiveness of technological interventions on psychosocial well-being and perception of technological interventions among people with Parkinson's disease: A systematic review. *Australasian journal on ageing*, *44*(2), e70034.
2. Liu, Y., Leung, A.Y.M, Lau T. K., Montayre, J., Wang, W. Wang, S., Huang, Y. (2024). "Sense of coherence in stroke: A concept analysis with Rodger's evolutionary approach." Nursing & Health Sciences 26(3): e13151.

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Conference Presentations

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Other publications and patents during PhD study

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2. Leung, A. Y. M., Lau, T. K., Molasiotis, A., & Cheung, R. (2024). An Internet-based Infectious Disease Prevention and Control Training System and Method (一种基于互联网的传染病防控培训系统和方法). (Hong Kong Short Term Patent Registry No. *30086664;* PCT Patent Application No. PCT/CN2024/076227; China Patent CN202310214233.0).
3. Leung, A. Y., Lau, T. K., & Leung, D. Y. (2023). BLENDED GAMING COVID-19 TRAINING SYSTEM (BGCTS) FOR RESIDENTIAL CARE HOMES: A CLUSTER RANDOMIZED CONTROLLED TRIAL. *Innovation in Aging*, *7*(Suppl 1), 564.

4. Leung, A. Y. M., Lau, T. K., Molasiotis, A., & Cheung, R. (2023). Game.ICT (Infection control training system). https://research.polyu.edu.hk/en/publications/gameict-infection-control-training-system
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6. Leung, A. Y. M., Zhao, I. Y., Lin, S., & Lau, T. K. (2022). Exploring the presence of humanoid social robots at home and capturing human-robot interactions with older adults: experiences from four case studies. In *Healthcare* (Vol. 11, No. 1, p. 39). MDPI.
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8. Leung, A. Y. M., Lau, T. K., Cheung, D. S. K., Tse, M., Leung, Y. P., Wong, E., ... & Molasiotis, A. (2021). Development and Testing of the Blended Gaming COVID-19 Training System (BGCTS) with WHO guidelines for staff in residential care homes. In *The 28th Annual Conference of the Hong Kong Association of Gerontology*.

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Table of contents

List of Tables

List of Figures

List of abbreviations

PD	Parkinson’s disease
PWP	People with Parkinson’s disease
H&Y scale	Hoehn and Yahr scale
QOL	quality of life
WHO	World Health Organization
VIPA	Voice-activated Intelligent Personal Assistant
MMAT	Mixed Method Appraisal Tool
SOC	Sense of coherence
GRR	Generalized Resistance Resources
SRR	Specific Resistance Resources
A.I.	Artificial intelligence
RCT	Randomized Controlled Trial
RQ	Research Question
PDQ-8	8-item Parkison’s Disease Questionnaire
i-CVI	item-Content Validity Index
EQ-5D-5L	EuroQol-5D-5L
MoCA	Montreal Cognitive Assessment
MCI	Mild Cognitive Impairment
MMSE	Mini-mental State Examination
NGO	Non-governmental organization
MDS-UPDRS	MDS-Unified Parkinson’s Disease Rating Scale
MTUAS	Media and Technology Usage and Attitudes Scale
IG & CG	Intervention & Control group
SOC-13	13-item Sense of Coherence Scale
UCLA-3	UCLA three-item loneliness scale
MHC-SF	Mental Health Continuum Short Form
SUS	System Usability Scale
BRCS	Brief Resilient Coping Scale
GEE	Generalized Estimating Equations
MCAR	Missing completely at random
MI	Multiple imputation
T0, T1, and T2	Baseline, Post-intervention (week 8), and Follow-up (week 12)

Chapter 1: Introduction

1.1. Introduction

The first chapter serves as an introduction to the thesis, providing background information on the current study, containing disease information about Parkinson's disease (PD), the psychosocial needs of people with PD (PWP), and the thesis outline.

1.2. Prevalence of Parkinson's disease

PD is one of the two most common and fastest-growing neurodegenerative disorders worldwide (NIEHS, 2021). Based on the estimation in 2016, 6.1 million individuals around the globe had been diagnosed with PD (Dorsey & Bloem, 2018), and it is projected to affect 9.3 million individuals by 2030 (Dorsey et al., 2007). The high incident rate of PD has been described by scholars as the "Parkinson Pandemic" (Dorsey et al., 2018). As of 2019, approximately 1.7 million people suffer from PD in China and 12,000 in Hong Kong (CUHK, 2019). The average age of diagnosis is approximately 66 years old (Wong et al., 2014), with males being 1.5 times more susceptible to the disease than females (Wooten et al., 2004) and increased lifetime risk till 89 years old (Driver et al., 2009).

1.3. Symptoms and diagnosis of Parkinson's disease

The wide range of motor symptoms experienced by PWP originated from the pathological changes of dopaminergic neurons and the buildup of α-synuclein protein in their substantia nigra, (Poewe et al., 2017; Reeve et al., 2014). PWP would experience complex motor dysfunction in gait, speech, handwriting and difficulty generating force or precision grip (Moustafa et al., 2016). Initially, the diagnostic criteria from the Parkinson's Disease Society Brain Bank focused on motor symptoms, such as bradykinesia, and cardinal motor symptoms, such as muscle rigidity and resting tremors (Hughes et al., 1992). The 5-level Hoehn and Yahr scale (H&Y scale) (Hoehn & Yahr, 1967) has been widely adopted as a professionally administered assessment tool to assess PWP's functional disability and disease progression. PWP in stage 1 will only experience minimal functional impairment and unilateral symptoms, and stage 2 involves bilateral motor symptoms without balancing issues. Stage 3 patients would be identified with disrupted postural reflexes and a moderate level of impairment but are still independent. The distinction between the last two stages is that stage 5 individuals would be chair- or bed-bounded if unassisted, while stage 4 PWP could walk unaided (Bhidayasiri et al., 2012).

Meanwhile, PWP's non-motor symptoms could begin prior to their disease diagnosis and negatively impact their life expectancy and their quality of life (QOL) greater than motor symptoms (Chaudhuri et al., 2006; Pfeiffer, 2016; Schapira et al., 2017). They suffered from sleep disturbance, neuropsychiatric, and sensory symptoms (Chaudhuri et al., 2006). The Movement Disorder Society recently revised PD diagnostic criteria to highlight non-motor PD manifestations (Postuma et al., 2015). The introduction of sleep and psychiatric features, such as depressive and anxiety symptoms in PD diagnostic criteria, signified the increased recognition of the psychosocial domain among PWP and how influential non-motor symptoms are to their well-being. More importantly, the COVID-19 pandemic has unearthed the long-hidden psychosocial needs of PWP and is likely to persist in the post-COVID era(Subramanian et al., 2021).

1.4. Psychosocial well-being in PWP

To fully understand how non-motor symptoms could impact PWP's psychosocial well-being, the construct of psychosocial well-being should be first introduced. The modern well-being framework can be traced back to the Aristotle era (Disabato et al., 2016; Ryan & Deci, 2001). Psychological well-being represents an individual's optimal functioning on a personal level, featuring six domains: Autonomy, Environmental mastery, Personal growth, positive relation with others, purpose in life, and self-acceptance (Ryff, 2013). In 1998, Keyes (Keyes, 1998) expanded the intrapersonal domain to the societal level and formulated the concept of social well-being. Meanwhile, hedonic well-being (emotional) is subjective well-being and emphasizes life satisfaction, positive affects, and avoiding undesirable emotions (Joshanloo, 2019; Ryan & Deci, 2001).

Psychosocial well-being was hypothesized as a superordinate concept over the three psychological, emotional, and social well-being constructs (Eiroa-Orosa, 2020; Martikainen et al., 2002). Keyes (Keyes, 2005) integrated these three well-being domains into a separate yet correlated unipolar continuum with mental illness and stressed on its significance to mental health. Similarly, such an approach coincides with the WHO's interpretation of mental health as not merely the absence of mental illness but a complex interaction between one's intrapersonal, societal, and structural determinants (Keyes & Haidt, 2010; WHO, 2022b). This framework has then been further examined through confirmatory factor analysis to form three second-order factors hierarchical structures (Gallagher et al., 2009).

From the emotional well-being perspective, the high prevalence of comorbidity with depression (Aarsland et al., 2012) and anxiety (Pontone et al., 2013; Yamanishi et al., 2013) were associated with motor and autonomic dysfunction, and the symptoms severity of PWP (Sagna et al., 2014). While these overlapping symptoms with depression, such as hypomimia, motor retardation, sleep disturbance, or the episodic anxiety features with motor disability, contributed to the underdiagnoses among the PD population because of their ambiguity or the non-adherence to the Diagnostic and Statistical Manual of Mental Disorders' anxiety diagnostic criteria (Pachana et al., 2013; Pontone et al., 2009). Even though existing literature showcasing how the emotional well-being aspect was hampered by PD, the dissensus on handling PD mood disorder remains an obstacle (Lintel et al., 2021).

Research has shown PWP's psychosocial well-being is affected by their disease symptoms. Psychological well-being was moderately impaired by non-motor symptoms such as fatigue, mood symptoms, and sleep deprivation (Nicoletti et al., 2017). In addition, the deeply rooted self-stigmatizations were documented throughout PD history, from a 1995 study (Nijhof, 1995) to a recent self-stigmatized focused review (Hanff et al., 2022). Finally, PWP were identified with lower perceived autonomy than those without PD (Vardanyan et al., 2022). Psychological well-being was protective against PD symptoms (Vescovelli et al., 2018). At the same time, PWP would become more and more vulnerable to decreased autonomy and grow dependent on their caregiver due to its progressive nature.

Secondly, the deteriorated physical and mood symptoms also disrupted PWP's social domain. PWP's social domain is also severely affected by hypomimia, dysarthria, and the decreased ability to recognize emotional cues, leading to stigma and loneliness (Prenger et al., 2020). Moreover, some PWP would conceal themselves from others because of symptoms deterioration and accompanied embarrassment (Soleimani et al., 2014). Hypomimia (facial masking) was also positively correlated with the experience of social rejection in PWP (Gunnery et al., 2016). The prolonged social isolation and reduced social contact were linked to an increased risk of dementia in the general public (Kuiper et al., 2015), worsening PWP's physical and mental health, increasing their mortality rate (Brooks et al., 2021; Subramanian et al., 2020), and the loneliness feeling could affect the depressive symptom severity and sleep dysfunction (Subramanian et al., 2020).

1.5. Summary

Existing PD research focused on the pathogenic aspect of their experienced symptoms, in light of the lack of positive-oriented and well-being research on PD (Cools et al., 2020; Vescovelli et al., 2018). There is a dire need to review the current evidence on PD psychosocial research and address their long-ignored needs. Therefore, the following chapters are dedicated to identifying, developing, and testing for a positive health-orientated PD psychosocial intervention to promote PWP's psychosocial well-being.

1.6. Thesis outline

The current thesis included seven chapters to illustrate how the salutogenic Voice-activated Intelligent Personal Assistant intervention (VIPA) was developed and implemented to promote PWP's psychosocial well-being. Chapter 2 contains the literature review on identifying suitable technologically imbued interventions and the salutogenic frameworks adopted to guide intervention development. Chapter 3 describes the methodology of the doctoral study across different phases to address the identified research questions. Chapter 4 presents the validation result of the 8-item Parkinson's Disease Questionnaire. Chapter 5 documents the VIPA user protocol development and its feasibility. Chapter 6 contains the quantitative and qualitative results from the pilot RCT and explanatory interviews, detailing the intervention's preliminary efficacy to promote sense of coherence and PWP's user experience. Chapter 7 discusses the findings and compares with existing research. Chapter 8 highlights the significance of the current thesis across academic and clinical professions and concludes the doctoral research.

Chapter 2: Literature review

2.1. Introduction

The following chapter contained a literature review of existing non-pharmacological PD research on the psychosocial domain and a systematic review of technological PD interventions to examine their potential therapeutic psychosocial effects and PWP user experience, which served as the foundations of the current thesis. Finally, the theoretical salutogenic framework was introduced to guide the intervention selection and subsequent development.

2.2. Existing Research on Non-Pharmacological PD Intervention

Conventional non-pharmacological PD interventions are pathogenic-orientated. However, a recent stakeholder and expert workshop prioritized researching non-pharmacological interventions in lifestyle management, such as physical activities, caregiver support, stress management, and mindfulness to handle various non-motor PD symptoms (Bogosian et al., 2020). Conventional non-pharmacological interventions supporting PWP primarily focus on physical rehabilitation (Cools et al., 2020) to slow down PD progression or as symptom relief. Little attention has been placed on the positive health approach in creating a more PD-friendly environment for PWP. The following paragraphs discussed how non-pharmacological interventions could benefit PWP's psychosocial well-being.

Recent PD reviews identified that non-pharmacological interventions such as balance training (Šumec et al., 2015), non-motor symptoms management (Hong et al., 2021), dance (Yuxin Wang et al., 2022), Yoga (Sagarwala & Nasrallah, 2020), and massage therapy (Tang et al., 2024) could promote the psychosocial well-being of PWP. Various primary research studies have also highlighted the potential psychosocial benefits. For example, Non-contact boxing could promote quality of life (Combs et al., 2013; Ghaffar et al., 2020; Sangarapillai et al., 2021) and depressive symptoms (Ghaffar et al., 2020); dance therapy to promote happiness, depressive and perceived well-being (Bouquiaux et al., 2022; Hadley et al., 2020; Hashimoto et al., 2015); and Tango to promote social domains of PWP in addition to their emotional aspect (Hackney & Earhart, 2009; Rawson et al., 2019).

Similarly, PD psychotherapies primarily focus on the psychological dimension of PD. Where Cognitive behavioural therapy was considered most effective against depression and sleep disorder for PWP (Koychev & Okai, 2017; Zarotti et al., 2021), other psychotherapies such as psychodrama (Sproesser et al., 2010), hope therapy (Moghtaderi et al., 2020; Saffarinia et al., 2019), and strength-based, hope-instilling programme (Murdoch et al., 2020) on PWP also documented significant improvement of PWP's QOL, psychosocial well-being, self-efficacy, and reduced depressive, anxiety, apathy, loneliness and insomnia symptoms.

2.2.1. The Future of Technologized and Personalized Home-based Approach

Scholars have advocated the transition of a patient-centered home care approach for future PD care, utilizing technologies to connect PWP with their geographically separated family members and enhance the accessibility of care providers (Achey et al., 2014; Dorsey et al., 2016). However, all aforementioned interventions demonstrated their potential for mental health promotion but would require active professional input, from protocol formulation to implementation. The presence and skills of the involved professionals may increase the variance between each delivery and limit the accessibility of the interventions. The insufficient resources for PD-focused healthcare professionals and technology access have been a withstanding issue hindering the care quality and accessibility to essential healthcare services (Subramanian et al., 2021). It is necessary to search for alternatives to professional-driven intervention. Due to recent technological advancements, technology-enabled care is believed to facilitate rehabilitation, promote remote care, enhance PD care accessibility and continuity, and provide personalized self-management care at community setting (Luis-Martínez et al., 2020). The following paragraphs will introduce a potential technologically imbued intervention to serve the PD population.

2.2.1.1. Potential Alternative—VIPA Intervention

To begin with, Voice-activated Intelligent Personal Assistant (VIPA) is a form of virtual assistant with artificial intelligent (A.I.) embodied in commercialized smart phones and smart speakers (e.g., Amazon Echo, Apple HomePod mini, Google Dot, etc.). They have been in popular demand in the western society, and approximately 146.9 million smart speakers were sold in 2019 (Koksal, 2020). They can perform the following duties: basic greetings, performing social games (generally in quizzes or trivia), and managing users' email, social network, and personal schedules (Reis et al., 2017).

Three reviews identified the current VIPA research on older adults were primarily in pilot stage, explorative, and stayed on a qualitative and descriptive level. Although not many studies have focused on the efficacy of VIPA, preliminary evidence showed promising results in using VIPA to counteract experienced loneliness and increase social connectedness (Arnold et al., 2024; Corbett et al., 2021; Kucharski & Merkel, 2020). Besides the overall positive qualitative findings documented in various articles (Kim, 2021; Kim & Choudhury, 2021), recent studies have begun to explore the efficacy of VIPA in different settings. The feasibility test of McCloud et al. (McCloud et al., 2022) reported that the VIPA could connect them to the world and ignite their interest in music and history among 39 older adults with low economic status. In addition, they also reported 38% of daily usage and 72% of participants willing to continue using the speaker. Other studies explored the efficacy of combining the VIPA with other smart home technologies or tailored applications. Smart home appliances (e.g., smart switches, lighting, doorbell, vacuum, etc.) significantly improved the quality of life among 60 older adults living alone within 12 weeks (Aggar et al., 2023). In addition, tailored applications were found to integrate with the VIPA to provide cognitive and exercise training. The metamemory programme from Kim et al.(J. Kim et al., 2021) study reported a significant improvement in cognitive ability in the intervention group, while another smart speaker-based exercise recorded a 115% adherence rate but a non-significant difference in participants' QOL (Jansons et al., 2022). These studies illustrated the potential of using the VIPA as a standalone intervention to a home-based approach.

Concerning VIPA usage, the most used functionalities among older adults were reminder settings, information searching, and weather checking (Arnold et al., 2024). Similar usage was also identified in the PD population within Duffy and team online survey (Duffy et al., 2021). Out of 290 recruited PWP, 70% owned a VIPA, 80% used it daily, and more than half could issue verbal commands without constantly repeating themselves. Moreover, it is also worth mentioning that around 30% of them would adopt the VIPA to address PD-related needs. PWP reported using the built-in speech-to-text function to cope with tremors and setting reminders for their medications. This study suggested PWP would use the VIPA similarly to other older adults, with additional PD-specific coping functions. The promising results on VIPA's usability, acceptability, and psychosocial promoting properties hint at the possibilities of implementing VIPA as a coping mechanism for PWP.

Secondly, the ability to converse with users allows VIPA and conversation agents to act as social companions for older adults and PD patients of old age to improve their social connectedness and companionship to reduce loneliness (Eschweiler & Wanner, 2018; F. Corbett et al., 2021). To instill a sense of warmth and sociability among PWP, this intervention should also mimic real-life interpersonal relationships or provide actual means of communication (Hassanein & Head, 2007). A retrospective analysis of user reviews identified virtues such as companionship, reminders, entertainment, home control, and emergency contacts that were highly sought after when older adults purchased a commercial VIPA (O'Brien et al., 2020). Similar loneliness and social isolation-related user reviews were also found in Chinese-speaking older adults, suggesting these mental health-promoting properties (Chung & Woo, 2020) were replicable across cultures. Moreover, older adults were observed to have a higher usage and were more likely to see other VIPA as a companion than younger adults (Oh et al., 2020). Although VIPA has gained momentum in the academic field in recent years, there is an existing gap in education and health domains (de Barcelos Silva et al., 2020). More sophisticated research on how VIPA could impact PWP or older adults' psychosocial well-being is needed to enhance the current evidence level and examine the efficacy of such implementation.

2.2.1.2. Literature Review Summary

A review conducted by Thangavelu and team (Thangavelu et al., 2022) concluded It is viable to convey psychotherapy via virtual reality to reduce anxiety symptoms in PWP. After examining the current literature, no existing review investigated the efficacy of implementing technological PD intervention to promote PWP's psychosocial well-being and PWP's user experience on these interventions, and there was a lack of PD-specific VIPA intervention. Therefore, a systematic review titled "Effectiveness of Technological Interventions on Psychosocial Well-Being and Perception on Technological Interventions among People with Parkinson's Disease: A Systematic Review" was conducted in 2021 to synthesize current evidence.

2.3. Systematic Review on the Efficacy of Technological Intervention for PWP

Part of the findings in the following section were published in "Australasian Journal on Ageing, Appendix 1": Lau, T. K., Tse, M. K., Liu, Y., & Leung, A. Y. (2025). Effectiveness of technological interventions on psychosocial well-being and perception of technological interventions among people with Parkinson's disease: A systematic review. *Australasian journal on ageing*, *44*(2), e70034. doi:10.1111/ ajag.70034.

The majority of the existing PD non-pharmacological interventions were physical rehabilitation orientated (Cools et al., 2020), aiming at symptom relief or delaying PD progression. PD research has also reflected recent technological advancements in combining telemedicine, wearable sensors, Virtual Reality (VR), or exoskeletons with neurorehabilitation (Luis-Martínez et al., 2020). Research indicates that such applications could promote older adults' PWP's physical and cognitive domains (Bevilacqua et al., 2024). For example, integrating Nintendo Wii with physiotherapy is more effective than traditional rehabilitation in targeting balance and promoting QOL in a recent meta-analysis. Secondly, reviews on wearable devices (Channa et al., 2020; Godoi et al., 2019) or VR rehabilitation (Dockx et al., 2016) also suggested that these technological interventions could nurture PWP’s QOL alongside their physical improvements.

Although the technological PD interventions’ efficacy on improving physical abilities has been thoroughly explored, only one review briefly explored VR training’s usability among two different populations, people with PD or stroke (Sevcenko & Lindgren, 2022). The user experience of PWP with the aforementioned technological interventions and their efficacy on psychosocial well-being remains unknown. Therefore, this systematic review examined the current literature and evaluated the efficacy of technological PD interventions on the psychosocial well-being of PWP's and their user perceptions.

2.3.1. Method

2.3.1.1. Literature Search

The current review systematically searched through five databases in November 2021. Specifically, these databases include PsycINFO, CENTRAL, Embase, Web of Science, and MEDLINE. The PICO search strategy is presented in Table 2.1, utilising Medical Subject Headings (MeSH) for PubMed. A manual search was conducted on the key journal, “Sensors,” and Google Scholar.

Table 2.1. *Search keywords and strategy for databases and MeSH term for PubMed*

Categories	Keywords & synonyms
Population (P)	
Target population AND	aged [MeSH] OR aged[Title/Abstract] OR older adults[Title/Abstract] OR Senior[Title/Abstract] OR over age 60[Title/Abstract] OR over age 65[Title/Abstract] OR elderly[Title/Abstract] OR Young-old [Title/Abstract] OR old-old[Title/Abstract] OR long-term care[Title/Abstract] OR late life[Title/Abstract] OR old age[Title/Abstract] OR older people [Title/Abstract]
Condition	Parkinson Disease[MeSH] OR Parkinson Disease[Title/Abstract] OR parkinsonism [Title/Abstract] OR parkinson's disease[Title/Abstract] OR Parkinson[Title/Abstract] OR parkinsonian syndromes [Title/Abstract]
Intervention (I)	Wearable Electronic Devices [MeSH] OR wearable technology[Title/Abstract] OR wearable sensors[Title/Abstract] OR wearable[Title/Abstract] OR technology[Title/Abstract] OR technologies[Title/Abstract] OR technological intervention[Title/Abstract] OR Robotics[Title/Abstract] OR Robotic[Title/Abstract] OR Robots[Title/Abstract] OR Robot [Title/Abstract] OR social robots[Title/Abstract] OR surgical robots[Title/Abstract] OR assistive robots[Title/Abstract] OR Robotic system[Title/Abstract] OR Virtual reality[Title/Abstract] OR VR[Title/Abstract] OR Augmented reality[Title/Abstract] OR AR[Title/Abstract]
Outcome (O)	psychosocial well-being[Title/Abstract] OR psychosocial wellbeing[Title/Abstract] OR psychological well-being[Title/Abstract] OR psychological wellbeing[Title/Abstract] OR Subjective well-being[Title/Abstract] OR Subjective wellbeing[Title/Abstract] OR social well-being[Title/Abstract] OR social wellbeing[Title/Abstract] OR Life satisfaction[Title/Abstract] OR Happiness[Title/Abstract] OR Quality of life[Title/Abstract] OR social connectedness[Title/Abstract]
Combination	P AND I AND O

2.3.1.2. Screening and Eligibility Criteria

For articles to be selected in the current review, they have to fit into the following inclusion criteria: 1. PD as target population; 2. Primary qualitative, quantitative, or mixed-method research; 3. Implemented technological intervention; 4. Measured user perception or psychological well-being; 5. Year of publishing: 2000-2022; 6. Full-text available. Those that met the following exclusion criteria were not selected: 1. Technology as a relay to deliver professional care or therapy; 2. Pharmacological research; 3. Deep brain stimulation; 4. Grey literature and study protocol; 5. Not available in English.

2.3.1.3. Data Extraction

The researcher first screened the titles and abstracts of the searched articles to identify relevant data for analysis, before proceeding to the full-text screening. The extracted data included authorship, year of publication, study design, PWP demographics, and intervention details along with their results.

2.3.1.4. Quality Appraisal

The doctoral student and another researcher with a master's degree assessed the selected articles independently using the Mixed Method Appraisal Tool (MMAT), formulated by Hong et al. (2018), for all qualitative, quantitative, or mixed-method research designs until consensus. Twenty-five of the selected studies satisfied 3 or more appraisal criteria and demonstrated a good fit for their research questions and study design. One study was recorded as having a high risk of bias because it was a case study. Only three of the selected articles were appraised under the qualitative or mixed-method categories due to their rigorous use of qualitative elements based on the MMAT guideline. No study was excluded due to a low-quality appraisal (Hong et al., 2018).

2.3.1.5. Data Analysis

Because of the complex PD interventional design, the current review adopted the mixed-method data synthesis approach for better synthesis (Noyes et al., 2019). Firstly, qualitative data were synthesised thematically to assess how appropriate, effective and acceptable these technological interventions were from PWP's point of view. Techniques such as inductive free coding, forming descriptive and overreaching themes were applied (Barnett-Page & Thomas, 2009; Thomas & Harden, 2008). The narrative synthesis approach was also used to analyze quantitative data because of the high heterogeneity identified from the reviewed data and deemed unsuitable for meta-analysis (Popay et al., 2006).

2.3.2. Result

The initial search identified three hundred and thirty-six articles from the selected databases, with fourteen additional manual search articles. Forty-nine full-text articles were extracted after removing duplicates and screened for both titles and abstracts. Finally, twenty-seven studies (three from manual search, see appendix 1. Table 2) were selected based on the aforementioned inclusion criteria and displayed in the following PRISMA flow chart (Figure 2.1) (Page et al., 2021).

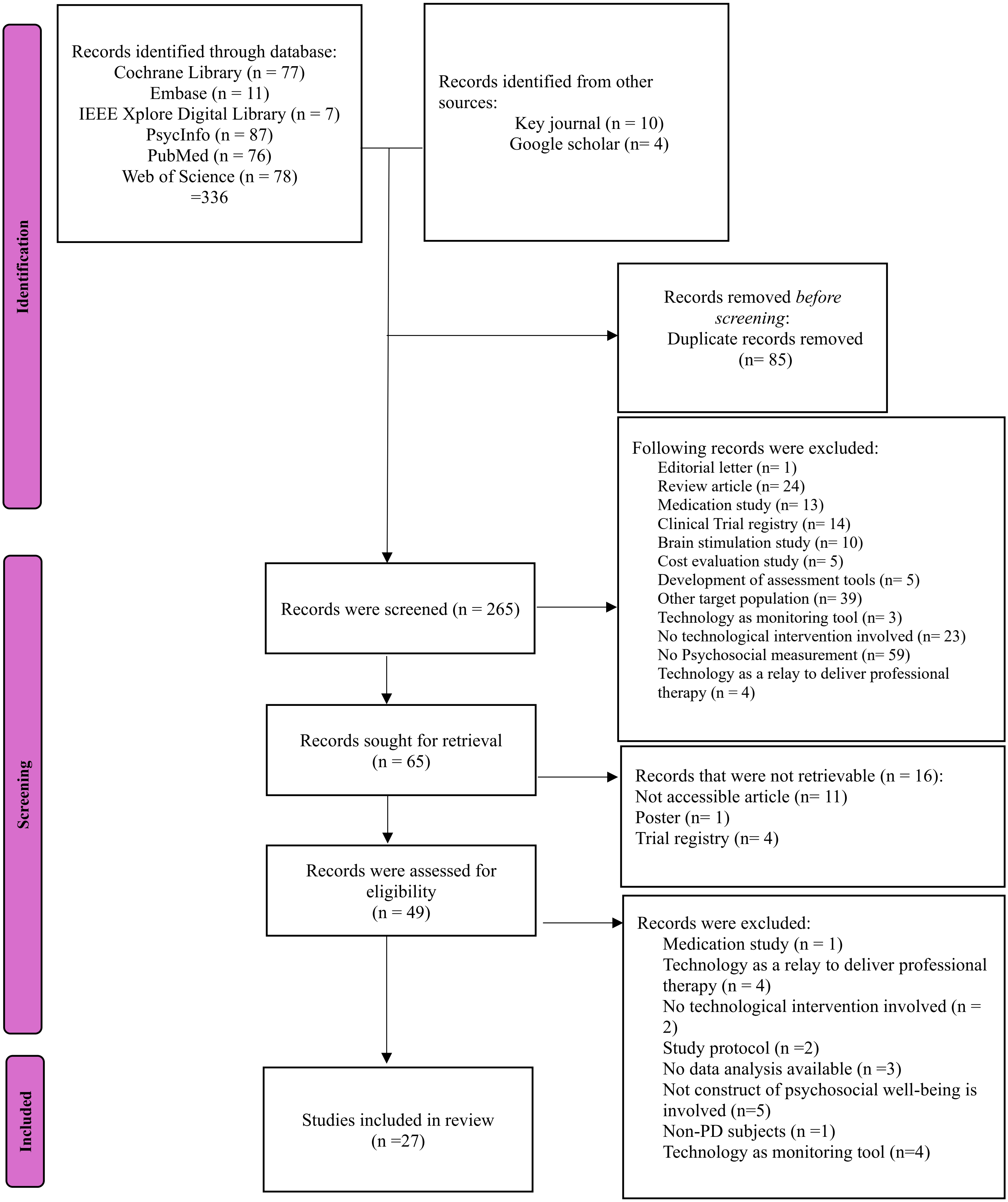


Figure 2.1. PRISMA Flow chart for the systematic review

2.3.2.1. Overview of Review Article

Among the selected articles, twenty-four were classified as quantitative studies, two as qualitative, and one as a mixed-methods study, with an average intervention period of 6.4 weeks. Over half of the study (n=19) was published from 2018 onward and based in European countries (n=13). Other studies were evenly spread across North America (n=5), Asia (n=5), and South America (n=4). The most common technological PD interventions (n=8) were gaming applications and gait training, followed by four studies using wearable devices, 3 with mobile applications, 2 telehealth care, and 2 studies that implemented metronome or social robots. Eleven studies involved VR or AR technologies.

Selected studies documented an average of twenty-eight PWP (range: 1-110), with a total of seven hundred and fifty-two participants and 50.1% being male. The documented mean age varied from 61-74.5 years, with the majority of the studies (n=22) adopted the H&Y scale to assess PD progression.

2.3.2.2. Thematic Synthesis of Qualitative Data

Thematic synthesis generated an overarching theme of "Coping with PD technological interventions", with the following themes on PWP's psychosocial well-being: User perception of intervention design and functional appropriateness, attitude shift during coping attempts, and the perceived psychosocial benefits from technological interventions.

2.3.2.3. User's Perception of the Intervention Design and Functional Appropriateness

Rodríguez et al. (2016) described functional appropriateness as the extent to which an implemented intervention could follow its intended usage. PWP from the selected articles reportedly formed an expectation of the goal, design, and intervention period of the implemented technological intervention before their first use. Interventions that were executed appropriately encouraged a sense of satisfaction, while undesirable emotions could be induced should they underperform.

From the study of Wilson et al. (2020), their participants experienced a sense of frustration upon interacting with the social robot, which they deemed as overcomplicated and commented that it was an "overkill" for medication administration when a phone could suffice. Similarly, confusion among PWP was found in Chatto et al. (2018) A.I. exercising study, where its feedback system was perceived as lacking elaboration or contradicting between its audio and visual commentary. At the same time, the intervention's high satisfaction score was contributed to by its high reliability, ensuring privacy, and ease of operation.

Two selected studies also grant insight into the optimal intervention period. Two exergaming trials held their intervention session between 10 and 30 minutes/ session, with the majority of participants (10/13) being satisfied with the arrangement and showing appreciation (Campo-Prieto et al., 2021; van Beek et al., 2019).

2.3.2.4. Attitude Shift During Coping Attempts

2.3.2.4.1. Initial emotional responses

When the implemented technological interventions were unable to execute their intended use, initial undesirable emotions could be induced. For example, participants experienced a sense of tension and nervousness during task-oriented interventions and could be dejected by their suboptimal performance (Chatto et al., 2018; Sanchez-Herrera-Baeza et al., 2020). Similarly, a feeling of frustration was reported among participants if they were unable to partake in the online support group designed for the Hermanns et al. (2019) activity tracking trial. At the same time, positive emotions such as amusement and enjoyment were noted among gaming and dancing interventions (Nuic et al., 2018; Tunur et al., 2020; van Beek et al., 2019).

2.3.2.4.2. Encountered barriers

PWP reported difficulties with operating the intervention, as well as with some task-based activities being too difficult or too cognitively demanding. Due to the poor sensitivity in the intervention along with unclear instructions, participants needed technical support from their peers and research staff (Chatto et al., 2018; Hermanns et al., 2019; Tunur et al., 2020; van Beek et al., 2019; Wilson et al., 2020).

Secondly, one VR gaming for improving PWP's physical condition was commented as more cognitive than physically demanding for them and posed more of a mental challenge (Sanchez-Herrera-Baeza et al., 2020). Another exergaming study also required PWP to maintain their concentration because of their intervention difficulties (van Beek et al., 2019).

2.3.2.4.3. Attitude shift

The initially lodged emotional response was noticed to gradually subside and shift into a more positive note as they became more experienced in operating the intervention (Sanchez-

Herrera-Baeza et al., 2020). Such transition was also found in another study that utilized an iPad, the initial negative evaluation upon coping difficulties subsided after participants figured out the control (Hermanns et al., 2019).

2.3.2.5. Perceived psychosocial benefits from technological interventions

2.3.2.5.1. Social support

Participants reported improved social relationships and interactions with their peers and families. Interactive components within intervention design are appreciated by participants in the exergaming study (van Beek et al., 2019). Not only did PWP note to provide mutual support to one another by sharing how to handle the aforementioned technical barriers, but they also grew closer with their family members in the process (Sanchez-Herrera-Baeza et al., 2020). Secondly, prosocial behaviours were observed among Hermanns et al. (2019) online support group, where the observed interactions among PWP were described as hopeful and inspiring.

2.3.2.5.2. Autonomy

Participants from Sanchez-Herrera-Baeza et al. (2020) VR gaming revealed that the intervention could encourage participants' autonomy more than the intended physical domains in enhancing their competence in daily life.

2.3.2.6. Effectiveness on improving psychosocial well-being

2.3.2.6.1. Emotional well-being

The current review also synthesized the quantitative evidence on how technological intervention could affect PWP's emotional well-being. The measured emotional scale was commonly found within their corresponding QOL measurements. The most commonly adopted

QOL scale was Parkinson’s Disease Questionnaire (PDQ) (n=14), followed by Short Form-12 & 36 (n=6). Among the 9 studies that reported their emotional well-being subdomain scores, 3 of them recorded significant differences, as shown in the Table. 2.2.

Table 2.2. *Psychosocial improvements identified from reviewed articles*

Reviewed Articles	Scales adopted	Effectiveness
Wearable device		
Cochen De Cock et al., 2021	1. EQ5-D 2. LARS	1. Overall QOL score significantly improved 2. Degree of apathy was significantly decreased.
Volpe et al. 2014	PDQ-39:	Significant improvement on overall QOL score
Mobile apps		
Kim et al., 2021	1. GDS- short form **2.** PDQ-39	1. Significantly reduced in depressive symptoms 2. Significantly improved total score, but not emotional well-being subdomain
Ginis et al., 2016	SF-36	Significant time by group effect on physical health domain, but no significant difference on mental health subdomain
Gaming		
van Beek et al., 2019	PDQ-39	Significant time x group interaction effect in total score for poor dexterity participants
Alves et al., 2018	1. BAI	1. Significantly reduced anxiety levels in Nintendo Wii$^{\text{TM}}$ group till follow up
Ferraz et al., 2018	1. EQ-5D **2.** PDQ-39	Functional training group: 1. Significantly improved total score 2. Non-significant changes Exergaming group: 1. Non-significant changes 2. Significantly improved total score
Pompeu et al., 2014	PDQ-39	Improved total score
Santos et al., 2019	PDQ-39	Significantly improved QOL across all groups.
Telehealth		
Chatto et al., 2018	PDQ-39	Improved QOL score on 1 participant
Isernia et al., 2020	1. SF-12 2. PANAS	1. Significantly improved mental health subscale 2. Significantly improved positive affect
Training		
Brandín-De la Cruz et al., 2020	SF-36	Significant differences documented in physical domains, but not mental health subscale
Capecci et al., 2019	PDQ-39	Significantly improved overall score
Lo et al., 2010	PDQ-39	Meaningful effect size changes on Emotional well-being and Social Support domains, but non-significant change in Communication subscale
Paker et al., 2013	PDQ	Significantly improved overall score
Wang et al., 2020	PDQL	Only non postural instability/ gait difficulty group reported with significant improvement
Yang et al., 2016	PDQ-39	Significantly improved total score for both groups
Pilleri et al., 2015	PDQ-8	Significantly improved total score
Pazzaglia et al., 2020	SF-36	Significantly improved mental composite score
Metronome		
Elston et al., 2010	SF-36	Subjective meaningful change in role limitation (emotion)

Note. Parkinson's Disease Questionnaire= PDQ; Short-Form Health Survey= SF; Positive Affect and Negative Affect Schedule= PANAS; Parkinson's Disease Quality of Life Questionnaire= PDQL; EuroQol- 5 Dimension= EQ-5D; Geriatric Depression Scale= GDS; Lille Apathy Rating Scale= LARS; Beck Anxiety Inventory= BAI.

The two significant improvements documented in the mental composite scores of SF-12 & 36 suggested the implemented VR rehabilitation could either maintain its favourable intervention effect upon integrating with telerehabilitation (Isernia et al., 2020), or was suggested to have better efficacy than traditional treatments (Pazzaglia et al., 2020). Furthermore, Isernia et al. (2020) also reported a small effect size on their other emotional well-being measurement, the Positive Affect and Negative Affect Scale. Secondly, a subjective clinical improvement on the SF-36, role limitation domain was reported in the study by Elston et al. (2010). A small to moderate effect size on the emotional well-being and social subdomains of the PDQ-39 adopted by Lo et al. (2010) was described as an unexpected result.

Four out of eight studies that explored the participants' anxiety and depressive scores documented significant changes, including the reduced anxiety score (BAI) from the Nintendo Wii group in the gaming intervention which could be sustained for a month (Alves et al., 2018); a wearable device, BeatWalk, reduced the apathy score (LARS) but not the depressive nor anxiety level (Cochen De Cock et al., 2021); a mobile health exercise intervention reduced the depressive score (GDS) (A. Kim et al., 2021).

2.3.2.7. Social well-being

The potential social well-being gain was reflected in the qualitative data. Of two studies that encouraged social interaction among their participants, face-to-face sharing or online support groups were included and reported a sense of unison and mutual assistance from peers and their family members (Hermanns et al., 2019; Sanchez-Herrera-Baeza et al., 2020).

2.3.3. Discussion

Most of the selected technological interventions were targeting PWP's physical attributes, and psychosocial-oriented interventions are still lacking. The current review identified the knowledge gap on the insufficient evidence on how these interventions could affect PWP's psychosocial well-being.

2.3.3.1. Unexpected Effect on Psychosocial Well-being

Although psychosocial well-being was not the primary outcome of the review studies, a promising therapeutic effect was identified through both quantitative and qualitative evidence, which complemented each other by highlighting the attitude shift. Another systematic review also identified a reduction of depression and anxiety in the mobility and activity of daily living rehabilitation for the PD population (Yang et al., 2012). These findings align with the unexpected psychosocial benefits identified in the reviewed articles.

Similar to how interactive social components embedded within technological interventions could help older adults living in the community (Heins et al., 2021). The current review identified qualitative evidence on how PWP's social well-being could be nurtured through peer and family support during the implementation of a technological intervention. More quantitative evidence is required to further the efficacy of such online social interaction on PWP's social well-being.

Although participants in the reviewed articles reported a perceived autonomy gain from the interventions, little research had reported their corresponding psychological subdomain scores to quantify it. Future research should address the current knowledge gap on the limited quantitative evidence on the efficacy of the technological intervention on PWP's psychosocial well-being.

Factors Affecting PWP's Psychosocial Well-being

2.3.3.1.1. Coping with Intervention

Coping with technological intervention could affect the psychosocial well-being of PWP. Other review had identified that adverse preconceptions could lead to unsuccessful VR intervention for stroke and the PD population (Sevcenko & Lindgren, 2022). The current research expanded on that notion and further suggested that the functional appropriateness and intervention delivery were also among participants' expectations of the implemented interventions.

2.3.3.1.2. Technological Literacy

Another element that affects PWP in coping with the implementation of interventions was their technological literacy. Dugger Jr (2001) proposed that such literacy could be understood through three different levels: awareness, praxis, and phronesis; one would be required to be aware of the technology first, then master it through training and practices to achieve technological competence (Davies, 2011).

PWP in the reviewed articles identified a lack of understanding of the implemented technology and the required operational techniques, remaining at the awareness and praxis levels. Technical support, such as peer support, was required during the intervention period, as negative emotions would arise if they received inadequate support. While some PWP were noticed to behave at the phronesis level and could advise their peers in Hermanns et al. (2019) study. Initiating a peer support system within the implemented intervention could allow peer technical support and promote social interaction among participants.

The discrepancy between participants' technological literacy and the complexity of the implemented intervention could lengthen the coping process, induce negative emotions, and increase the demand for technical support. Future intervention could therefore consider inviting other experienced participants into the technical support to facilitate peer support.

2.3.4. Intervention Rewardibility and Design

A well-designed intervention should balance its task difficulties and the finishing rewards. Participants with decent performance lodged during the intervention period reported a sense of satisfaction and a heightened sense of self-acceptance and autonomy. On the contrary, suboptimal performance was found to induce stress among PWP.

To ensure a smooth intervention delivery, selected studies suggested various improvements, such as allowing participants to join an introduction before the intervention period (Sanchez-Herrera-Baeza et al., 2020; van Beek et al., 2019) and gradually increasing with each intervention session duration to better fit participants' ability (Tunur et al., 2020). These suggested arrangements could promote intervention coping and reduce the possibilities of inducing undesirable emotions. Finally, scholars advocated that the involvement of PWP in intervention design could refine the implemented intervention and improve the potential therapeutic effects (Revenas et al., 2018).

2.3.5. Quality of Selected Studies

The high heterogeneity of the selected studies did not allow meta-analysis to be performed nor generate an effect size on the psychosocial domain. Secondly, 44% of the selected articles were in pilot stages, which contributed to a small sample size with limited data. Therefore, the findings of the current review may not be generalized to the entire PD population or all PD technological interventions.

Secondly, some of the extracted qualitative data was of low quality. Some of the selected studies did not utilize a rigorous qualitative approach in their research design and could not be identified as mixed-method research under the MMAT. The lowered trustworthiness signified the necessity for more rigorous qualitative research in exploring the user perception of these technological interventions.

2.3.6. Identified Literature Gap

The systematic review first identified the increasing prevalence of technological interventions for the PD population. Although there was an unintended psychosocial gain among the reviewed articles in the systematic review, most of them were designed as physical rehabilitation with a pathogenic approach. There is currently a knowledge gap on how positive-health-oriented psychosocial interventions could maximize these psychosocial therapeutic effects among PWP in the technological era. Such findings resonate with scholars who identify a lack of research on the psychosocial well-being and positive resources of PWP (Subramanian et al., 2020; Vescovelli et al., 2018), with the existing ones primarily focuses on improving participants' motor scorings (Cools et al., 2020). Moreover, the mental well-being measured in the reviewed articles often focuses on emotional well-being and was embedded into QOL scales. There is a need to develop the next generation of psychosocial well-being interventions infused with technology to examine their efficacy beyond emotional well-being.

2.3.6.1. Salutogenesis in PD, a Positive Health Approach

Antonovsky conceptualised Salutogenesis in 1979. This concept differs from traditional pathogenesis and focuses on the interaction between accessible health-promoting factors and identified stressors (Antonovsky, 1979; Langeland & Vinje, 2012). Salutogenesis regards health as a continuum, ranging "from emotional pain and total psychological malfunctioning, at one extreme, to a full, vibrant sense of psychological well-being at the other" (Antonovsky, 1985). Well-being and mental illness are suggested to behave as two distinct yet associated unipolar measures in clinical settings (Keyes, 2005). The increase in the well-being domain is observed alongside the reduction of mental illness. This perspective of the mental health continuum would constitute one's overall mental health (Langeland & Vinje, 2012). Figure 2.2 shows the salutogenic model described by Idan et al. (Idan et al., 2017) and Lindström & Eriksson (Lindström & Eriksson, 2010), integrating with Keyes's (Keyes, 2005) clinical findings and Roskams & Haynes's (Roskams & Haynes, 2020) illustration.

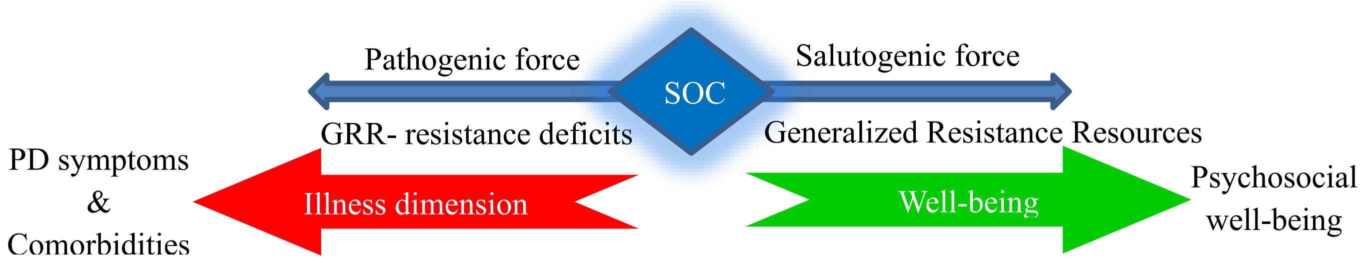


Figure 2.2. Salutogenic model in PD.

Salutogenesis aims to enhance awareness of an individual's existing resources and confidence in utilizing them to promote coping and sense of coherence (SOC) to ultimately attain a state of well-being (Langeland & Vinje, 2017). SOC depicts an individual's global orientation of life and capability to utilize resources to cope with tensions, which could be explained through an individual's comprehensibility, manageability, and meaningfulness (Antonovsky, 1987; Bauer et al., 2020; Lindström & Eriksson, 2005). These three domains each represent a different angle for SOC to impact an individual's life. Comprehensibility represents the cognitive aspect of how an individual perceives and gives cognitive meaning to stimuli from internal and external surroundings. Manageability is the behavioural dimension accounting for one's perception of the capability and availability of their resources to cope with their stimuli. Whereas meaningfulness is the motivational domain to consider life to consist of emotional meanings and worth of their devotion and commitment, instead of a burden, driving them to regard stressors as stimulating and challenging (Antonovsky, 1987; Eriksson & Contu, 2022; Saravia et al., 2014).

The correlation between SOC and perceived mental health (Eriksson & Lindström, 2006) in the general public was also reported among PWP. A strong SOC could positively impact the psychosocial domains of PWP and predict their QOL and emotional distress, but not medical variables (Gison et al., 2014; Pusswald et al., 2012). On top of that, PWP were reported with a lower SOC than other people with non-neurological chronic diseases (Pusswald et al., 2012). Similar associations between SOC and QOL and depressive symptoms were also identified in Caap-Ahlgren and Dehlin (2004) study, stating SOC is a more sensitive measure than the Geriatric Depression Scale or 36-Item Short Form Survey among PWP. In addition, the perceived effective coping strategies were able to mediate SOC and QOL in people with chronic disease, including PWP (Kristofferzon et al., 2018).

2.3.6.2. Existing Salutogenic Research in PD

The salutogenic approach has gained momentum in qualitative research and has been applied to various healthcare studies in recent years. Existing qualitative articles on PD focus on treatment evaluation, experience, needs, the impact of PD (Bramley & Eatough, 2005; Sjödahl Hammarlund et al., 2018), and the adaptation of PD (Rosengren et al., 2021). The two other core domains of SOC, comprehensibility and meaningfulness, were not thoroughly explored. Rosengren et al. (Rosengren et al., 2021) described their retrospective salutogenic evaluation as appealing and hypothesized that SOC could affect PD adaptation among PWP. These articles hint at the salutogenesis approach's applicability in exploring the psychosocial domains of PWP and their coping strategies.

Saboga-Nunes et al. (2022) believe salutogenesis in the digital era could unlock new GRR and specific resistance resources (SRR) in nurturing individual's well-being with newly developed health activities. However, there is also limited SOC interventional study among PWP. Two PD-related SOC interventions were identified. Virtual support groups with video conferencing tools significantly enhanced PD caregivers' SOC (Khalil et al., 2020). At the same time, a non-significant SOC between-group differences (as a secondary outcome) among PWP was reported for an education programme (Chlond et al., 2016). Different technologies have been implemented to promote participants' SOC, highlighting the possibility of integrating the salutogenesis framework into the technology domain. For example, scholars have implemented tele-support for PD caregivers (Khalil et al., 2020) or symphonic virtual reality (Faw et al., 2021) among older community adults to promote their salutogenic qualities. While the majority of the listed studies were not theoretically based on the salutogenesis model and could contribute to their non-significant result in promoting participants' SOC.

2.3.6.3. VIPA Serving as PWP's Generalized Resistance Resources

From a salutogenic perspective, the capability to operate and the access of vast VIPA functionalities fit the narrative of GRR. It beholds a wide range of utilities (e.g., making schedules, phone calls, smart home controls, and marking reminders, etc.) to facilitate coping and enable the use of situational specific resistance resources (SRR), such as accessing specific health information on the Internet or the phone number of their family member (Antonovsky, 1979, 1987; M. B. Mittelmark et al., 2017). Secondly, GRR shared a reciprocal relationship with SOC. The use of GRR will contribute to a greater SOC, and the enhanced SOC would facilitate the utilization of GRR (Antonovsky, 1979; Hochwälder, 2019), forming a positive feedback loop. Such a theoretical stance was supported by an early study by Volanen et al. (Volanen et al., 2004). They showed that social support and accompanied satisfaction were strongly correlated with SOC and suggested that social relationships were reciprocal with SOC.

2.3.6.4. VIPA as a More Comprehensive Psychosocial Intervention

The majority of interventions reviewed in the systematic review were primarily for physical rehabilitation, only 1 study explored the feasibility of implementing social robot, but were commented as overcomplicated and frustrating (Wilson et al., 2020). Although socially assistive robots have been theorized to help maintain PWP's dignity and autonomy (Arkin et al., 2014; Briggs et al., 2015; Pettinati et al., 2016; Wilson et al., 2020). The rigidity of the robot and the inability to comprehend PWP's command would lead to negative emotions. It was argued at this stage of development, socially assistive robots might not be able to fully take up the assistive role, such as medication sorting for PWP or speech interaction in general (Olde Keizer et al., 2019; Wilson et al., 2020).

On the other hand, chatbots have a more sophisticated communication capability but have relatively lower assistive elements embedded. An A.I.-powered chatbot is a software focused on mimicking human-to-human interaction and aimed at monitoring, providing education, and promoting self-management to nurture well-being results in people with chronic disease (Islam et al., 2023; Kurniawan et al., 2024). In addition, the communication process has been found to positively affect PWP's smile index and speech domains (Ogawa et al., 2022). In comparison, VIPA is an electronic appliance with a combined artificial intelligence (A.I.) compartment to communicate with its users. It can also provide assistive features to facilitate users' daily lives. Therefore, when weighing the developmental stage of socially assistive robots, conversation agents, and VIPA, the more sophisticated artificial intelligence from commercialized VIPA and its accompanied assistive functionalities could be a better option for PD research in terms of usability, software sophistication, and the applicable functionalities.

2.3.6.4.1. Highly Anthropomorphic and Usable

Social presence and anthropomorphism could facilitate the exploration of the social domain of the VIPA. Social Presence Theory depicts the degree of psychosocial awareness that one has when noticing another individual during the interaction with a particular medium (Fulk et al., 1987). Thus, if certain media can mimic personal social interaction, they would radiate a sense of warmth and sociability to users and positively correlate to feelings of perceived usefulness and trust (Hassanein & Head, 2007; Yoo & Alavi, 2001). On the other hand, anthropomorphism is the process of instilling human-like features among inanimate objects, considering them as one of our own (Epley et al., 2007; Wan & Chen, 2021).

Anthropomorphism was theorized to be influenced by the socioemotional context of older adults. The lonelier they are, the higher the degree of anthropomorphism (Epley et al., 2007). Inventions such as VIPA have expanded the traditional human-to-human communication mode into human-to-robot interaction. One has been observed to unconsciously apply social rules and behaviours during human-computer interaction (Hassanein & Head, 2007; Nass & Moon, 2000), making interpersonal communication theories transferable to human-to-robot scenarios (Krämer et al., 2012). In addition, human-to-robot interaction could be as valuable as conventional communication methods. Wu et al. (2017) proposed that life-like communication with a friendly approach could better foster attachment over computer-like interactions. The correlation between anthropomorphism and loneliness (Epley et al., 2007) was supported by a qualitative study by Pradhan et al. (2019). VIPA was observed to be personified by older adults, especially when they were lonely and needed social contact. In addition, the machine-like appearance was perceived as a better service provider than their human-looking counterparts (Kwak, 2014).

Secondly, the VIPA has higher usability for PWP with low technological literacy. During the home-based caring transition, PWP will unavoidably encounter different technological interventions. VIPA's voice-activated nature does not depend on visual interaction, making it more approachable, accessible, and natural to interact with for disabled people or low-technology use older adults to facilitate their independence (Pradhan et al., 2020; Pradhan et al., 2018). The hands-free, remote control nature of VIPA is particularly valued among users (Pradhan et al., 2018) in contrast with conventional computers with complex control. Furthermore, such physical embodiment (e.g., adopting smart speakers as the VIPA medium) has been hypothesized to positively impact their social capability and others' perception of them (Wainer et al., 2006). It is recommended when the implementation goal is focused on forming a relationship and social engagement (Deng et al., 2019). Finally, social robot users in Segura and team study (Segura et al., 2012) reported less annoyance and a greater sense of social presence. They preferred interacting with the physical companion robot over the virtual agent. These literatures supported the physical embodiment of VIPA's easy-to-use nature, making it a good starting point for PWP to embrace the technological intervention and maximize technological acceptance to minimize physical manipulation of electronic appliances, such as smartphones, while retaining its assistive nature.

2.3.6.4.2. Standardized and Less Stigmatized Intervention

Finally, interventions delivered by VIPA can provide users with more consistent and standardized care than conventional researcher-led psychotherapies or rehabilitation. Similar to social robots and chatbots, VIPA is designed to be independent appliances that can operate without technicians' active involvement. The artificial intelligence within the VIPA could take up part of the administrative and therapist roles, minimizing researcher input to limit variations between researchers and enhance the accessibility of services. These perks would allow PWP to use VIPA without concern for their mobility or transportation limitations and possibly become a long-term installment to promote their psychosocial well-being.

Traditional physical rehabilitation would require a long period of implementation sessions and a maintenance period to sustain their therapeutic gains. Recent reviews identified that the most positive effects of aerobic and strength training on motor functioning can be retained for up to 12 weeks (Mak et al., 2017). Still, they would require six months of moderate level of aerobic exercise and physical therapy to achieve a significant change in the Unified Parkinson's disease rating scale-III motor scales or cognitive aspects to possibly trigger neuroplasticity (Erickson & Kramer, 2009; Mak et al., 2017). To slow down PD progression, the randomized controlled trial of Tollár et al. (Tollár et al., 2018) stressed the necessity of a maintenance programme, stating that a high-intensity agility intervention with two-year maintenance was required to delay both motor and non-motor symptoms progression in PD. In contrast, the VIPA could be installed as a long-term intervention that continues to assist PWP's daily life without needing a maintenance dose.

Additionally, the readily available commercial VIPA could be less stigmatized to PWP than targeted psychotherapies and tailored socially assistive technologies. PD-specific psychotherapies and technological intervention have long been associated with perceived stigma because of their pathogenic approach and were commonly primed with mental illness and feelings of inadequacy in both older adults and the PD population (Hannaford et al., 2019; Oehlberg et al., 2008). Similar perceived stigma was also found within the terminologies of gerontechnology and other target-specific technological applications. If a particular technology is designed specifically and only for the oldest old, negative attitudes could be induced among users, perceiving themselves as old and frail (Coughlin et al., 2007; Yusif et al., 2016). These negative symbolic meanings could be enforced and became substantial barriers to the acceptance among PWP. Unlike other pathogenic interventions, VIPA is a commercialized product available to all. The high prevalence of VIPA was noted in different European and American countries. With 146.9 million smart speakers sold in 2019 (Koksal, 2020), 53% of US and 1 in 5 UK households owned a VIPA (CDEI, 2019; Voicebot, 2018). The normalization process could be induced by educating PWP on how common VIPA is in western society and explaining the current trend of integrating smart home technologies. Through normalization, PWP would be less likely to consider themselves an outgroup requiring specialized care but merely another regular VIPA user, ultimately disrupting the formation of perceived stigma. To sum up, Choosing the VIPA to deliver the intervention makes it easier for PWP to access, operate, and less stigmatized. It could be introduced as a long-term installment to support PD coping and PWP's daily living continuously.

2.3.6.5. The Psychosocial Benefits for VIPA

2.3.6.5.1. Senese of Coherence

The VIPA intervention was theorized to promote PWP's SOC subdomains and contribute to attaining a state of well-being within the Salutogenic framework. Joachim et al. (Joachim et al., 2003) suggested that mental health patients' SOC could be nurtured through illness acceptance, resource utilization to relieve symptoms, and the identification of meaning in life. Piculell and team's (Piculell et al., 2021) qualitative research also suggested that their technological-based communication could help cognitively impaired older adults make sense of, master, and identify the need-fulfilling characteristics of the intervention under the SOC model.

PWP's comprehensibility could be promoted via VIPA's non-stigmatized nature and the information searching function. The VIPA intervention is less stigmatized than traditional PD-specific interventions, hence avoiding reinforcing their sick role. Secondly, the VIPA is always connected to the Internet, making information searching just a voice command away. The enhanced access to online healthcare information could increase PWP exposure to health-related information, help them search for desired healthcare services, and help them seek professional aids to help them comprehend it as a manageable disease.

By introducing VIPA intervention as a possible PD coping strategy, the manageability of PD symptoms could be improved. PWP were observed with less active coping strategies than other chronic non-neurological disease patients (Pusswald et al., 2012). PWP was already noted using functionalities to counteract PD-related symptoms that hinder their daily life in the community. For example, using speech-to-text technology to mitigate tremor-related problems, making calls to communicate with others, setting medication reminders, or utilizing speech training (Duffy et al., 2021). Other utility functions, such as reading news or weather forecast, could serve as reality orientation to PWP. By providing an alternative communication means and other PD support functionalities, the VIPA intervention can reduce the inconvenience and disability of PD, better manage their symptoms, and aid PWP in regaining control of their daily life to counteract the observed social embarrassment, rejection, or self-isolation from PD deterioration and hypomimia (Gunnery et al., 2016; Soleimani et al., 2014).

Finally, the entertainment functions (music playing, radio broadcasting, and hobby-related information search) of VIPA could promote the PWP's meaningfulness. Life enjoyment is a crucial element within the meaningfulness component of SOC. In the McCloud et al. (McCloud et al., 2022) study, VIPA was reported to reconnect 44% of older adults' interest in music and history. PWP could rekindle their once-lost interests within the meaningfulness domain by providing a more convenient means to access these entertainments. When VIPA has already been recognized as a possible coping mechanism in the community, a standardized VIPA intervention protocol is needed to provide training and maximize its therapeutic potential to foster a consistent salutogenic force to promote psychosocial well-being and offset the progressive pathogenic deterioration.

2.3.6.5.2. Psychosocial Well-being

It is believed that the health-promoting effect of socialization is not limited to human-to-human interaction and could be extended into human-to-robot communication within the PD population, which is vital to their social well-being. The preliminary evidence of virtual interactions being mental health-promoting for both younger (Sahi et al., 2021) may also be generalized to older adults(Cotten et al., 2013). The phenomenon of older adults cherishing the companionship formed with their virtual assistants (Chung & Woo, 2020; O'Brien et al., 2020), PWP using VIPA to place calls (Duffy et al., 2021), or the soothing effect observed from late-stage PWP from companion dolls (Virameteekul & Bhidayasiri, 2022) hinted at the importance and possible impact of virtual interactions among PD population. These interactions could subsequently alleviate the experienced loneliness and social isolation among PWP, improving their interpersonal relationship and emotional well-being.

VIPA was found beneficial to older adults' psychological well-being by improving participants' autonomy, positive affection, interpersonal relationships, health, and personal growth (Budd, 2020). They further categorized psychological promoting functions into four different domains. Namely, cognitive functions (news retrieval, question asking), hedonic functions (listening to music and radio), socialization (both human-to-human and human-to-robot interaction), and utility (reminder and timer setting) aspects. In addition, Ryff (Ryff, 1989) defined environmental mastery as the capability to alter and create an environment in favor of their well-being, seizing the available opportunities to take control of the environment. By introducing VIPA intervention into the PD population, PWP could utilize the PD support functions (e.g., speech-to-text messaging, smart home managements, alarms setting, etc.) to create a an environment that could be easily controlled via voice commands to lessen their symptom impacts and ultimately increasing their autonomy.

In addition, Because of the low technological literacy observed among older adults (Wang et al., 2019), the implementation of VIPA could be seen as a valuable learning experience and personal growth opportunity. The easily operated and approachable VIPA could lower technological barriers and facilitate personal growth in PWP. These experiences can also pave the road to implementing more complex technological interventions and transitioning to home-based care in the future.

2.4. ***Conclusion of Systematic and Literature Review***

The knowledge gap revealed in the systematic review was twofold. The first niche we identified was the lack of psychosocial-oriented interventions in the positive health approach. Although most of the reviewed articles were pathogenic-based and emphasized on physical rehabilitation, there was an unintended psychosocial gain reported. It is of interest to study how a psychosocial-oriented intervention, developed with a positive health approach, could maximise these therapeutic gains. Secondly, the mental health well-being measurements primarily focused on emotional well-being and are often embedded within the quality of life scale. There is a need to develop the next generation of psychosocial well-being interventions infused with technology to examine their efficacy beyond emotional well-being.

The salutogenic framework serves as the cornerstone of the current thesis study in answering the literature gap, not only due to its positive health-oriented nature but also its close connection with psychosocial well-being. The recent technological advancements provide an excellent opportunity for exploring new GRR for the PD population and given its hypothesized reciprocal relationship with sense of coherence (Antonovsky, 1979; Hochwälder, 2019; Saboga-Nunes et al., 2022). Developing a technological intervention as PWP's GRR could potentially initiate positive feedback to promote psychosocial well-being.

Not only could VIPA become PWP's GRR, allowing access to various assistive functions that cater to both their assistive and emotional needs, but it is also a more technologically sophisticated intervention compared to existing social robots and chatbots at their current stage of development. Scholars have been calling for more research on VIPA and mental well-being interventions in the PD population (O'Brien et al., 2020; Subramanian et al., 2021). VIPA's readily accessible voice-activated features could be beneficial to PWP's sense of coherence and psychological well-being. Implementing VIPA as an intervention medium could answer the literature gap identified in the systematic review.

The VIPA is not a well-known electronic appliance among Asians, especially in Japan and Hong Kong (Dentsu_Digital, 2019; Rakuten_Insight, 2020), making them an ideal population for examining the potential efficacy of VIPA. The current doctoral thesis tailored a VIPA user protocol based on the salutogenic framework and examined its preliminary efficacy on PWP's sense of coherence and psychosocial well-being through a pilot RCT.

Chapter 3: Methodology

3.1.Introduction

Chapter 3 documents the methodology used in the current study. Section 3.2 describes the research aims, questions, and their corresponding hypotheses. Section 3.3 details the research design for the 8-item Parkison's Disease Questionnaire (PDQ-8) translation and validation study and the entire thesis study, including the phase 1 explorative qualitative study, phase 2a pilot RCT, and phase 2b of the explanatory qualitative study. Finally, section 3.4 focused on the ethical considerations of the current study.

3.2.Research Aims and Hypotheses

The current thesis study aims to develop the VIPA intervention user protocol and examine its feasibility, preliminary efficacy, and users' perceptions among recruited PWP.

3.2.1. Research Questions

PDQ-8 validation:

1. Is the newly translated PDQ-8 a valid tool to measure PWP's QOL in Hong Kong?

Phase 1:

1. What key contents should be included in a user protocol and technical support protocol for PWP to use the VIPA intervention at home?
2. Is it feasible to implement the VIPA intervention in the PD population?

Phase 2a:

1. What is the preliminary efficacy of VIPA intervention on PWP's SOC and psychosocial well-being?
2. Can such effect sustain for 1 month after the intervention?

Phase 2b:

3. What is the users' experience on the VIPA?

3.2.2. Research Hypothesis

H_1: The VIPA intervention and technical support protocol are validated and useful for PWP.

H_2: It is feasible to implement VIPA intervention in the PD population

H_3: The VIPA intervention can significantly improve IG participants' SOC over time compared to CG participants.

H_4: The VIPA intervention can significantly improve IG participants' psychosocial well-being over time compared to CG participants.

H_5: Beneficial effects of the VIPA intervention could be sustained till follow-up.

H_6: The PDQ-8 shared a moderate correlation to EuroQol-5D-5L and psychosocial well-being.

3.3.Research Design

The current thesis is designed as a three-stage sequential mixed method design combining exploratory qualitative, pilot RCT, and explanatory qualitative approach was implemented to develop a VIPA intervention protocol and examine its feasibility, acceptability, and preliminary efficacy on PWP.

3.3.1. PDQ-8 Translation and Validation study

Due to the doubtful translation quality of the previous best available traditional Chinese PDQ-8, a localization of traditional Chinese PDQ-8 was initiated with the copyright holder, Oxford University Innovation Limited. The original PDQ-8 (English version) first underwent independent dual forward translation and reconciliation by the researcher. The conceptual accuracy was then examined by independent dual back translations. The validation process first calculated the item-Content Validity Index (i-CVI) and linguistic equivalence with an expert panel consisting 2 charted psychologists and 3 registered psychiatric nurses. Face validity was then examined through 5 cognitive interviews with PWP. Finally, a quality check with the linguistic validation manager from the copyright holder was conducted to finalize the scale translation and prepare for the subsequent quantitative validation study to examine its criterion and convergent validity.

EuroQol-5D-5L (EQ-5D-5L) (Herdman et al., 2011) is a standardized tool measuring the general public's health-related quality of life within 24 countries (Cabasés & Rabin, 2014), and was selected as a gold standard for testing PDQ-8's criterion validity. It utilized a visual analogue scale allowing respondents to rate their perceived health status from 0-100 (100 being the best imaginable health status), and 5 descriptive statements covering mobility, self-care, usual activities, pain & discomfort, and anxiety & depression domains. It was also documented with a 0.83 Cronbach's alpha within the Mexican PD population (Alvarado-Bolanos et al., 2015). Using the Hong Kong population value set obtained from the Wong et al. (Wong et al., 2018) study, its index score was generated based on PWP's answers from the 5 descriptive statements and correlated with the PDQ-8 score for criterion validity. Based on previous literature examining the correlation between EQ-5D-5L and PDQ-8, it ranged from -0.60 to -0.79 (Alvarado-Bolanos et al., 2015; Stathis & Papadopoulos, 2022). Therefore, the recruited 51 PWP satisfy the sample requirement of 29 participants from G*Power (version 3.1.9.4) calculation (setting target correlation= 0.5; $\alpha = .05$; $1\text{-}\beta = .8$; $H0= 0$) to participate in the validation survey.

3.3.1.1. Eligibility

The inclusion criteria for the PDQ-8 translations were: 1. Beholds 3 years of post-certified translating experience or above; 2. Had experience in translating health-related materials; 3. Had never seen the original nor other existing translations of PDQ-8; 4. Native English or Cantonese speakers to work on their respective languages.

To be included in the PDQ-8 validation study, convenience sampling via local NGOs across different districts was done to recruit PWP, who are as follows: 1. Community-dwelling PWP; 2. Literate in Traditional Chinese; 3. Cognitively intact (Montreal Cognitive Assessment; MoCA score <21; (Dalrymple-Alford et al., 2010)) to participate.

3.3.1.2. Translation

PDQ-8 translation involved 4 certified translators who would only work on their native language independently during the dual forward and backwards translations with the cognitive elaboration document provided to them. The doctoral student conducted reconciliations to harmonise any discrepancies, then proceeded to be reviewed by the linguistic manager officer from the copyright holder.

The content validity and linguistic equivalence of the translated PDQ-8 were then examined by three psychiatric nurses and two chartered psychologists using a 4-point Likert scale (1-4; not relevant- very relevant; and 1-4; not appropriate- very appropriate;). Suggestions were collected for any item that scored below a 3 and those scored a 1 would be subject to revision (formula as shown in Fig. 3.1).

$$\text{i-CVI/ Linguistic equivalence score} = \frac{\text{Number of experts rating an item of 3 or 4}}{\text{total number of experts}}$$

Figure 3.1. The formula for calculating i-CVI & linguistic equivalence

3.3.1.3. Validation

The translated scale's face validity was then examined by a 5 PWP individually through cognitive interviews under retrospective probing and concurrent verbalization. The meaning of the scale's wording and options among participants was explored, and any possible revision could be done to finalize the localized PDQ-8.

The validation study adopted convenience sampling to recruit 51 PWP and analysed through SPSS (ver. 28). Descriptive statistics were implemented for participants' demographic variables. Its reliability was then examined through mean inter-item correlation, corrected Item-total correlation, and Cronbach's alpha.

The convergent and criterion validity were examined through Pearson r correlations with EuroQol-5D-5L, 13-item Sense of Coherence Scale, UCLA three-item loneliness scale, Mental Health Continuum Short Form, Brief Resilient Coping Scale (psychometric properties discussed in section 3.3.3.3, Outcome measures), with a 2-tailed design at a 5% significance level.

3.3.2. Phase 1a: Explorative Qualitative Interview

Phase 1 of the current research adopted an explorative qualitative approach to explore the Salutogenic properties of VIPA, validate the generated VIPA user protocol, and test its feasibility among PWP.

3.3.2.1. Methodological Approach and Epidemiology Stance

The current research integrated a pilot RCT and qualitative elements in explorative and explanatory interviews to design and deploy the VIPA intervention. The mixed methodological approach is useful in nursing by generating more robust evidence than the individual approach, integrating the "how and why" from the qualitative perspective and the quantified efficacy to explore complex situations (Bressan et al., 2017; Creswell, 2015; Malina et al., 2011). Interpretive description approach (Thorne, 2016) was adopted to explore the feasibility and acceptability the among PWP and to inform future VIPA design.

The doctoral student is a younger registered psychiatric nurse with higher technological literacy. Therefore, the student would possess the knowledge on nurturing psychosocial well-being. The student would avoid making assumptions about VIPA's efficiency since PWP's perception and experience would differ from one another based on their disease progression and clinical representation.

3.3.2.2. Target Population

Only cognitively intact PWP was included in the current study as a recent study suggested that a cognitive capability of Mini-mental State Examination (MMSE) scores 24, the dementia screening cutoff, was required to operate VIPA efficiently (Masina et al., 2020). MoCA, a 10-minute professional-administered cognitive assessment (Nasreddine et al., 2005), was chosen to exclude PWP with dementia because of its higher sensitive psychometric properties in screening MCI and dementia cases than MMSE within the PD population (Hoops et al., 2009). The MoCA cutoff score for the current study was set as <21 referenced with Dalrymple-Alford et al. (Dalrymple-Alford et al., 2010) article for PD-appropriate adjustment and recorded a 0.86 Cronback's alpha value, test-retest reliability of 0.88, and high predictive validity on cognitive impairment in Taiwan (Tsai et al., 2012).

3.3.2.3. Eligibility

The current research partnered with local Non-governmental organizations (NGO), Hong Kong Parkinson's Disease Association (香港柏金遜症會), and The Hong Kong Society for

Rehabilitation (香港復康會) across 5 HK districts (HK island, Kowloon East and West, Tseung Kwan O, and New Territories West) for subject recruitment. The detailed inclusion and exclusion criteria are listed as follows:

Inclusion criteria: 1. Cantonese-speaking Hong Kong permanent resident; 2. Diagnosed with Parkinson's disease; 3. Community dwelling; 5. Level 1-4 in the H&Y scale (Hoehn & Yahr, 1967); 6. Not currently using or owning VIPA; 7. Has internet connection.

Exclusion criteria: 1. PWP or their caregivers that fail to provide valid consent; 2. Individuals with hearing loss in both ears (2 negative Rinni tests); 3. Severe voice impairment (level 4 on MDS-Unified Parkinson's Disease Rating Scale (MDS-UPDRS) item 2.1; (Goetz et al., 2008)); 4. Dementia patients (MoCA score <21); 5. PWP that would leave HK during the intervention period.

Participants for the PDQ-8 validation and pilot RCT were recruited through convenience sampling, with 48 PWP participating in the pilot RCT and 51 in the validation study. In-person recruitment sessions and promotional posters were made to facilitate recruitment progress. Secondly, purposeful sampling was adopted for all qualitative interviews until data saturation was reached. Only 1 participant refused interview due to declined memory from medication titration. No prior relationship was established between the research team and the participants.

3.3.2.4. Research Methods

Both focus group and cognitive interviews were conducted in phase 1. Focus group interviews were conducted to generate protocol content, as there was a lack of substantial information in the PD VIPA domain, and the interaction between participants was expected to produce more ideas. Moreover, small groupings could make participants more at ease and enhance the sharing opportunities (Dilshad & Latif, 2013; Krueger, 2014; Stage & Manning, 2015). The generated VIPA protocol was tested for validity and feasibility before being implemented in the pilot RCT. The developmental process resonates with the updated Medical Research Council guidance (Skivington et al., 2021) for developing complex interventions, including intervention development, feasibility testing, implementation, and evaluation.

3.3.2.4.1. Focus Group Interviews

Heterogeneous grouping was implemented to purposefully select participants based on their daily technology usage by adopting five subdomains (22 items, 10-point Likert scale, with a higher score representing higher daily technology usage) of the Media and Technology Usage and Attitudes Scale (MTUAS) (Table 1) (Rosen et al., 2013). Specifically, these include smartphone usage, Internet searching, emailing, text messaging, and phone calling subscales. Two doctoral students moderated and observed the interviews following the formulated interview guide (Table 3.1.).

Table 3.1. *Interview guides for focus group interviews*

Stem questions for focus group interview

1. What functionalities do you expect from the VIPA intervention?
2. What information should be included in the user protocol?
3. How can we encourage the use of VIPA among PWP?

Prompts:

   a) How could VIPA help with your PD symptoms
   b) How suitable is the intervention for other PWP?
   c) Which function should PWP use most?
   d) How to make you more comfortable with VIPA?

3.3.2.4.2. Cognitive Interviews and Expert Panel

To investigate the feasibility and face validity of the VIPA intervention and clarify potentially confusing elements (Peterson et al., 2017). Cognitive interviewing was adopted to generate insight into PWP's attitude and perception of the VIPA intervention (Hirschey et al., 2021). Techniques such as concurrent verbalization and retrospective probing were used (Beatty & Willis, 2007; Hofmeyer et al., 2015; Pepper et al., 2018) (see Table 3.2). The feasibility and acceptability were explored through concurrent verbalization and retrospective probing, where participants were invited for a VIPA trial on the major functions identified from previous interviews in the University interview room.

Any difficulties encountered and their corresponding solutions were logged down to perfect the VIPA user protocol, technical support protocol, and training content for the VIPA intervention. Similar telephone-based support was also adopted in existing studies (F. Corbett et al., 2021; McCloud et al., 2022), demonstrating its applicability among older adults. The generated training materials, user protocol, and support protocol are not only intended to serve as guidance for PWP. They can also standardize the technical support the researcher gave, minimizing social interference.

Table 3.2. *Interview guides for cognitive interviews*

Stem question for cognitive interview

1. What is your experience in operating the VIPA?

Prompts:

   a) Are there any difficulties you have encountered? How would you solve it?
   b) What improvements would you make to the user protocol?
   c) What training/ support should be provided to PWP?
   d) What functions would be mental health promoting

Experts then examined the content validity of the generated VIPA protocol in healthcare professions. Utilizing the i-CVI for eHealth interventions is suggested to be straightforward and feasible (Kassam-Adams et al., 2015). It has been implemented in the mental health nursing field (Sampaio et al., 2017). The minimum i-CVI score was set as 1 for a 4-point rating scale with an expert panel of 5 (Lynn, 1986) to assess each item's relevancy (1: not relevant – 4: very relevant). In addition, experts were invited to provide suggestions for improvement in cases of suboptimal relevance (1-2). Any item with a score lower than 1 was discarded or subject to revision.

3.3.2.5. Rigor and Data Analysis

The collected verbal and non-verbal data were first anonymized before the transcription process with Sonix®. Inductive content analysis was conducted via QDA Miner Lite® in Cantonese. Content analysis was considered an effective method for cognitive interviewing and a starting point for analysis (Blair & Brick, 2010; Hsieh & Shannon, 2005).

The doctoral student read through the transcriptions repetitively for content familiarization before the coding process. Peer review with the research team member was also conducted to examine the interview content (Graneheim & Lundman, 2004). Additional strategies, such as code-recode and providing a detailed description of the current research design and data collection process would ensure the trustworthiness and credibility of the current study (Anney, 2014). In addition, A reflective journal was used throughout the qualitative data collection to enhance transparency and reduce research bias (Ortlipp, 2008). The researcher was also mindful of avoiding assuming himself as an insider (going native), fixating on present findings (premature closure), and failing to explore the depth of the data (bloodless findings) (Thorne et al., 2004).

3.3.2.6. VIPA Intervention Delivery: Smart Speakers

Besides all the other perks mentioned in section 2.3.8.2, the physical embodiment of VIPA could promote relationship and social engagement (Deng et al., 2019). It is common among other VIPA researchers to deliver their intervention via smart speakers. From the articles reviewed by both Arnold et al. (Arnold et al., 2024) and Corbett et al. (Corbett et al., 2021) review on VIPA, the most common intervention delivery medium is Amazon Echo(n=12) followed by Google Assistant n=3; Line Clova n=2; Apple Siri (iPhone 5s) n=1; Xiaomi n=1; Novel technology n= 4; Combined intervention n=4. Most VIPA interventions are delivered through smart speakers. Therefore, Apple HomePod Mini was chosen as the medium to deliver the VIPA intervention to allow result generalization, its more sophisticated voice recognition capability, commercialized nature, and being the only VIPA available for Cantonese communication during proposal writing.

3.3.3. Phase 2a: Pilot RCT

The Pilot RCT was a 2-arm assessor-blinded randomized controlled trial to assess the preliminary efficacy of the VIPA intervention on 48 PWP. Intervention group (IG) participants (n=24) were given the 8-week VIPA intervention, and comparisons were made with another 24 PWP in the control group (CG), who received usual care. Although power analysis was not necessary for pilot studies (NIH, 2025), the sample size of the current research not only exceeded the median sample size of both publicly funded (33 participants) and industry-funded (25 participants) pilot trials in Billingham et al. review article (Billingham et al., 2013). It also exceeded the recommended 12 participants per arm for pilot studies (Julious, 2005). In addition, having around 25 participants in each arm is also suitable for pilot testing with a small (.2) effect size (Whitehead et al., 2016). The inclusion criteria adopted for Phase 1 also applied to the current pilot RCT.

3.3.3.1. Intervention and Usual Care

IG participants received the following materials for their 8-week intervention period: User protocol formulated in Phase 1; 2. A VIPA; 3. 45 minutes VIPA training; 4. Apple gift cards for HKD 150 for music playing; 5. Communal iPhone SE for participants with Andriod operation system. The user protocol integrated technical support inquiries from phase 1 into frequently asked questions. Moreover, when answering queries from participants, the researcher followed the technical support protocol (in Question & Answer format) and training material to minimize social interference from research personnel and standardize the technical support process.

CG participants will be placed under usual care, and no intervention will be provided. Involved PWP continued their daily life during the intervention period, minimizing any behavioral change induced by the current study (Smelt et al., 2010). The conceptual framework for the pilot RCT is displayed in Fig. 3.2.

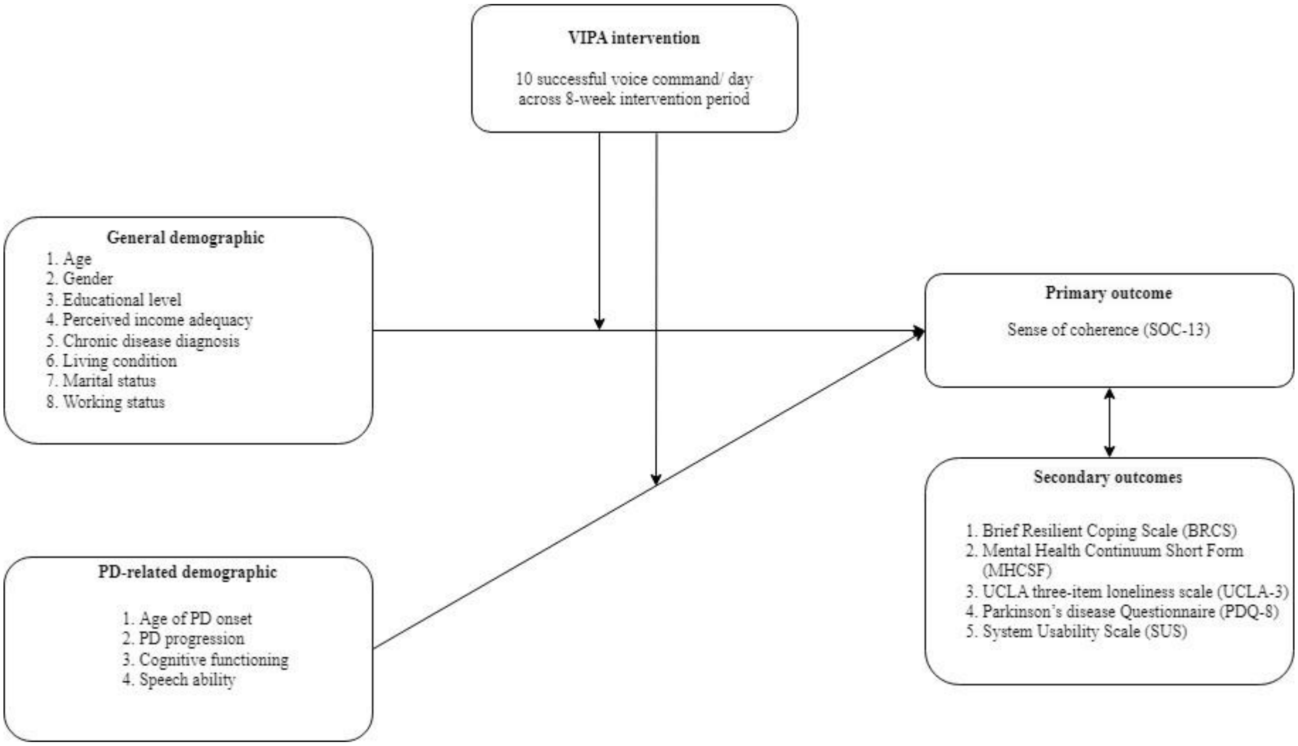


Fig. 3.2. Conceptual framework for the VIPA intervention

3.3.3.2. Randomization and Assessor Blinding

An independent researcher performed the 1:1 block randomization via third-party website and had no contact with all the participants. The group allocation was revealed at the start of the intervention period and could not be altered. All assessors were blinded from such allocation.

Assessors (5 nursing students) were recruited to screen and access PWP. They received training to ensure inter-rater reliability and proper execution of assessment scales. For example, videos and stage descriptions of the H&Y scale (Bhidayasiri et al., 2012) were introduced to enhance their understanding of PD staging. Secondly, all assessors completed the official MoCA training course to ensure quality assessments. Finally, although the remaining assessment scales were self-administrated, assessors were briefed in responding to PWP's enquiries. Team meetings were conducted to clarify queries and ensure smooth operation.

3.3.3.3. Outcome Measures

3.3.3.3.1. Primary Outcome

13-item Sense of Coherence Scale (SOC-13). The 7-point Likert SOC-13 (score range 13-91) (Antonovsky, 1987) will measure PWP's SOC through its 3 subdomains, comprehensibility, manageability, and meaningfulness, with a higher score representing a better sense of coherence. The scale was also implemented into the PD (Gison et al., 2014), and Chinese population (Ding et al., 2012) with satisfactory internal reliability of 0.82 Cronbach's alpha value. Research has identified that educational level, stage of PD, and socioeconomic status served as a covariate to SOC. Multiple regression analysis identified these variables as influencing factors among older adults with China's PD population (Jian et al., 2017). These data resonate with Volanen's (Volanen, 2011) research suggesting one's SOC is dependent on their socioeconomic status.

These covariates were measured in participants' demographic data, where the perceived income adequacy was adapted from WHO SAGE wave 1 individual questionnaire (WHO, 2010), a 5-point Likert scale asking participants do they consider themselves have enough money to meet their meets (from none at all to completely). The detailed data collection plan is presented in Table. 3.3.

3.3.3.3.2. Secondary Outcomes

UCLA three-item loneliness scale (UCLA-3). UCLA-3 (Hughes et al., 2004) is refined from the revised UCLA loneliness scale (Russell et al., 1980). This 4-point Likert scale (score: 3-9, higher score represent higher sense of loneliness) has a reliable Cronbach’s alpha coefficient of 0.87 in its Chinese version (Liu et al., 2020). Other versions of this scale were used in China (Wang et al., 2017; Wu et al., 2010) and PD populations (Khazen et al., 2021; Tait et al., 2019).

Parkinson’s Disease Questionnaire (PDQ-8). This 8-item, 5-point Likert (score: 0-32, higher score represent lower QOL), PD-specific QOL measure was developed by (Jenkinson et al., 1997). The localization of the original PDQ-8 into the traditional Chinese version was conducted in collaboration with the copyright holder, Oxford University Innovation Limited as mentioned in section 3.2.6.3

Mental Health Continuum Short Form (MHC-SF). The 14 items, 6-point Likert (0=never, 6= every day) MHC-SF (Keyes, 2018), can measure three domains of well-being, with a higher score indicating better psychosocial well-being. The scale has been translated into different languages and documented with a satisfactory Cronbach’s alpha value (0.8 or above) in all subscales and total scores, and able to derive a three-factor model among Chinese populations (Guo et al., 2015). In addition, the PD population reported a 0.94 internal reliability of MHC-SF in the Murdoch et al. (Murdoch et al., 2020) study.

System Usability Scale (SUS). The usability of VIPA will be measured with the 10-item SUS scale, a high score indicating decent usability among users (scoring from 0-100) (Brooke, 1996). This generic, ready-to-use scale has been applied to evaluate various PD interventions (Botros et al., 2019; Smilowska et al., 2019; van Beek et al., 2019). Wang et al. (Wang et al.,

2020) also validated its Chinese version, reporting a 0.84 Cronbach alpha value and a satisfactory construct and concurrent validity. SUS will only be implemented in IG at the end of the intervention period.

Brief Resilient Coping Scale (BRCS). A 4-item coping measurement designed by Sinclair & Wallston (Sinclair & Wallston, 2004) that has been applied in neurological patients (including PD) (Kamenov et al., 2016) and the Chinese population and demonstrated good criterion validity and a .88 Cronbach's alpha value in Hong Kong(Chair et al., 2021; Fung, 2020; Han et al., 2021).

Self-report VIPA usage. Because of the unavailability of user logs in Apple HomePod mini and no existing validated technology usage measurement covering all targeted VIPA usage, a tailored questionnaire will be created to report their daily VIPA usage frequency. Participants were instructed to mark down their successful primary commands, verbal commands that were initiated by "Hey Siri" (Pradhan et al., 2019), daily and rank their most used functions per week to reflect their compliance rate. A reminder notification was set at 8o'clock in the evening to remind participants to log down their daily usage. The outcome measurements for the pilot RCT is presented in Table 3.3.

Table 3.3. Pilot RCT outcome measurements across time points

Scales	Group(s) involved	Measured time T_0	Measured time T_1	Measured time T_2
H&Y scale	Screening	✓		
MDS-UPDRS (item 2.1)	Screening	✓		
MTUAS	Screening	✓		
Rinne Test	Screening	✓		
MoCA	Screening	✓		
SOC-13	IG & CG	✓	✓	✓
MHC-SF	IG & CG	✓	✓	✓
UCLA-3	IG & CG	✓	✓	✓
PDQ-8	IG & CG	✓	✓	✓
BRCS	IG & CG	✓	✓	✓
SUS	IG		✓	
VIPA usage	IG	Daily self-report from T_0 - T_1		

Note. T_0= Baseline; T_1= post-intervention (week 8); T_2= 4 week follow-up (week 12); Hoehn and Yahr scale= H&Y scale; MDS-Unified Parkinson's Disease Rating Scale = MDS-UPDRS; Montreal Cognitive Assessment= MoCA; 13-item Sense of Coherence Scale= SOC-13; UCLA three-item loneliness scale = UCLA-3; Depression Anxiety Stress Scales= DASS21; Mental Health Continuum Short Form= MHC-SF; Brief Resilient Coping Scale= BRCS; System Usability Scale= SUS.

3.3.3.4. Data Entry

All psychometric scales except the professionally administrated MoCA and UCLA-3 were administrated to participants in pen and paper by a blinded assessor. Collected data were then inputted into the online Qualtrics database by the same assessor immediately after checking for completeness. They were required to double-check their data entry before the submission to reduce manual error. The Qualtrics system was password protected so only authorized research personnel could assess, and no personal identifiers were kept.

3.3.3.5. Data Analysis

Quantitative data was analysed with SPSS (ver. 28) based on the intention-to-treat principle. Participants' demographic variables were presented with descriptive statistics, and their between-group differences were examined through an independent sample t-test and a Chi-square test at 2 2-tailed design with a 5% significance level.

Generalized Estimating Equations (GEE) was used to analyze group differences in the primary outcome (SOC) and other secondary outcomes at different time points. Because GEE could yield consistent estimations against missing completely at random data (Lipsitz et al., 2020), robust against both non-normally distributed data for behavioural data (Pekár & Brabec, 2018) or misspecified correlation structure (Wang, 2014), and has lowest Type 1 error with small sample size from small sample correction (Ma et al., 2012; Morel et al., 2003).

Although unadjusted analysis alone is appropriate for primary data analysis, adjusting baseline covariates based on their correlation between variables and outcome measures could improve GEE analysis's power, precision (smaller p value), narrow its confidence intervals, and to obtain a closer estimate from individual level (CHMP, 2015; FDA, 2023a; Yu et al., 2010). The current study adjusted for demographic variables that were significantly associated the study outcomes in randomized clinical trials (FDA, 2023a) using Pearson r correlations and reported both the adjusted and unadjusted GEE values. The effect size (Cohen's d) was calculated with the calculator set up by the Center for Evaluation and Monitoring at Cambridge University (CEM, 2024) and interpreted based on the Cochrane Handbook, small (<0.4), moderate (0.4-0.7), and large (>0.7) (Schünemann et al., 2023). The obtained effect size was computed with G*Power (ver. 3.1) to calculate the required sample size for future RCT.

3.3.3.6. Handling Missing Data and Sensitivity Analysis

The current dataset had 13.19% missing data with a nonsignificant Little's missing completely at random test among outcome variables ($\chi 2= 85.78$, df= 82, p= 0.37). Analysis with all observed data was adopted since the missing data were between the 5%- 40% threshold and potentially missing completely at random, based on the recommendation from Jakobsen et al. (2017). In addition, the intention-to-treat principle was adopted as GEE only depends on means, variance, and the working correlation between measurements, but not their distribution. The missingness with MCAR data could be ignorable, and GEE is therefore recommended for analysis (DeSouza et al., 2009; Salazar et al., 2016). Upon comparing with other imputation methods, GEE without imputation is better or comparable to cross-sectional, longitudinal, and MI for data analysis (Twisk & de Vente, 2002).

MI was chosen as the method of sensitive analysis to examine the impact of different missing data handling techniques and the robustness of the primary analytical result, as MI is considered more theoretically valid than simple and longitudinal imputations (Thabane et al., 2013; Twisk & de Vente, 2002). MI predicts missing values from existing variables to restore the variability back into the dataset and retain the uncertainty from the missing data with multiple estimations and is considered a valid and theoretically elegant approach in clinical trials to handle both missing at random and MCAR data (Jakobsen et al., 2017; Pedersen et al., 2017; Sterne et al., 2009; Twisk & de Vente, 2002; Wayman, 2003). The MI was done with the following settings: 5 sets of imputations as it is theoretically sufficient (Jakobsen et al., 2017); fully conditional specification because of its high flexibility and the missing pattern being non-monotone (Van Buuren, 2007); and predictive mean matching for its high applicability, suitability to small sample size, and robustness towards imputation model misspecifications in clinical trials than parametric imputation (Bailey et al., 2020; Kleinke, 2018; Morris et al., 2014). The imputation sets were then checked against all outcome variables' normal scale scoring range to ensure valid and reasonable imputations.

3.3.4. Phase 2b: Explanatory Qualitative Research

The final phase of the current study, explanatory qualitative research, was built on the quantitative phase and aimed to explain its result, providing a general understanding of the situation (Bressan et al., 2017; Ivankova et al., 2006). 7 PWP from IG were recruited through extreme case sampling based on their primary outcome (SOC) to participate in the in-depth semi-structured interview. The extreme case sampling method was used to interview subjects that deviated from the norms in intervention studies, exploring how the selected intervention should be and could be (Sandelowski, 1996; Suri, 2011). The researcher could therefore identify what makes the intervention work or fail.

3.3.4.1. Research Method

Individual in-depth interviews moderated by the doctoral student were conducted to explore the users' perceptions via extreme case sampling. IG participants with the greatest increase or decrease in their primary outcome, SOC-13, from T0 to T1, were invited to participate in the post-intervention explanatory qualitative interviews. Interview questions were formulated based on the salutogenic framework to explore their comprehensibility, manageability, and meaningfulness when using VIPA interventions (see Table 3.4). Interview locations were picked by participants, such as their homes, nearby cafes, or university interview room to make them at ease.

Table 3.4. *Interview guide for in-depth interviews*

Stem questions	Prompts
1. What is your experience in using the VIPA intervention?	a) To what extent would the VIPA affect your daily life? b) Would you continue to use the VIPA in the future?
2. What did you learn from the VIPA? 3. Can you share an experience where the VIPA helped you cope with PD?	a) How confident are you in managing PD symptoms with the intervention? b) How could the intervention affect your feelings of loneliness? c) Would you take VIPA as your electronic companion?
4. How do you feel about the VIPA?	a) Do you enjoy your time using the VIPA? b) What motivates you to keep using the VIPA? c) Can you share what aspect of the VIPA do you value the most?

3.3.4.2. Data Analysis

Hybrid thematic analysis was adopted to integrate both inductive and deductive approaches (Fereday & Muir-Cochrane, 2006). With all interviews transcribed through Sonix®, the data analysis was prepared through QDA Miner Lite® through the following procedures. Namely, peer reviewing the coding manual, transcripts familiarization, independent deductive coding by two doctoral students through salutogenic framework with an additional inductive coding were conducted. The analytical process first conducted cross-sectionally, followed by theme identification and clusterization.

3.4.Ethical Consideration

Ethical approval was obtained from The Hong Kong Polytechnic University Institutional Review Board (reference number: HSEARS20221107005). Participants were informed the interview would be audiotaped with the information provided to them, detailing the research procedures and their right to withdraw. Prior written consents were collected.

To avoid technological exclusion, necessary electronic compliances such as 5 communal iOS devices (iPhone SE) were provided to PWP if they use other operating systems. HKD 50 (all in form of supermarket coupons) was provided to those who completed the baseline or PDQ-8 validation assessment, HKD 100 for attending an interview, HKD 200 for completing the pilot RCT to compensate for their time. IG participants were also provided an optional HKD 150 worth of music selection through iTunes gift card at the installation date to ensure the music playing function is properly functional. To minimize the risk of infection amidst the COVID-19 pandemic, focus group interviews were conducted via Zoom interviews with the help of their carers for safety measures.

3.4.1. Data Management

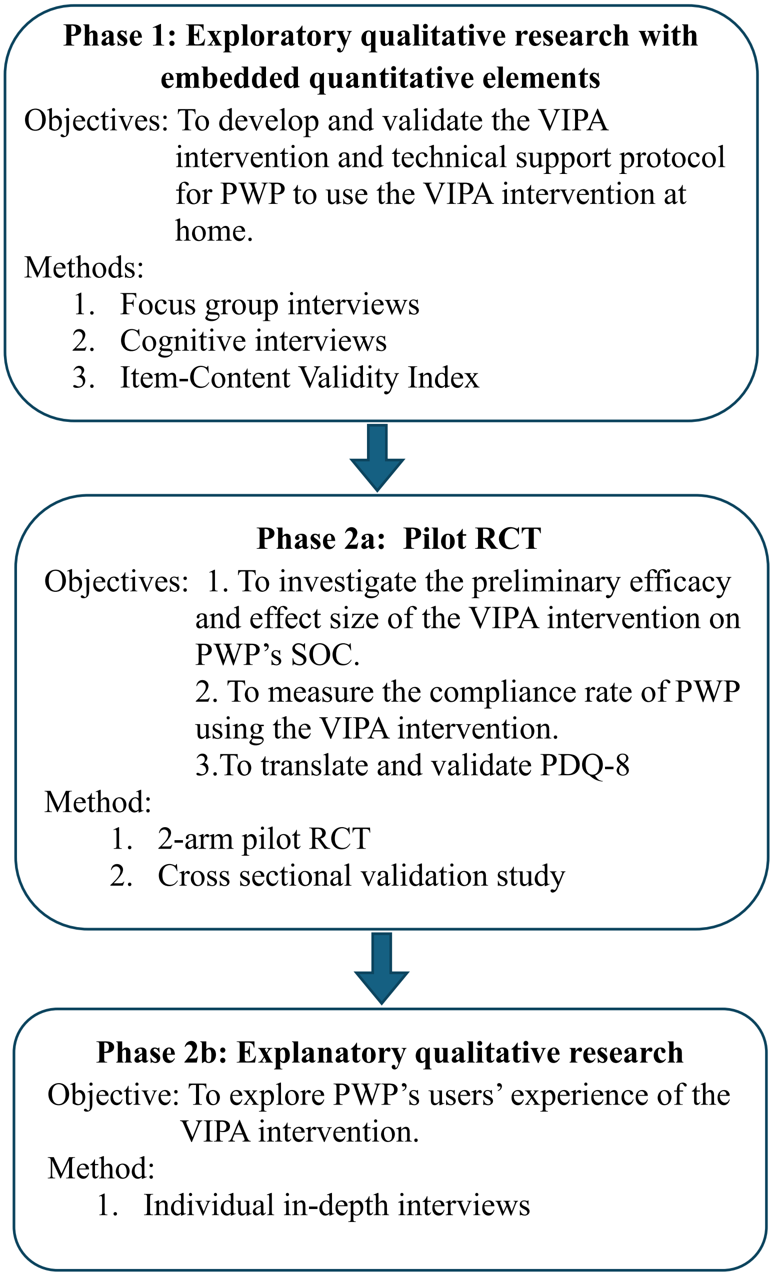
All collected data were anonymized and stored within a password-protected device. Only authorized research personnel can access the mentioned files. Each participant was assigned a participant ID to encode the collected data instead of their personal identifiers. A record of participants' name and their telephone numbers were kept on a secured device for follow-up purposes. Only relevant research personnel (assessors) could access such information to ensure confidentiality. All research personnel were instructed to delete participants' contact information upon completion. All related documents, including the contact record, were disposed of in adherence to PolyU's policy on handling confidential documents.

Concerning the privacy of the VIPA intervention, although the existing autonomy vs. privacy tradeoff model suggests older adults are willing to accept monitoring technology for autonomy enhancement (Townsend et al., 2011). The current study took extra measures to ensure PWP are at ease with the VIPA intervention. The VIPA was only installed in a location of PWP's liking and ensured PWP no user log (usage nor commend content) could be retrieved from VIPA, not even the researcher. During the uninstall process, all personal information (contacts, messages) stored in communal devices was deleted before PWP by factory resetting the devices to maximize privacy with their confirmation.

The A.I. transcription Sonix is selected for transcription due to its secured nature. They are a fully automated system without staff involvement, the deleted data is promised non-retrievable, and SOC 2 Type 2 certified (a data security framework) (Sonix, 2023). In addition, their term of service stated, "We will not use or share your audio files for any other purposes except to provide you with our transcription and other related services" (Sonix, 2023) under their confidentiality section. Finally, all recordings were anonymized before transcribing, and all audio files were removed upon completion.

3.5.Conclusion

Chapter 3 illustrated the methodology for the current thesis study to translate and validate the PDQ-8, and set up a three-stage sequential mixed method study, including an exploratory qualitative, pilot RCT, and explanatory qualitative approach, to develop a VIPA intervention protocol and examine its feasibility, acceptability, and preliminary efficacy on PWP. SOC-13 was selected as the study's primary outcome, and the intervention was delivered through Apple HomePod mini. A summary of the thesis study sequence is displayed in Fig 3.3.



Phase 1: Exploratory qualitative research with embedded quantitative elements

Objectives: To develop and validate the VIPA intervention and technical support protocol for PWP to use the VIPA intervention at home.

Methods:

1. Focus group interviews
2. Cognitive interviews
3. Item-Content Validity Index

Phase 2a: Pilot RCT

Objectives: 1. To investigate the preliminary efficacy and effect size of the VIPA intervention on PWP's SOC.
2. To measure the compliance rate of PWP using the VIPA intervention.
3.To translate and validate PDQ-8

Method:

1. 2-arm pilot RCT
2. Cross sectional validation study

Phase 2b: Explanatory qualitative research

Objective: To explore PWP's users' experience of the VIPA intervention.

Method:

1. Individual in-depth interviews

Fig. 3.3 Thesis flowchart

Chapter 4: Validation Study Result of the 8-item Parkinson's Disease Questionnaire

4.1. Introduction

This chapter reports the findings of the cognitive interviews and the validation study, answering the first research question (RQ), "Is the newly translated PDQ-8 a valid tool to measure PWP's QOL in Hong Kong?". Section 4.2 contains demographic data of the recruited translators and PWP across the translation and validation phase. Section 4.3 documents the PDQ-8 score distribution and explores its reliability through Cronbach's alpha value, item-total correlation, and mean inter-item correlation. Section 4.4 describes the result of PDQ-8's face, content, criterion, and convergent validity. The translated PDQ-8 demonstrated satisfactory criterion, convergent, face validity, and reliability among PWP in the Hong Kong population.

4.2. Demographic Data

4.2.1. Demographics of the Translators

Each recruited translator from the Centre for Translation Studies, Chinese and Bilingual Studies, The Hong Kong Polytechnic Universitybeheld 3 years or more post-certificate experience and had worked on health-realted translations before. None of them had piror knowledge on the PDQ-8.

4.2.2. Participants in the Cognitive Interviews

The stakeholder panel for cognitive interviews consisted of five PWP (Table 4.1). They averaged a mean age of 65.8 and a mean duration of 3 mins 41 secs to complete the questionnaire.

Table 4.1. *Stakeholder panels for cognitive interviews*

Participant ID	Age (Gender)	PD progression (H&Y level)
1	57 (M)	1
2	72 (M)	3
3	65 (F)	1
4	68 (F)	3
5	67 (F)	4

4.2.3. Participants in the Validation Study

51 PWP were recruited from 57 applications with around half of them (54.2%) were female. There were 88% unemployed or retiree among participants, with 62% of them married and living with others (88%; as shown in Table 2).

Table 4.2. D*emographic data for PDQ-8 validation study*

	Total (n=51)	
Continuous Variables	**M(SD)**	**Range**
Age	63.38 (7.54)	37-76
Age of onset	56.36 (9.32)	35-73
MoCA	26.82 (2.50)	21-30
Categorical Characteristics	**N**	**%**
Gender		
Male	24	47.1
Female	27	52.9
Living condition		
Living alone	6	12
Living with others	44	88
PD stage (H&Y scale)		
Level 1	20	39.21
Level 2	12	23.53
Level 3	13	25.49
Level 4	6	11.76

Speech difficulties		
Normal	10	19.61
Slight	14	27.45
Mild	16	31.37
Moderate	10	19.61
Severe	1	1.96
Educational level		
Primary school	8	16
Secondary education	28	56
Tertiary education	14	28
Working condition		
Working	6	12
Unemployed/ Retired	44	88
Marital status		
Single	5	10
Married	31	62
Living together	3	6
Divorced/ Separated	6	12
Widow	5	10

Note. MoCA: Montreal Cognitive Assessment, higher score represents a better cognitive level; H&Y scale for assessing severity of PD, higher level represents a higher PD progression

4.3. PDQ-8 Score Distribution and Reliability Testing

The total score of the PDQ-8 was presented in the form of a summative index (PDQ-SI) by dividing the obtained score by 32 and multiplying by 100 (Table 4.3). result indicated the participants averaged a 34.69 mean score with generally increasing trend across their disease progression, except with level 4 participants (PDQ-SI= 34.38)

Table 4.3. *PDQ-SI across PD progression level*

		Level 1	Level 2	Level 3	Level 4
	All	n= 20	n= 12	n= 13	n= 6
PDQ-SI mean	34.69	30.63	35.0	40.87	34.38
SD	16.1	13.36	14.04	21.17	14.66
Mean disease duration (years)	7.02	4.2	6.27	9.15	13.17
SD	5.88	3.79	4.90	4.28	10.09

Note. PDQ-SI: Parkinson's Disease Questionnaire Summative Index, a higher score represents a lower QOL; H&Y scale: Hoehn and Yahr scale, a higher level represents a higher PD progression

The significant result from the Shapiro-Wilk testing on PDQ-8 total score (W= 0.94, p< 0.05) turned non-significant (W= 0.98, p= 0.51) upon removing the outlier (participant 33). No participants scored a full mark or zero score on the PDQ-8 SI (6.25-96.88). Floor effects were observed among 6 of the 8 items, with more than 15% (Gulledge et al., 2019) participants selecting the lowest-scoring option.

Concerning the reliability of the PDQ-8, both the Cronbach's alpha of 0.79 and the mean inter-item correlation of 0.32 exceeded the threshold of α> 0.7 (Hair et al., 2019)and correlation of 0.2-0.4 (Piedmont, 2014). For the item-total correlation, all but item 8 exceed the 0.3 threshold (Ebrahimi et al., 2013) and contributed to PDQ-8 scoring discrimination (Table 4.4). The translated PDQ-8 demonstrated satisfactory item-total correlations, inter-item correlations, and Cronbach's alpha values.

Table 4.4. *PDQ-8 item scoring*

Items	Mean (SD)	Observed range	Skewness	Floor/ Ceiling effect (%)	Item-total correlation
Total score	11.1 (5.15)	2-31	1.05	None	-
1. Mobility	1.65 (1.18)	0-4	0.25	18.4/6.1	0.53
2. Activities of daily living	1.10 (1.05)	0-4	0.81	34.7/4.1	0.48
3. Emotional well-being	1.35 (0.81)	0-4	1.02	8.2/2	0.56
4. Social support	1.20 (0.87)	0-4	0.59	20.4/2	0.55
5. Cognitions	1.51 (0.94)	0-4	0.36	12.2/2	0.64
6. Communication	1.10 (1.07)	0-4	0.87	34.7/4.1	0.56
7. Bodily discomfort	1.80 (1.14)	0-4	-0.20	16.3/2	0.52
8. Stigma	1.06 (1.39)	0-3	0.14	24.5/0	0.17

4.4. PDQ-8 Validity Testing

4.4.1. Face Validity

Other than the minor grammatical corrections on item 6, communication, other participants demonstrated understanding on the scale translation. Suggestions were also made in bolding the measuring duration (the last month) to further enhance clarity. The satisfactory face validity was concluded since stakeholder panel was able to complete the questionnaire independently without difficulties, with an averaged 3 minutes and 41 seconds

4.4.2. Content Validity and Linguistic Equivalence

The 1.0 item-Content Validity Index calculated from the expert panel indicated satisfactory content validity Lynn (1986). Minor grammatical revision was done on the social support item, adding the word “中 (Chinese word of “in”) for clarity purposes. The translated PDQ-8 yielded a satisfactory result in terms of both content validity and linguistic equivalence.

4.4.3. Criterion and Convergent Validity

The weak to moderately significant Pearson r correlation (Schober et al., 2018) between PDQ-8 and EQ-5D-5L’s index score (r= -0.63, p<.01), and its visual analogue score (r= -0.36, p<.05) demonstrated satisfactory criterion validity. Other significant correlations were also documented between PDQ-8 and MHC-SF (r= -0.50, p<.01); SOC-13 total score (r= -0.51, p<.01), and UCLA-3(r= 0.34, p<.05), also reported satisfactory convergent validity as shown in Table 4.5.

Table 4.5. *Correlations of PDQ-8 with other scales*

	Mean (SD)	**EQ-I**	**SOC-13 Total**	**SOC-13 COMP**	**SOC-13 MAN**	**SOC-13 MEAN**	**MHCSF Total**	**MHCSF Emotional well-being**	**MHCSF Social well-being**	**MHCSF Psychological well-being**	**UCLA-3**	**BRCS**	**PDQ-8**
EQ-VA	68.78 (16.95)	**0.60****	**0.30***	0.15	**0.32***	**0.36***	**0.48****	**0.42****	**0.38****	**0.47****	-0.19	**0.29***	**-0.36***
EQ-5D-5L index score	0.58 (0.25)	—	**0.33***	0.20	**0.40****	**0.29***	**0.49****	**0.54****	**0.41****	**0.41****	**-0.49****	0.21	**-0.63****
SOC-13 Total	59.65 (11.54)	—	—	**0.90****	**0.91****	**0.81****	**0.53****	**0.61****	**0.42****	**0.44****	**-0.46****	**0.39****	**-0.51****
SOC-13 COMP	22.76 (4.98)	—	—	—	**0.77****	**0.54****	**0.36***	**0.47****	**0.29***	0.27	**-0.38****	**0.38***	**-0.43****
SOC-13 MAN	17.96 (4.23)	—	—	—	—	**0.63****	**0.49****	**0.61****	**0.40****	**0.38****	**-0.45****	**0.32***	**-0.56****
SOC-13 MEAN	18.94 (3.97)	—	—	—	—	—	**0.56****	**0.53****	**0.44****	**0.54****	**-0.38****	**0.32***	**-0.36***
MHCSF Total	41.78 (13.24)	—	—	—	—	—	—	**0.77****	**0.93****	**0.93****	-0.22	**0.58****	**-0.50****
MHCSF Emotional well-being	9.31 (3.14)	—	—	—	—	—	—	—	**0.65****	**0.56****	-0.28	**0.53****	**-0.61****
MHCSF Social well-being	13.41 (5.25)	—	—	—	—	—	—	—	—	**0.78****	-0.19	**0.58****	**-0.41****
MHCSF Psychological well-being	19.06 (6.43)	—	—	—	—	—	—	—	—	—	-0.16	**0.48****	**-0.39****
UCLA-3	4.09 (1.32)	—	—	—	—	—	—	—	—	—	—	-0.11	**0.34***
BRCS	14.67 (2.70)	—	—	—	—	—	—	—	—	—	—	—	-0.21

Note. **: Significant at 0.01 level (2-tailed); *: Significant at 0.05 level (2-tailed); EQ-5D-5L= EuroQol-5 Dimensions-5 Levels; EQ-VA= EQ-5D-5L Visual analogue; SOC-13= 13-item Sense of Coherence Scale; ; SOC COM= SOC-13 comprehensibility subdomain; SOC MAN= SOC-13 manageability subdomain; SOC MEAN= SOC-13 meaningfulness subdomain; MHC-SF= Mental Health Continuum Short Form; BRCS= Brief Resilient Coping Scale; PDQ-8= Parkinson's Disease Questionnaire UCLA-3= UCLA three-item loneliness scale

4.5. Conclusion

The translated PDQ-8 demonstrated a satisfactory psychometric property among recruited participants and is a viable scale for measuring PWP's QOL in Hong Kong. Not only did it record no floor/ ceiling effect, but it also illustrated a normal distribution once the outlier was removed. Secondly, The satisfactory face and content validity suggested that both PWP and healthcare professionals considered the translated scale easily understandable and relevant to clinical practices. The significant correlation between the PDQ-8 with other QOL and well-being domains represented a satisfactory criterion, and convergent validity revealed that the scale was valid. While the item of stigma was noted with a suboptimal item-total correlation, the overall satisfactory internal reliability and mean inter-item correlation suggested the PDQ-8 remains a reliable QOL measuring scale among the Hong Kong population.

Chapter 5: Development of VIPA User Protocol

5.1. Introduction

The current chapter documented the findings from the phase 1 exploratory qualitative interviews in answering RQ 2, “What key contents should be included in a user protocol and technical support protocol for PWP to use the VIPA intervention at home?” and RQ 3, “Is it feasible to implement the VIPA intervention in the PD population?”. Section 5.2 shows the preliminary protocol for users. Section 5.3 presents the findings of the cognitive interviews. Finally, the process of finalizing the user protocol through calculating the i-CVI from the expert panel and its finalized content outline is presented in section 5.4.

5.2. Development of the VIPA User Protocol

5.2.1. Formulating the Preliminary Protocol by Literature Review

Before the exploratory qualitative interview, a literature-based framework for the VIPA intervention was synthesized based on existing evidence. Since PD-specific intervention could induce self-stigmatization among PWP (Oehlberg et al., 2008), the first part of the protocol focused on introducing the global popularity of VIPA among Western societies, with 146.9 million smart speakers sold in 2019 (Koksal, 2020), 53% of US and 1 in 5 UK households owned a VIPA (CDEI, 2019; Voicebot, 2018) to highlight its commonality to serve as an everyday electronic compliance to facilitate our lives.

The intervention period was set to 8 weeks to allow familiarization with VIPA and to form companionship referencing existing evidence, as shown in Table 4.4. (Arnold et al., 2024; Kim & Choudhury, 2021). There was one theme per week for participants to operate the VIPA. They were encouraged to interact with the VIPA intervention 10 times daily, aligning with the naturalistic mean usage of 59.6 weekly commands in older adults with low technological use (Pradhan et al., 2020).

Five psycho-social VIPA functions: PD support, communication, entertainment and reality orientation were identified from research on older adults and the PD population (Budd, 2020; Duffy et al., 2021; O'Brien et al., 2022). Table 5.1 shows the preliminary VIPA user protocol where the first category, PD support, contained VIPA functionalities used by PWP to cope with their symptoms identified in an online survey, including online information searching, voice-to-text, and setting medication reminders or timers. The communication category extended from VIPA's voice-to-text capability to promote interpersonal communication (human-to-human interaction) and virtual interaction (human-to-robot) to promote psychological well-being and used by PWP (Budd, 2020). At the same time, the entertainment category focused on music, radio, or video playing capability as its value was also highlighted across VIPA research in both older adult and PD populations. Finally, the reality orientation and miscellaneous categories focused on the utility aspect of VIPA to keep PWP in touch with the outside world. Voice commands in the user protocol referenced the official HomePod guide from Apple support in traditional Chinese (Apple, 2022) and tailored scenarios to fit the PD populations.

Table 5.1. *Preliminary VIPA user protocol*

Dosage & planned activities	Index	Descriptions
	Introduction	
	1. Basic functions of VIPA	A brief list of VIPA functions
	2. VIPA use in Western society	Global statistics to normalize the intervention
10 voice commands/ day	3. Recommended use of VIPA	Detailing the recommended dosage, duration, and planned weekly technical support, contact information
	4. How to pair with mobile phones	Listing procedures and technical support number.
Week 1	**PD support**	**Voice commands (examples)**
	1. Medication reminder	Hey Siri, remind me to take medicine at 4.
	2. Timer/ alarms	Hey Siri, Set a 10-minute timer.
	3. Information retrieval	Hey Siri, where is the nearest hospital; what is XXX?
	4. Making to-do list	Hey Siri, remind me to go follow up next Monday at 2
	5. Scheduling	Hey Siri, What's on my schedule; create an event on Tuesday.
Week 2	**Communication**	
	1. Phone and Video calling	Hey Siri, Answer the call; who's calling; Call XXX (contact name).
	2. Sending message	Hey Siri, send a WhatsApp to XXX; Send a WeChat to XXX; do I have any new messages?
	3. Chatting with VIPA	Hey Siri, who are you; what can you do?
	4. Email	Hey Siri, Read out my email.
	5. Emergency calling (in case of emergency)	Hey Siri, call 999; call emergency service.
Week 3	**Entertainment**	
	1. Jokes	Hey Siri, tell me a joke.
	2. Listening to music	Hey Siri, play music; play XXX music (songs or singers' names); turn up the volume; stop.
	3. Radio broadcast	Hey Siri, play RTHK radio.
Week 4	**Reality orientation**	
	1. Weather checking	Hey Siri, how's the weather today?
	2. Calendar	Hey Siri, what date/ time is it?; when is my dinner with XXX
	Utilities	
	1. Travelling	Hey Siri, I want to travel to XXX; where is the nearest XXX?
	2. Calculation	Hey Siri, What is 5+5?
Week 5-8	Use the VIPA as they like	

Note. Apple, 2022

5.2.2. Generating Contents of the Protocol Contents through Focus Group Interviews

5.2.2.1. Demographic Data

The three semi-structured focus groups were conducted via Zoom during the COVID-19 period to minimise infection risk, and three cognitive interviews were held in the University interview rooms from May to August 2023 with 14 PWP in heterogeneous groups based on their daily technological usage (see Table 5.2). Of all participants, only Participant 7 reported previous VIPA experience. For cognitive interviews, participants with different smartphone operating systems and experience on VIPA were purposefully selected. Participants 12 and 14 used Android, and Participant 7 used iOS.

Table 5.2. Demographic background for focus group interviews

Participant ID	Gender	Age	Highest Education Level	H&Y level	MTUAS score
Group 1 – 66 minutes					
1	M	65	Secondary education	2	48
2	M	53	Secondary education	3	175
3	F	68	Secondary education	4	126
4	F	68	Tertiary education	3	80
5	F	65	Secondary education	3	115
Group 2 – 74 minutes					
6	F	56	Secondary education	1	187
7	M	72	Secondary education	3	179
8	F	67	Secondary education	4	92
9	F	70	Secondary education	2	116
Group 3 – 61 minutes					
10	M	57	Tertiary education	2	138
11	M	57	Tertiary education	3	118
12	M	65	Secondary education	1	120
13	F	60	Secondary education	3	68
Cognitive interviews – 63 to 127 minutes					
7	M	72	Secondary education	3	179
12	M	65	Secondary education	1	120
14	M	63	Secondary education	3	99

Note. H&Y scale= Hoehn & Yahr Scale H&Y scale for assessing severity of PD, higher level represents a higher PD progression, ranged from 1 to 5; MTUAS= Media and Technology Usage and Attitudes Scale, scoring from 22-220, higher score represent higher technological use

5.2.2.2. Findings from Interviews

These interviews aim to identify the functions needed by PWP. With the coding for the exploratory interviews shown in Table 5.3, 3 subthemes and 1 overarching theme “The desirable design of psychosocial oriented VIPA for PD” were generated.

Table 5.3. *Coding for exploratory interviews and mentioned frequency*

Themes	Categories (mentioned frequency)	Codes
Versatile role of VIPA		
	Secretary (50)	1. Voice-to-text function 2. Phonographic function 3. Itinerary scheduling 4. Navigation
	Caregiving (50)	1. Facilitate sleeping 2. Provide symptom intervention 3. Comforting response 4. Medication reminder
	Messenger and Companion (26)	1. Interpersonal contact 2. Emergency Contact 3. E-companion
	Health advisor (21)	1. Physical exercise 2. Sedentary 3. Vital sign 4. Facilitate communication with professionals
	Entertainer (19)	1. Jokes telling 2. Music playing 3. Karaoke
	Smart home butler (9)	1. Smart home accessories
All-in-one information hub		
	Center point of information(48)	1. Community resources 2. Health information 3. Healthy lifestyle 4. PD Treatment 5. Weather checking 6. Technological support 7. Translation services
Desirable designs in VIPA		
	Software component (14)	1. Convenience 2. Proactive greetings 3. Daily voice calibration 4. Vital sign taking 5. Exercise reminder
	Physical component (15)	1. Portable 2. Customizable shortcut 3. Functional specific 4. Standalone

5.2.2.2.1. Versatile Role of VIPA

A total of 6 assistive VIPA roles for PWP were formulated from the qualitative data, with the secretarial and caregiver roles being the most mentioned categories in serving PWP (50 mentions each). Participants anticipated that the VIPA could manage their appointments or provide voice-to-text transcriptions in mitigating their voice impairment or tremors.

"The most important feature is that we can communicate with it with only our voice."

(Participant 12)

"VIPA is just like a mini secretary."

(Participant 8)

Participants also wished the VIPA could mitigate their PD symptoms with a built-in intervention, as if it were their caregivers, with only voice activation. For example, brief counselling with reassurances, motivational speeches, or religious support could help lessen the impact of a low mood. Peaceful music that resembles mindfulness could facilitate sleeping to mitigate insomnia.

"Can we tell VIPA to play some mindfulness music during our sleepless nights?"

(Participant 6)

"When I'm feeling low, it can speak some positive quotes or Christian poems according to my mood"

(Participant 4)

The voice activation properties of the VIPA were thought to lessen the impact of PWP's motor symptoms, such as freezing of gait (FOG), by installing nursing interventions in it, or utilizing the alarm function to enhance their medication adherence.

"We can say, "Siri, I'm experiencing freezing of gaits." Then VIPA can say, "Oh, you can't walk? You can try some deep breathing exercises," and guide us through it."

(Participant 6)

"I'd like VIPA to remind us of our medication time, and it's best for it to document our reaction, too."

(Participant 1)

The third most mentioned category, messenger and companion categories (26 mentions) focused on the PWP's interpersonal domain with both human and robot interactions. The VIPA could relay phone calls and messages to their friends or initiate virtual conversations with their users if they were home alone.

"An e-companion to monitor my progress"

(Participant 4)

"Phone calling is the most important. We can use voice commands to phone someone if anything comes up."

(Participant 13)

"It could proactively greet us in the morning without us speaking "How are you today," as we'd not speak for the entire day if there's no one at home."

(Participant 4)

The VIAP could also monitor and advise PWP's exercise routine with a health advisor role (21 mentions), by collecting users' vital signs for review by healthcare professionals.

"Lead us through some daytime exercises by voicing out like a radio, "Raise your hands," and guide us for a 15-minute exercise."

(Participant 5)

"I want VIPA to teach us how to report to doctors."

(Participant 1)

With VIPA's entertainment functions, participants could utilize music playing for relaxation or as speech training. Finally, participants would appreciate the VIPA in controlling smart home electronics in their homes.

"Singing can help with our speech... Yes, because it could improve our speaking."

(Participant 2)

5.2.2.2.2. All-in-one Information Hub

Participants also anticipated the VIPA in referring them to available community resources, searching for PD-related information online, and integrating all apps and functions from their smartphones.

> "If it (VIPA) can integrate my existing apps...Then, it can be truly a "smart" technology."
>
> (Participant 14)
>
> "Making a reservation with "rehab bus" (non-emergency transportation operated by NGO)."
>
> (Participant 3)

The online information of interest included both specific disease-related treatments, generic weather forecasts, and technological supports.

> "information such as how many steps I should walk per day or what food with high fiber and protein I should eat."
>
> "The mechanism, side effects of our medication, and how to adjust the device after the surgery (deep brain stimulation)."
>
> (Participant 1)

5.2.2.2.3. Desirable Designs in VIPA

Participants also revealed that a proactive, intuitive and convenient design in VIPA is important in increasing their intention to use and should be able to work without prompting, such as greeting them or making reminders.

> "The more simplistic it is, the better. We'd give up if it's too complicated and difficult to use."
>
> (Participant 13)
>
> "Sometimes we have no idea what to use the VIPA for. It should tell us without prompting."

(Participant 4)

Secondly, a portable VIPA that is not bound to any smartphone operating system is also appreciated by participants. Participant 13 further elaborated on the idea of implanting VIPA as their emergency call.

"Do we need to pair it with iOS phones? Would other cheaper phones be able to do it?"

(Participant 11)

"We should be able to wear it like a ping on chung."

(Participant 13)

"It's a faulty design if it's not portable."

(Participant 3)

5.3. Feasibility Testing of the VIPA User Protocol through Cognitive Interviews

After completing the preliminary VIPA user protocol, PWP was invited to participate in the cognitive interviews to test for its feasibility. They were instructed to try out all primary VIPA functions listed in the preliminary user protocol. The technological and speech barriers signified the need for a training session before the implementation. At the same time, more structured and simplified user protocol content was generated to facilitate PWP how to use VIPA.

5.3.1. Technological and Speech Barriers

Observations and qualitative data collected from cognitive interviews indicated that the VIPA intervention was feasible for the PD population. The VIPA was feasible in recognizing participants' voices (MDS-UPDRS speech impairment level 0-2) in the University interview room environment. Participants could generally execute the planned VIPA functions upon clarification and repetition of commands. The following paragraphs describe the lowest 68.6% voice recognition recorded in Participant 7. Although they reported with a MDS-UPDRS level 1, mildly impaired speech. They presented with a soft-spoken voice and slurred speech. A total of 102 attempts were made during the interview, and 70 primary commands were successfully executed. Among those 32 unsuccessful executions, the majority were due to inaccurate voice recognition (n=22), including the VIPA being unable to recognize their wake-up phrase or wrongly interpreting their commands. Other unsuccessful attempts were due to mixing Cantonese with English (n=6), double-barreled questions (n=3), and premature execution before they could fully formulate the command (n=1). The participant had trouble enunciating keywords such as “Siri,” “YouTube,” and “podcast”, thus lowering the voice recognition accuracy.

Participants were also observed to be unfamiliar with the intervention’s operative design and the voice commands used. The voice activation was not as naturalistic as interpersonal interaction and relied on specific, simple keywords. The VIPA noted difficulties in handling double-barrel questions, mid-sentence revision, or premature execution when participant were still articulating their commands. Moreover, participants’ smartphone operation techniques could not be entirely translated into voice-activation. Participants were observed tapping on the VIPA trying to wake up the device instead of using the wake phrase.

Retrospective probing suggested the protocol has satisfactory face validity. Participants reported the intervention protocol as not complicated (participant 7) and step-by-step but would require some time to get used to (participant 14). The unfamiliarity of VIPA interventions suggested that a training section was necessary for PWP to operate the VIPA intervention effectively. Firstly, the wording in the instruction part of the user protocol was revised to enhance clarity and simplification was made to voice command syntax to reduce phonetic difficulties. Secondly, a 45-minute VIPA training session was arranged for each participant on the installation date. The training material includes fundamental VIPA operation techniques, such as buttons and command syntax, and a return demonstration on VIPA functions to ensure participants are familiar with the control and can operate the VIPA independently. Finally, all the enquiries lodged in phase 1 were integrated into a technical frequently asked questions within the user protocol, and all IG participants were provided with a technical support hotline for enquiries.

5.3.2. Unconsciously Applying Social Rules During Interaction

Participants were also observed applying human-to-human social cues when communicating with the VIPA, such as saying "please" (n=11 for Participant 14). These social behavious were observed affecting the VIPA executing accuracy and could lead to unsuccessful voice recognition as they were not initially included in the command structures.

5.4. Finalized VIPA User Protocol

A finalized VIPA user protocol was formulated after the phase 1 explorative qualitative interview, with the sequence arranged in descending order, mentioning frequency and ascending operation difficulties, as presented in Table 4.6.

The introduction section contains a brief introduction of VIPA, a step-by-step VIPA operation guide, frequently asked questions, and the global prevalence of VIPA in Western society. Each category includes simple descriptions and related voice commands. These commands were introduced in prompt languages to enhance effective human-to-robot communication. For example, the voice command formula provided in scheduling activities was in the syntax form of “Hey Siri, arrange activity on **[date & time]** for **[activity content]**” to schedule events. Participants were advised only to alter the bolded words to promote voice recognition. Real-life applications and scenarios were drawn from interview transcripts to be relevant to participants' daily lives. Because information searching was also one of the main applications for the VIPA intervention, participants were advised to search with credible sources such as governmental websites to avoid misinformation (e.g., Hey Siri, search for **[information content]** on Department of Health).

The VIPA could generally handle the needs of PWP's secretarial, messenger, companion, entertainer, and butler. At the same time, additional nursing interventions were required in the VIPA intervention to support their disturbed mood, freezing of gait, or insomnia management. Both participants 4 & 8 mentioned positive encouragement could boost their morale when experiencing low mood or feeling worried during focus group interviews.

> "I want some motivational poem or songs in it."
>
> (Participant 8)

> "For example, when I say I'm unhappy, it could recite motivational quotes or poems according to my moods."
>
> (Participant 4)

A study conducted by Pretzer-Aboff and team identified emotional support and continuous encouragement could facilitate PWP's daily functioning (Pretzer-Aboff et al., 2009). Therefore, nursing interventions were integrated into the VIPA intervention using the shortcut functions in iOS. PWP would only need to say, "Hey Siri, tell me some motivational quotes" to initiate the installed motivational quotes. In addition, the user protocol included a contingency plan for utilizing emergency services if needed. Secondly, the nursing intervention for FOG was referenced by the Parkinson's Foundation (Parkinson's_Foundation, 2023), integrating techniques such as stepping over an imaginary line and utilizing music to facilitate walking.

Finally, participant 6 reported using mindfulness music to help with their insomnia. Such techniques coincide with the documented beneficial effect of mindfulness on older adults in improving sleep quality (Black et al., 2015) and similar qualitative research findings on how mindfulness can facilitate relaxation and sleep in PWP (Bogosian et al., 2022). Therefore, the formulated VIPA user protocol (see Table 5.4) included instructions to search for mindfulness videos, and participants could also play music to their liking was ready for validity testing.

> "It could play some mindfulness music to help us relax when we can't fall asleep."
>
> (Participant 8)

Table 5.4. *VIPA user protocol content*

Execution plan	Index	Descriptions
	Introduction	
	5. Basic operation - Prompt grammar	Training on reading prompt language
	6. Prevalence of Western society	To normalize the intervention
10 voice commands/ day	7. Technical support - Frequently asked questions - Trouble shooting	Detailing the recommended dosage, duration, and planned weekly technical support, contact information
Week 1- Secretarial functions and information searching		**Voice commands (examples)**
	1. Medication reminder	Hey Siri, set an alarm for 3 in the afternoon as medication time
	2. Daily schedule update & Weather checking	Hey Siri, what's my update for tomorrow (customized)
	3. Information retrieval	Hey Siri, where is the nearest hospital; what is XXX?
	4. Voice-to-text function	Hey Siri, write down xxx
	5. Voice amplification	Hey Siri, repeat the last memo
	6. Recording	Hey Siri, what's on my schedule; create an event on Tuesday.
Week 2- Symptoms management		
	1. Freezing of gait	Hey Siri, I'm experiencing freezing of gait (customized)
	2. Low mood	Hey Siri, read me some motivational quotes (customized)
	3. Insomnia	Hey Siri, play some forest sounds
	4. Exercising	Hey Siri, search for older adults exercise from Department of Health
Week 3- Communication		
	Human-to-Human interaction	
	4. Phone and Video calling	Hey Siri, Answer the call; who's calling; Call XXX (contact name).
	5. Emergency calling	Hey Siri, call 999; call emergency service.
	Human-to-robot interaction	
	6. Chatting with VIPA	Hey Siri, who are you; read a poem for me?
	7. Jokes	Hey Siri, tell me a joke.
Week 4- Scheduling and navigation		
	1. Calendar	Hey Siri, when is next follow-up date
	2. Traveling	Hey Siri, I want to travel to XXX; show me the way to XXX?
	3. Flow chart on making appointment and map navigation	
Week 5- Entertainment and miscellaneous functions		
	1. Radio broadcast	Hey Siri, play radio.
	2. Listening to music	Hey Siri, play music
	3. Podcast	Hey Siri, play news podcast
	4. Timer	Hey Siri, play 30 mins music
Week 6-8	**Use the VIPA intervention as they like**	

Note. Apple, 2022

5.4.1. Content Validity

The finalized VIPA user protocol was sent to an expert panel of 2 psychologists, 2 psychiatric nurses and 1 who worked in the information technology domain to examine its i-CVI on each section of the user protocols. All items' i-CVI scores obtained a 1.0 score for all items, indicating that the VIPA user protocol has satisfactory content validity for the pilot RCT.

5.5. Conclusion

The VIPA protocol framework was designed based on the six different VIPA roles generated to serve the PD population. The intervention could not only act as the information hub for searching for disease information and community resources. It could also take up six other roles: secretary, caregiving, messenger and companion, health advisor, entertainer, and smart home butler. Customized nursing interventions were integrated into the VIPA intervention to fit the needs of the PD population.

Secondly, the feasibility of VIPA intervention was supported by the cognitive interviews. PWP could operate the intervention without major issues after a training session and reported satisfactory face and content validity from expert panels.

Chapter 6: Pilot RCT & Explanatory Qualitative Study Result

6.1. Introduction

The current chapter documents the quantitative and qualitative results of the pilot RCT and the subsequent explanatory qualitative interviews. Section 6.2 answers RQ 4, “What is the preliminary efficacy of VIPA intervention on PWP’s SOC and psychosocial well-being?” and RQ 5, “Can such effect sustain for 1 month after the intervention?” Sections 6.2.1 & 6.2.2 describe the recruitment process and participants’ demographic data. Section 6.2.3 reported the preliminary efficacy of the intervention, while 6.2.4 & 6.2.5 contain the VIPA usage and their preferred functionalities among IG participants. Finally, section 6.3 presents the qualitative result of the explanatory qualitative interview for RQ 6, “What is the users’ experience on the VIPA?”

6.2. Pilot RCT

The current section documented the result of the pilot RCT, detailing its preliminary efficacy, intervention usage, and preferred functions.

6.2.1. Participants Recruitment

Among those 51 PWP partaking in the PDQ-8 validation study, 3 were not qualified to participate in the pilot RCT because these people could not use the VIPA. Therefore, the remaining 48 PWP were randomized into IG and CG on a 1:1 ratio detailed in the consort flow chart in Fig. 6.1 (Schulz et al., 2010) to initiate the VIPA pilot RCT.

The pilot RCT later recorded 9 dropouts, with 5 participants in IG leaving and 4 in CG. Those who did not receive the intervention (n=3) in the IG were due to being untraceable (n=1), left HK (n=1), and withdrawn from the study after briefing (n=1; participant 21). Participant 21 withdrew from the study due to believing the VIPA could be too convenient and “do not wish to become dependent on it” despite explanations. Participant 5 in IG withdrew from the study RCT shortly after the installation due to a deteriorated mental state from medication titration, reporting visual hallucinations before even using the intervention. They were advised to consult with the out-patient healthcare professional on his situation. The last participant in the IG left HK after the post-test assessment and did not undergo the follow-up assessment. A good retention rate of 95% of participants completed the intervention after the installation. At the same time, 4 CG participants were untraceable (3 not replying to phone calls, and 1 was unavailable during the assessment period) in the follow-up assessment.

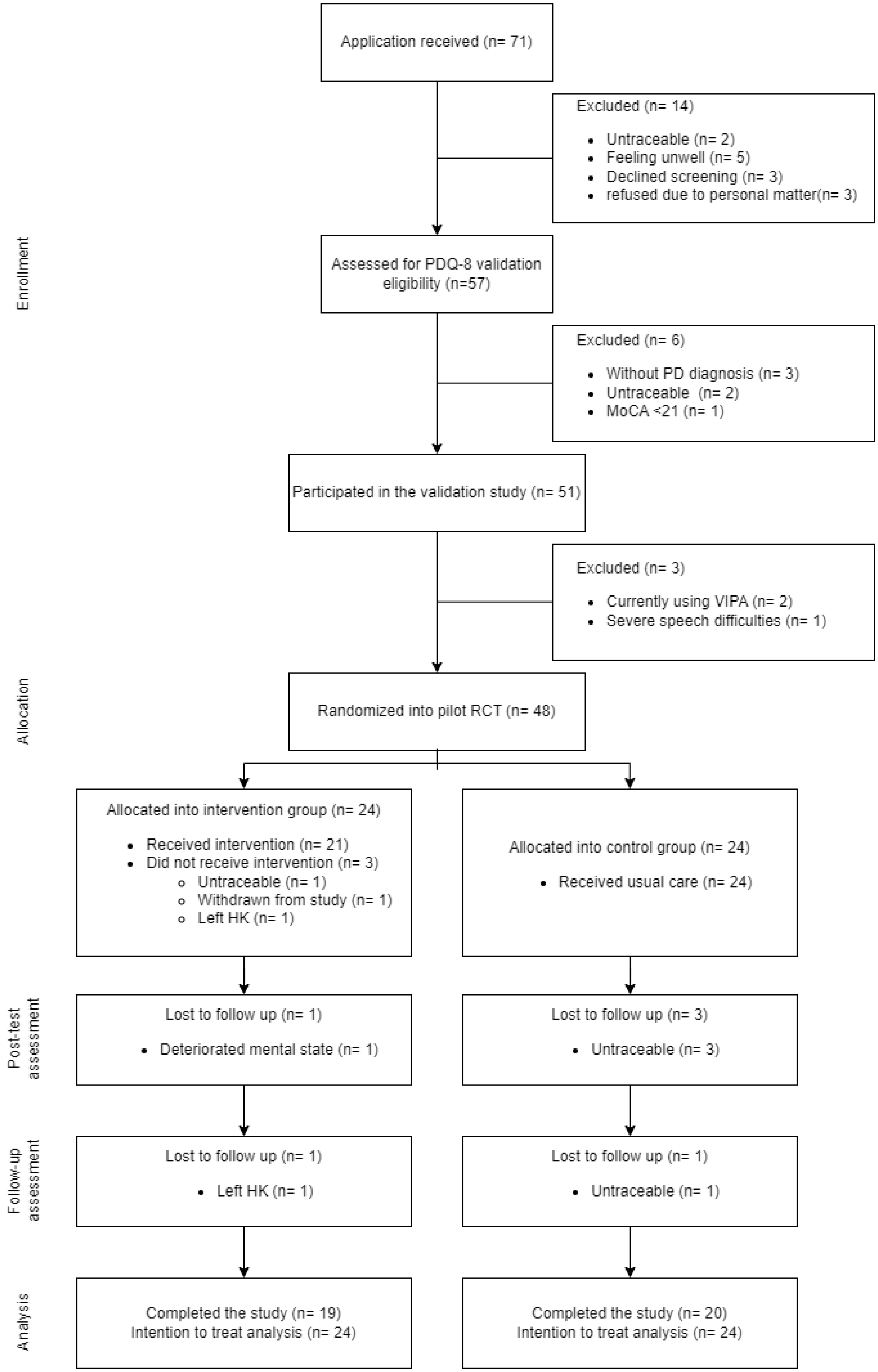


Fig 6.1. CONSORT diagram for the current study

6.2.2. Demographic Data

6.2.2.1. Demographic Data for Participants

The participants' composition within the pilot RCT remains largely the same as the aforementioned PDQ-8 validation study, with 3 participants less (see Table 6.1). Non-significant chi-square and between-group differences were identified across IG and CG participants in all demographic variables at baseline. The recorded mean age for participants was 63.5 years old (SD= 7.72) and was tested to be non-normally distributed with the Shapiro-Wilk test (W=0.89, p<0.001) with a skewness of -1.40. At the same time, one-third (n=8) of the IG participants were iOS users, while the rest used the Android phone operating system. Two IG participants who lived alone dropped out of the study before the VIPA installation.

Concerning participants' PD-related background, the average PD onset among participants was 56.5 years old (SD= 9.55), and over one-third (35.4%) of participants were assessed with the lowest disease progression of H&Y scale level 1, followed by stage 3 (27.1%), stage 2 (25%), and stage 4 (12.5%) in decreasing trend. 81.3% (n= 39) of participants reported different levels of speech difficulties, with 62.5% being mild to moderately impaired. Over half of the participants (56.3%) reported comorbidities, and most of the common ones were high blood pressure and depression (12.5%). The mean MoCA score is 26.94 (SD= 2.93). With 81.2% of participants (n=39) are cognitively intact, 9 participants (18.8%) (n=9) had a MoCA score below 26 (the threshold for Mild Cognitive Impairment; MCI) (Nasreddine et al., 2005). Mann-Whitney U Test was performed on participants' MoCA score due to its non-normally distribution (W= 0.90, p< 0.001; skewness= -0.95) and resulted with a non-significant between group difference between IG and CG (U= 284, p=0.93).

Table 6.1 *Baseline demographic data across groups in pilot RCT*

	Total (n=48)		IG (n=24)		CG (n=24)			
Continuous Variables	**M(SD)**	**Range**	**M**	**SD**	**M**	**SD**	**T/U value**	**P value**
Age	63.5(7.72)	37-76	63.5	8.1	63.5	7.5	251*	0.59
Age of onset	56.5(9.55)	35-73	56.9	9.1	56.1	10.2	0.28	0.78
MoCA	26.9(2.39)	21-30	26.8	2.7	27.0	2.1	284*	0.93
Categorical Characteristics	**N**	**%**	**N**	**%**	**N**	**%**	**χ2 (df)**	**P value**
Gender							0 (1)	1.00
Male	22	45.8	11	45.8	11	45.8		
Female	26	54.2	13	54.2	13	54.2		
Cognitive function							0.14(1)	0.71
MCI (21<MoCA<26)	9	18.8	5	20.8	4	16.7		
Cognitively intact (MoCA≥26)	39	81.2	19	79.2	20	83.3		
Living condition							0.87(1)	0.35
Living alone	6	12.8	2	8.3	4	17.4		
Living with others	41	87.2	22	91.7	19	82.6		
PD stage (H&Y level)							4.0(3)	0.26
Least severe- Level 1	17	35.4	9	37.5	8	33.3		
Level 2	12	25	4	16.7	8	33.3		
Level 3	13	27.1	9	37.5	4	16.7		
Level 4	6	12.5	2	8.3	4	16.7		
Speech difficulties							1.65(3)	0.65
Normal	9	18.8	6	25	3	12.5		
Slight	14	29.2	6	25	8	33.3		
Mild	16	33.3	7	29.2	9	37.5		
Moderate	9	18.8	5	20.8	4	16.7		
Educational level							4.0(6)	0.67
Primary school	7	14.6	2	8.3	5	20.8		
Secondary education	27	55.5	16	66.7	10	41.7		
Tertiary education	13	27.1	6	25	8	33.3		

Perceived income adequacy							1.2(4)	0.88
None at all	2	4.2	1	4.2	1	4.2		
A little	10	20.8	4	16.7	6	25		
Moderately	20	41.7	10	41.7	10	41.7		
Mostly	11	22.9	7	29.2	4	16.7		
Completely	4	8.3	2	8.3	2	8.3		
Working condition							0.003(1)	0.96
Working	6	12.5	3	12.5	3	12.5		
Unemployed/ Retired	41	85.4	21	87.5	20	83.3		
Marital status							4.1(4)	0.39
Single	5	10.4	1	4.2	4	16.7		
Married	29	60.4	16	66.7	13	54.2		
Living together	3	6.3	2	8.3	1	4.2		
Divorced/ Separated	6	12.5	4	16.7	2	8.3		
Widow	4	8.3	1	4.2	3	12.5		
Comorbidity							0.56(1)	0.45
None reported	21	43.8	12	25.5	9	19.1		
High blood pressure	6	12.5	5	20.8	1	4.2		
Obesity	2	4.2	2	8.3	0	0		
Diabetes	4	8.3	1	4.2	3	12.5		
Depression	6	12.5	2	8.3	4	16.7		
Anxiety	3	6.3	0	0	3	12.5		

Note. * Mann-Whitney U Test; IG= Intervention Group; CG= Control Group; H&Y scale= Hoehn & Yahr Scale H&Y scale for assessing severity of PD, higher level represents a higher PD progression, ranged from 1 to 5

6.2.2.2. Outcome Variables at Baseline

No significant statistical difference could be identified among all outcome variables at baseline among IG and CG participants (see Table 6.2). Patterns of non-normal distributions were identified from PDQ-8 (W= 0.93, p< 0.01; skewness= 1.11); UCLA-3 (W= 0.79, p< 0.001; skewness= 1.41) with the significant Shapiro-Wilk test. Mann-Whitney U Test was performed to examine the baseline difference between these two variables instead of the independent t-test. Finally, all outcome variables demonstrated satisfactory internal reliability of > 0.7 (Hair et al., 2019).

Table 6.2. *Baseline outcome variables across groups in pilot RCT*

Baseline measurement	Scale scoring	Cronbach's α	Total (n= 48)		IG (n= 24)		CG (n= 24)		T/U value	P value
			M(SD)	Range	M	SD	M	SD		
SOC-13	13-91	0.83	60.19(11.81)	35-86	60.46	11.95	59.91	11.92	-0.16	0.88
Comprehensibility	5-35		22.98(4.98)	11-32	23.38	5.27	22.57	4.74	-0.55	0.58
Manageability	4-28		18.09(4.30)	10-27	18.08	4.21	18.09	4.49	0.00	1.00
Meaningfulness	4-28		19.13(4.10)	11-27	19.00	3.93	19.26	4.35	0.22	0.83
MHC-SF	0-70	0.92	42.07(13.40)	14-67	42.39	15.37	41.74	11.45	-0.16	0.87
Emotional well-being	0-15		9.22(3.18)	3-15	9.35	3.14	9.09	3.29	-0.28	0.78
Social well-being	0-25		13.50(5.35)	3-24	13.74	6.19	13.26	4.49	-0.30	0.77
Psychological well-being	0-30		19.35(6.31)	6-30	19.30	7.20	19.39	5.43	0.05	0.96
BRCS	4-20	0.78	14.67(2.73)	9-19	14.83	2.82	14.52	2.69	-0.37	0.71
PDQ-8*	0-32	0.78	11.28(5.12)	2-31	11.43	5.75	11.13	4.54	249.50	0.74
UCLA-3*	3-9	0.77	4.14(1.39)	2-9	4.00	1.18	4.27	1.58	209.50	0.58

Note. * Mann-Whitney U Test; SOC-13= 13-item Sense of Coherence Scale, a higher score represents a higher sense of coherence; MHC-SF= Mental Health Continuum Short Form, a higher score represents better mental well-being; BRCS= Brief Resilient Coping Scale, a higher score represents a better stress adaptability; PDQ-8= Parkinson's Disease Questionnaire, a lower score represents better quality of life; UCLA-3= UCLA three-item loneliness scale, a lower score represents a lower sense of loneliness; IG= Intervention Group; CG= Control Group

Pearson r correlation was also conducted between outcome variables and demographic variables. Table 6.3 presented the correlational strength between the primary outcome, SOC-13, and demographic variables. SOC (total) was moderately correlated with the perceived income adequacy ($r= 0.45$, $p<0.01$). Similarly, SOC (manageability) and SOC (meaningfulness) moderately correlated with perceived income adequacy ($r= 0.46$, $p<0.01$; $r= 0.51$, $p<0.01$ respectively). At the same time, the meaningfulness domain was also negatively correlated with comorbidity ($r= -0.29$, $p<0.05$).

Table 6.4 presented the Pearson r correlational matrix of secondary outcomes and baseline variables. Educational levels were found to be positively correlated with the MHCSF-emotional domain ($r= 0.31$, $p<0.05$), BRCS ($r= 0.32$, $p<0.05$), and negatively with PDQ-8 ($r= -0.38$, $p<0.05$). Secondly, perceived income adequacy was found to be positively correlated with all MHCSF subdomains (total score: $r= 0.43$, $p<0.01$) and negatively with PDQ-8 ($r= -0.46$, $p<0.01$). Finally, comorbidity was found to be negatively correlated with participants' MHCSF social ($r= -0.33$, $p<0.05$), psychological well-being ($r= -0.29$, $p<0.05$) domains, and positively with PDQ-8 ($r= 0.35$, $p<0.05$).

Table 6.3. *Pearson r correlational between SOC-13 (primary outcome) and demographic variables*

	MDS-UPDRS 2.1	**Gender**	**Age**	**Age of onset**	**Living condition**	**Marital status**	**Employment status**	**Educational level**	**Perceived income adequacy**	**Chronic disease diagnosis**	**MoCA**	**SOC-13 Total**	**SOC-13 COMP**	**SOC-13 MAN**	**SOC-13 MEAN**
H&Y level	**0.31***	-0.01	0.11	-0.25	0.04	-0.29	0.24	-0.04	-0.12	-0.06	-0.13	0.01	0.09	-0.06	-0.03
MDS-UPDRS 2.1	—	0.23	0.12	0.05	**0.34***	0.06	0.13	-0.07	-0.03	-0.03	-0.13	0.11	0.15	0.05	0.08
Gender	—	—	0.10	-0.04	0.21	0.20	0.28	-0.10	0.19	-0.16	0.05	0.16	0.09	0.03	**0.31***
Age	—	—	—	**0.78****	-0.07	0.15	**0.38****	**-0.29***	0.01	0.01	-0.13	0.01	-0.01	-0.06	0.11
Age of onset	—	—	—	—	-0.10	0.08	0.08	-0.22	-0.03	0.14	-0.12	0.01	0.01	0.02	-0.02
Living condition	—	—	—	—	—	0.02	0.12	0.00	-0.06	-0.01	0.11	-0.06	-0.04	-0.07	-0.05
Marital status	—	—	—	—	—	—	0.16	-0.07	-0.03	-0.05	-0.07	-0.12	-0.17	-0.05	-0.09
Employment status	—	—	—	—	—	—	—	**-0.32***	-0.09	-0.09	0.12	-0.21	-0.16	-0.23	-0.16
Educational level	—	—	—	—	—	—	—	—	**0.42****	-0.25	0.25	0.25	0.14	0.27	0.26
Perceived income adequacy	—	—	—	—	—	—	—	—	—	-0.21	0.21	**0.45****	0.25	**0.46****	**0.51****
Comorbidity	—	—	—	—	—	—	—	—	—	—	-0.16	-0.20	-0.10	-0.16	**-0.29***
MoCA	—	—	—	—	—	—	—	—	—	—	—	0.14	0.11	0.14	0.13
SOC-13 Total	—	—	—	—	—	—	—	—	—	—	—	—	**0.90****	**0.92****	**0.82****
SOC-13 COM	—	—	—	—	—	—	—	—	—	—	—	—	—	**0.78****	**0.57****
SOC-13 MAN	—	—	—	—	—	—	—	—	—	—	—	—	—	—	**0.65****

Note. **: Significant at 0.01 level (2-tailed); *: Significant at 0.05 level (2-tailed); SOC-13= 13-item Sense of Coherence Scale; SOC COM= SOC-13 comprehensibility subdomain; SOC MAN= SOC-13 manageability subdomain; SOC MEAN= SOC-13 meaningfulness subdomain; MDS-UPDRS 2.1= Movement Disorder Society- Unified Parkinson's Disease Rating Scale item 2.1; MoCA= Montreal Cognitive Assessment; H&Y scale= Hoehn & Yahr Scale H&Y scale for assessing severity of PD, higher level represents a higher PD progression, ranged from 1 to 5

Table 6.4. *Pearson r correlational between secondary outcomes and demographic variables*

	MHCSF Total score	**MHCSF Emotional well-being**	**MHCSF Social well-being**	**MHCSF Psychological well-being**	**BRCS**	**UCLA-3**	**PDQ-8**
H&Y level	-0.06	0.01	0.03	-0.16	0.06	0.21	0.16
MDS-UPDRS 2.1	-0.27	-0.20	-0.24	-0.28	0.00	0.06	0.22
Gender	0.17	-0.01	0.14	0.24	0.03	0.09	0.18
Age	0.00	0.00	0.07	-0.07	0.03	-0.04	-0.03
Age of onset	-0.13	-0.02	-0.12	-0.16	-0.02	-0.09	-0.11
Living condition	0.03	-0.27	0.13	0.09	0.06	0.14	0.10
Marital status	0.06	-0.09	0.13	0.05	0.13	-0.01	0.08
Employment status	-0.15	-0.20	-0.07	-0.16	-0.17	0.20	0.20
Educational level	0.26	**0.31***	0.20	0.23	**0.32***	-0.29	**-0.38****
Perceived income adequacy	**0.43****	**0.48****	**0.29***	**0.41****	0.13	-0.21	**-0.46****
Comorbidity	**-0.33***	-0.26	**-0.33***	**-0.29***	-0.13	0.27	**0.35***
MoCA	0.02	-0.05	-0.01	0.06	0.00	-0.02	-0.13
MHCSF Total	—	0.78**	**0.94****	**0.94****	**0.62****	-0.25	**-0.50****
MHCSF Emotional well-being	—	—	**0.66****	**0.60****	**0.54****	-0.29	**-0.60****
MHCSF Social well-being	—	—	—	**0.81****	**0.61****	-0.22	**-0.41****
MHCSF Psychological well-being	—	—	—	—	**0.51****	-0.20	**-0.41****
BRCS	—	—	—	—	—	-0.14	-0.26
UCLA-3	—	—	—	—	—	—	**0.46****

Note. **: Significant at 0.01 level (2-tailed); *: Significant at 0.05 level (2-tailed); MHC-SF= Mental Health Continuum Short Form; BRCS= Brief Resilient Coping Scale; PDQ-8= Parkinson's Disease Questionnaire; UCLA-3= UCLA three-item loneliness scale; MDS-UPDRS 2.1= Movement Disorder Society- Unified Parkinson's Disease Rating Scale item 20.1; MoCA= Montreal Cognitive Assessment; H&Y scale= Hoehn & Yahr Scale H&Y scale for assessing severity of PD, higher level represents a higher PD progression, ranged from 1 to 5

6.2.3. Preliminary Efficacy

6.2.3.1. Primary Outcome— SOC-13

Table 6.5 shows the preliminary efficacy of the VIPA intervention on SOC. The SOC-13 total score demonstrated a non-significant group by time interaction effect at T1 (β= -2.42, *p*= 0.36; see Table 6.5) and T2 (β= -4.21, *p*= 0.15) with an effect size of 0.09 when controlling for perceived income adequacy. A non-significant group by time interaction effect was also documented within participants' comprehensibility at both T1 (β= -2.45, *p*= 0.093) and T2 (β= -2.60, *p*= 0.07), IG participants observed a slightly decreased predicted means at T1 with a -0.16 effect size and maintained till T2. Fig 6.2 reported the predicted means obtained from the GEE model to account for the within participants' correlation, which has also been reported in other interventional studies (Albertella et al., 2019; Spinella et al., 2021). There was a decrease in their perception of how understandable their situation when CG participants experienced a gradual increase in comprehensibility till T2. Moreover, both IG and CG participants recorded non-significant within-group differences between T0 to T1 and T0 to T2, as presented in Table 6.6.

Similarly, the manageability domain also recorded a non-significant group by time interaction effect at T1 (β= -0.36, *p*= 0.72) when controlling perceived income adequacy with an effect size of 0.19. While the effect on manageability was not sustained till T2 upon the discontinuation of the intervention as shown in Fig 6.2, it recorded a -0.19 Cohan's d value from IG participants at T2. Finally, The meaningfulness domain yielded the largest 0.27 Cohen's d effect size despite its non-significant group by time interaction effect at T1 (β= -0.36, *p*= 0.72) upon controlling for gender, perceived income adequacy, and comorbidity. Such effect was sustained till T2 with a 0.20 effect size. Fig 6.2 also indicated that IG participants experienced a greater slope of increment with its predicted means on meaningfulness domain than CG in from T0 to T1. Additionally, there was an observable increase in variance among IG participants across the SOC-13 total score and its subdomains, with a non-significant Levene test result at T1 (Table 6.7).

Table 6.5. *Intervention effect on SOC-13*

Time	Groups				Effect size	The GEE model for outcomes across time (Group* Time Effect)		
	IG		CG				95% CI	
	mean	SD	mean	SD	*d*	β	lower upper	*p*
SOC-13 total score		Scale range: 13-91						
T0	60.46	11.95	59.91	11.92				
T1	61.65	12.85	60.0	11.88	0.09	-2.42	-7.64 2.80	0.363
T2	60.74	14.62	61.45	11.26	-0.10	-4.21	-9.96 1.55	0.152
Comprehensibility		Scale range: 5-35						
T0	23.38	5.27	22.57	4.74				
T1	22.75	5.87	22.80	4.86	-0.16	-2.45	-5.30 0.41	0.093*
T2	22.74	6.02	23.35	4.56	-0.27	-2.60	-5.41 0.21	0.070*
Manageability		Scale range: 4-28						
T0	18.08	4.21	18.09	4.49				
T1	18.8	4.37	18.0	3.97	0.19	-0.13	-2.28 2.03	0.908
T2	18.05	4.77	18.9	4.13	-0.19	-1.63	-3.69 0.44	0.123
Meaningfulness		Scale range: 4-28						
T0	19.00	3.93	19.26	4.35				
T1	20.1	4.27	19.2	4.40	0.27	0.36	-1.59 2.32	0.716
T2	19.95	4.81	19.4	3.32	0.20	0.17	-1.91 2.24	0.874

Note. *: unadjusted GEE model; SOC-13= 13-item Sense of Coherence Scale, a higher score represents a higher sense of coherence; IG= Intervention Group; CG= Control Group; T0= Baseline; T1= immediately post-intervention (at week 8); T2= 4 weeks after intervention (at week 12)

Table 6.6. *Within group differences across intervention groups on SOC-13*

	Time	Score differences	t/Z score	95% CI lower upper	*p*
SOC-13 total score					
IG	T0-T1	1.19	0.25	-3.64 4.64	0.803
	T0-T2	0.28	0.64	-3.36 6.31	0.530
CG	T0-T1	0.09	-0.15	-4.59 3.99	0.885
	T0-T2	1.54	0.00	-4.83 4.83	1.00
Comprehensibility					
IG	T0-T1	-0.63	1.22	-1.00 3.80	0.237
	T0-T2	-0.64	1.40	-0.72 3.56	0.180
CG	T0-T1	0.23	-0.71	-2.56 1.26	0.485
	T0-T2	0.78	-0.41	-2.47 1.67	0.690
Manageability					
IG	T0-T1	0.72	-0.27	-1.73 1.33	0.787
	T0-T2	-0.03	0.98	-0.91 2.49	0.341
CG	T0-T1	-0.09	0.11	-1.87 2.07	0.917
	T0-T2	0.81	-0.32	-1.91 1.41	0.756
Meaningfulness					
IG	T0-T1	1.1	-1.14	-1.98 0.58	0.267
	T0-T2*	0.95	-7.34	-0.77 2.24	0.462
CG	T0-T1	-0.06	0.29	-1.57 2.07	0.776
	T0-T2	0.14	0.55	-1.26 2.16	0.589

Note. *: Wilcoxon Signed Ranks test, due to non-normal distribution; SOC-13= 13-item Sense of Coherence Scale, a higher score represents a higher sense of coherence; IG= Intervention Group; CG= Control Group; T0= Baseline; T1= immediately post-intervention (at week 8); T2= 4 weeks after intervention (at week 12)

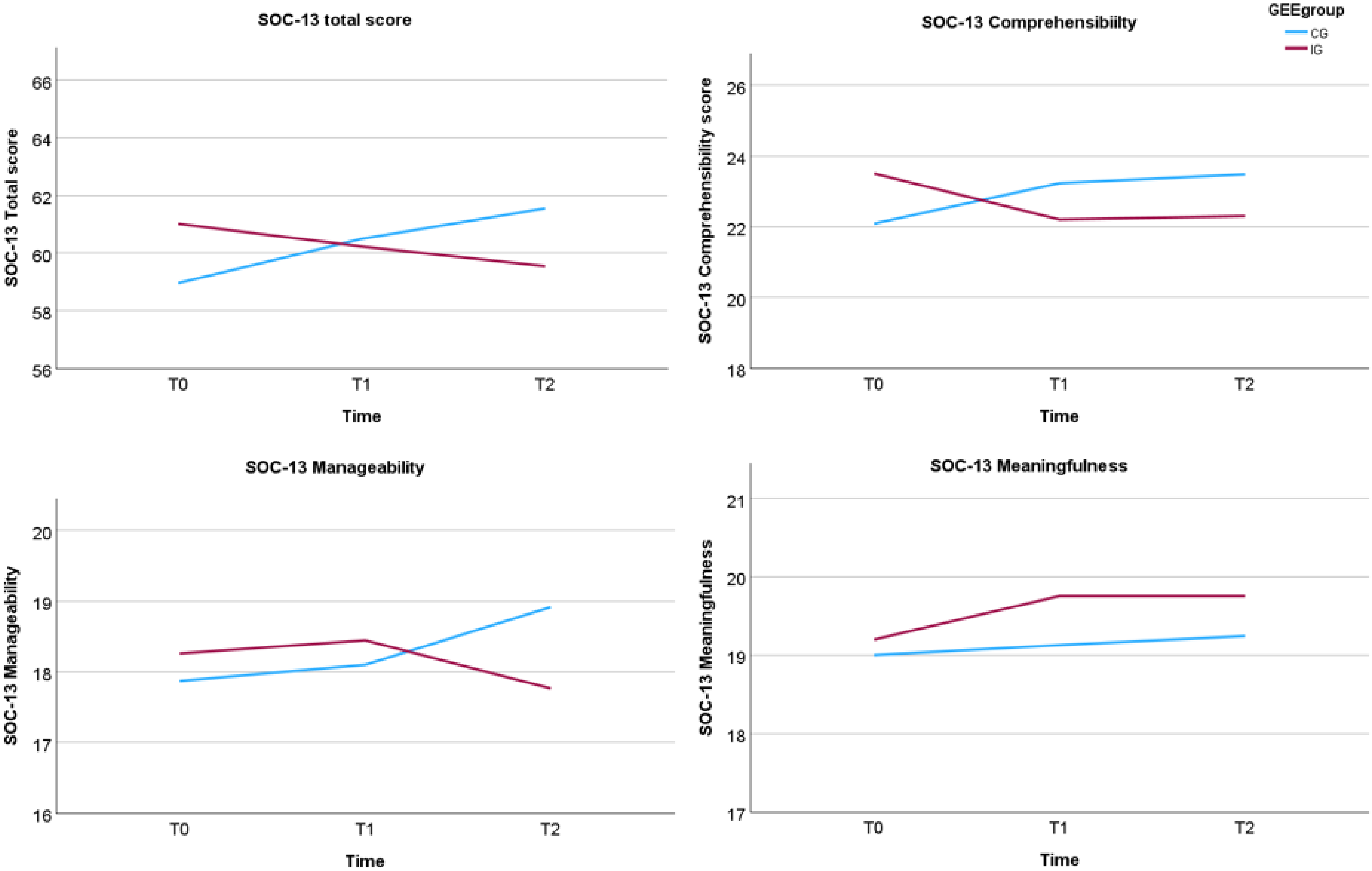


Fig 6.2. The predicted means of SOC-13 and subdomain scores across time

Table 6.7. *Variance on SOC-13 and subdomains across timepoint*

Time	Groups				Effect size
	IG		CG		
	Mean (SD)	Variance	Mean (SD)	Variance	*d*
SOC-13 total score					
T0	60.46 (11.95)	142.69	59.91 (11.92)	142.08	
T1	61.65 (12.85)	165.08	60.0 (11.88)	141.16	0.09
Comprehensibility					
T0	23.38 (5.27)	27.81	22.57 (4.74)	22.44	
T1	22.75 (5.87)	34.51	22.80 (4.86)	23.64	-0.16
Manageability					
T0	18.08 (4.21)	17.73	18.09 (4.49)	20.17	
T1	18.8 (4.37)	19.12	18.0 (3.97)	15.79	0.19
Meaningfulness					
T0	19.00 (3.93)	15.48	19.26 (4.35)	18.93	
T1	20.1 (4.27)	18.2	19.2 (4.40)	19.33	0.27

6.2.3.2. Secondary Outcome— MHCSF

The MHCSF total score did not identify any group by time interaction effect at T1(β= 0.20, *p*= 0.94; see Table 6.6) and T2 (β= -2.52, *p*= 0.43) when controlling for perceived income adequacy and comorbidity as shown in table 6.8.

A significant group by time interaction effect was identified within the emotional well-being domain at T1 (β= -0.49, $p < 0.05$) with an effect size of -0.49 upon adjusting educational level and perceived income adequacy, suggesting IG participants experienced reduced positive emotion during VIPA intervention. With a higher score representing better mental well-being, the decrease in IG participants' emotional well-being at T1 was also reflected in its predicted means in Fig. 6.3. Such effect did not sustain till T2 upon the removal of VIPA intervention with a non-significant group by time interaction effect (β= -1.06, *p*= 0.25) and a gradual increase in predicted means at T2. At the same time, non-significant within-group differences (see Table 6.9) were identified across all MHCSF subdomains, including emotional well-being, across time in both IG and CG participants.

Similarly, both social (β= 0.53, *p*= 0.71) and psychological well-being (β= 1.44, *p*= 0.34) domains record non-significant group by time interaction effect at T1 upon controlling the same covariates, both recorded a 0.15 to 0.27 effect size when IG participants using the VIPA intervention and demonstrated a more stable curve when compared to the drop in predicted means in CG participants in Fig. 6.3. to improve their social and psychological well-being. Meanwhile, IG participants experienced a drop in predicted means of social well-being at T2 with a -0.19 effect size.

Table 6.8. *Intervention effect on MHCSF*

Time	Groups				Effect size	The covariate-adjusted GEE model for outcomes across time (Group* Time Effect)		
	IG		CG				95% CI	
	mean	SD	mean	SD	*d*	β	lower upper	*p*
MHCSF total score	Scale range: 0-70							
T0	42.39	15.37	41.74	11.45				
T1	42.95	14.69	41.15	12.63	0.08	0.20	-5.04 5.44	0.942
T2	43.58	13.33	44.15	11.41	-0.10	-2.52	-8.80 3.76	0.432
Emotional well-being	Scale range: 0-15							
T0	9.35	3.14	9.09	3.29				
T1	8.50	3.38	9.75	2.81	-0.49	-1.77	-3.26 -0.29	0.019
T2	9.37	3.85	9.90	2.69	-0.24	-1.06	-2.87 0.75	0.253
Social well-being	Scale range: 0-25							
T0	13.74	6.19	13.26	4.49				
T1	14.30	6.67	12.95	4.83	0.15	0.53	-2.21 3.27	0.706
T2	13.95	5.99	13.95	4.76	-0.19	-1.34	-4.26 1.59	0.371
Psychological well-being	Scale range: 0-30							
T0	19.30	7.20	19.39	5.43				
T1	20.15	6.09	18.45	7.19	0.27	1.44	-1.54 4.43	0.342
T2	20.26	5.14	20.3	5.53	0.01	-0.10	-3.43 3.23	0.953

Note. MHC-SF= Mental Health Continuum Short Form, a higher score represents better mental well-being; IG= Intervention Group; CG= Control Group; T0= Baseline; T1= immediately post-intervention (at week 8); T2= 4 weeks after intervention (at week 12)

Table 6.9. *Within group differences across intervention groups on MHCSF*

Time		Score differences	t/Z score	95% CI lower upper	*p*
MHCSF total score					
IG	T0-T1	0.56	0.86	-2.30 5.46	0.404
	T0-T2	1.19	0.47	-4.22 6.67	0.642
CG	T0-T1	-0.59	0.86	-2.57 6.17	0.399
	T0-T2	2.41	-0.72	-6.48 3.18	0.483
Emotional well-being					
IG	T0-T1	-0.85	1.99	-0.07 2.60	0.062
	T0-T2	0.02	0.89	-0.84 2.06	0.386
CG	T0-T1	0.66	-0.92	-1.47 0.57	0.369
	T0-T2	0.81	-0.54	-1.72 1.02	0.599
Social well-being					
IG	T0-T1	0.56	0.20	-1.95 2.38	0.840
	T0-T2	0.21	0.65	-1.87 3.53	0.523
CG	T0-T1	-0.31	0.74	-1.39 2.89	0.471
	T0-T2	0.69	-0.73	-2.91 1.41	0.476
Psychological well-being					
IG	T0-T1	0.85	0.11	-1.88 2.09	0.913
	T0-T2	0.96	-0.16	-3.16 2.72	0.875
CG	T0-T1	-0.94	1.18	-1.16 4.16	0.253
	T0-T2	0.91	-0.53	-2.71 1.61	0.600

Note. *: Wilcoxon Signed Ranks test, due to non-normal distribution; MHC-SF= Mental Health Continuum Short Form, a higher score represents better mental well-being; IG= Intervention Group; CG= Control Group; T0= Baseline; T1= immediately post-intervention (at week 8); T2= 4 weeks after intervention (at week 12)

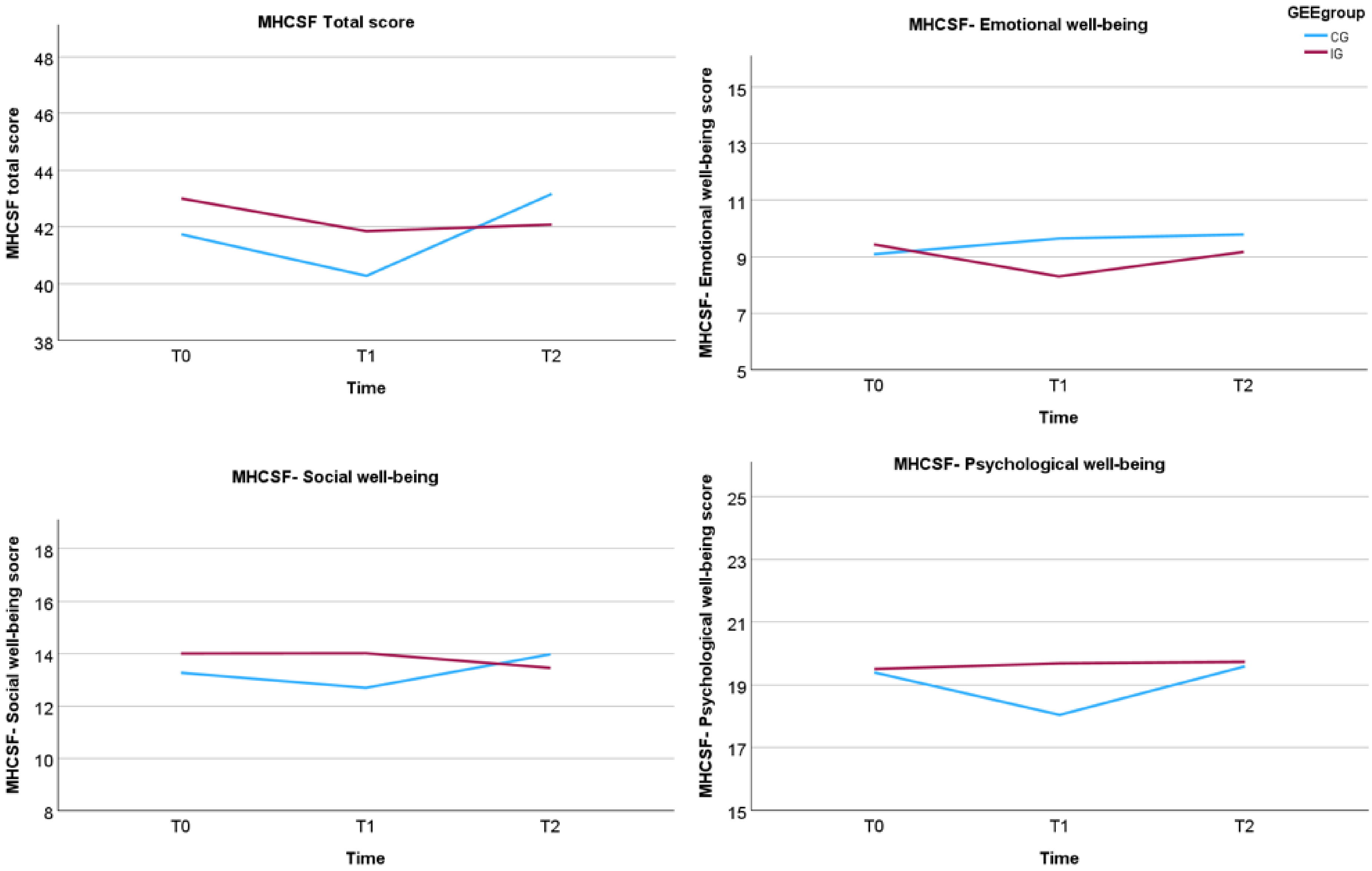


Fig 6.3. The predicted means of MHCSF and subdomain scores across time

6.2.3.3. Secondary Outcome— BRCS

Although the non-significant group by time interaction effect had resulted at T1 (β= 0.59, *p*= 0.34; see Table 6.10) and T2 (β= -0.018, *p*= 0.98) with BRCS when controlling for educational level. With a higher score representing better stress adaptability, the predicted means in Fig 6.4 shows IG participants experienced a smaller slope of decline in perceived stress adaptability than CG at T1 with an effect size of 0.16. At the same time, such effect did not sustain till follow up when the increment slope at T2 is lower than that of CG participants (Cohan's d -0.06) without the VIPA intervention. Similarly, non-significant within group differences were identified from both IG and CG across timepoints as displays in Table 6.11.

Table 6.10. *Intervention effect on BRCS*

Time	**Groups**				Effect size	**The covariate-adjusted GEE model for outcomes across time (Group* Time Effect)**		
	IG		CG				95% CI	
	mean	SD	mean	SD	*d*	β	lower upper	*p*
BRCS	Scale range: 4-20							
T0	14.83	2.82	14.52	2.69				
T1	14.60	2.39	13.90	2.69	0.16	0.59	-0.64 1.82	0.344
T2	15.05	2.90	14.90	2.20	-0.06	-0.018	-1.38 1.35	0.980

Note. BRCS= Brief Resilient Coping Scale, a higher score represents a better stress adaptability; IG= Intervention Group; CG= Control Group; T0= Baseline; T1= immediately post-intervention (at week 8); T2= 4 weeks after intervention (at week 12)

Table 6.11. *Within group difference across intervention groups on BRCS*

	Time	Score differences	t/Z score	95% CI lower upper	*p*
BRCS total score					
IG	T0-T1	-0.23	0.56	-0.55 0.95	0.585
	T0-T2	0.22	-0.34	-0.77 0.56	0.742
CG	T0-T1	-0.62	1.71	-0.21 2.11	0.103
	T0-T2	0.38	0.08	-1.34 1.44	0.941

Note. *: Wilcoxon Signed Ranks test, due to non-normal distribution; BRCS= Brief Resilient Coping Scale, a higher score represents a better stress adaptability; IG= Intervention Group; CG= Control Group; T0= Baseline; T1= immediately post-intervention (at week 8); T2= 4 weeks after intervention (at week 12)

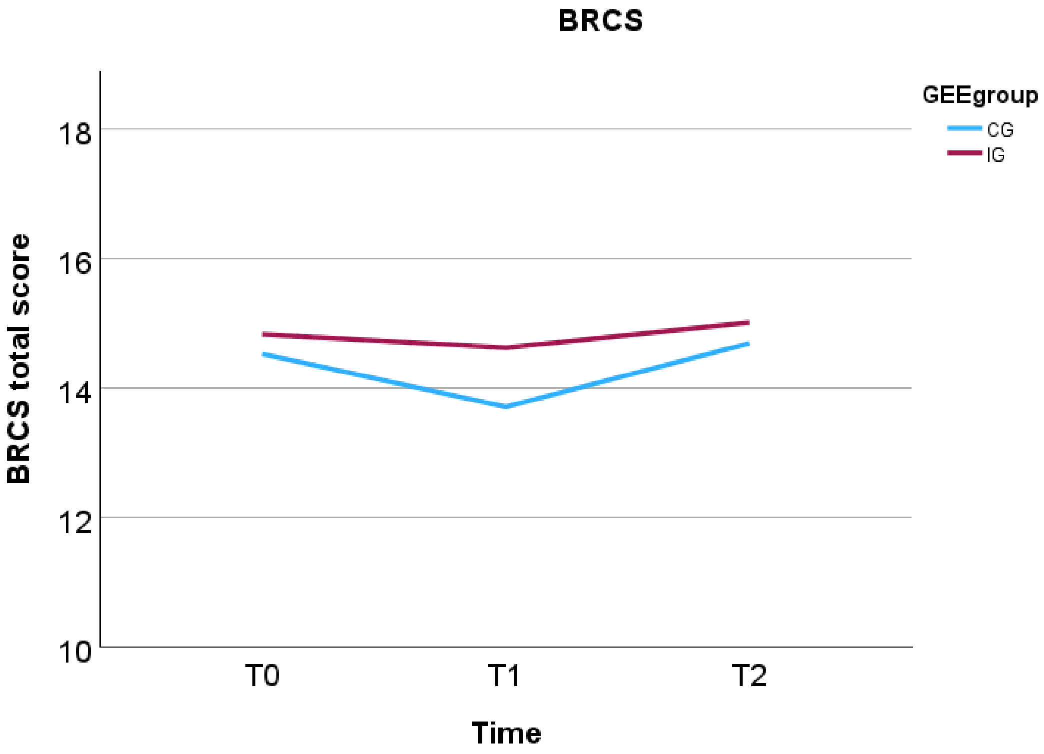


Fig 6.4. The predicted means of BRCS across time

6.2.3.4. Secondary Outcome— PDQ-8

Table 6.12 shows the adjusted GEE model also yielded a non-significant group by time interaction effect when controlled for participants' educational level, perceived income adequacy, and comorbidity at T1 (β= 0.60, *p*= 0.59) and T2 (β= 0.035, *p*= 0.98) when controlled for educational level, income adequacy, and comorbidity with a -0.13 effect size at T1, with a lower score represents better quality of life.

The predicted means shown in Fig 6.5 indicated that QOL in IG participants remains largely stable across T0 to T2. CG participants first experienced a greater slope of improvement at T1, but experienced worse QOL at T2 than baseline, resulting in a greater effect size of -0.18. Secondly, non-significant within-group differences were also reported by both IG and CG in Table 6.13.

Table 6.12. *Intervention effect on PDQ-8*

Time	**Groups**				Effect size	**The covariate-adjusted GEE model for outcomes across time (Group* Time Effect)**		
	IG		CG				95% CI	
	mean	SD	mean	SD	*d*	β	lower upper	*p*
PDQ-8		Scale range: 0-32						
T0	11.43	5.75	11.13	4.54				
T1	10.0	4.72	10.3	4.26	-0.13	0.60	-1.62 2.82	0.594
T2	10.84	4.31	11.3	3.96	-0.18	0.035	-2.17 2.24	0.975

Note. PDQ-8= Parkinson's Disease Questionnaire, a lower score represents better quality of life; IG= Intervention Group; CG= Control Group; T0= Baseline; T1= immediately post-intervention (at week 8); T2= 4 weeks after intervention (at week 12)

Table 6.13. *Within group differences across intervention groups on PDQ-8*

	Time	Score differences	t/Z score	95% CI lower upper	*p*
PDQ-8 total score					
IG*	T0-T1	-1.43	-0.36	-1.20 1.72	0.720
	T0-T2	-0.59	-1.36	-0.51 2.62	0.174
CG	T0-T1	-0.83	0.84	-1.04 2.44	0.410
	T0-T2	0.17	-0.99	-2.33 0.83	0.334

Note. *: Wilcoxon Signed Ranks test, due to non-normal distribution; PDQ-8= Parkinson’s Disease Questionnaire, a lower score represents better quality of life; IG= Intervention Group; CG= Control Group; T0= Baseline; T1= immediately post-intervention (at week 8); T2= 4 weeks after intervention (at week 12)

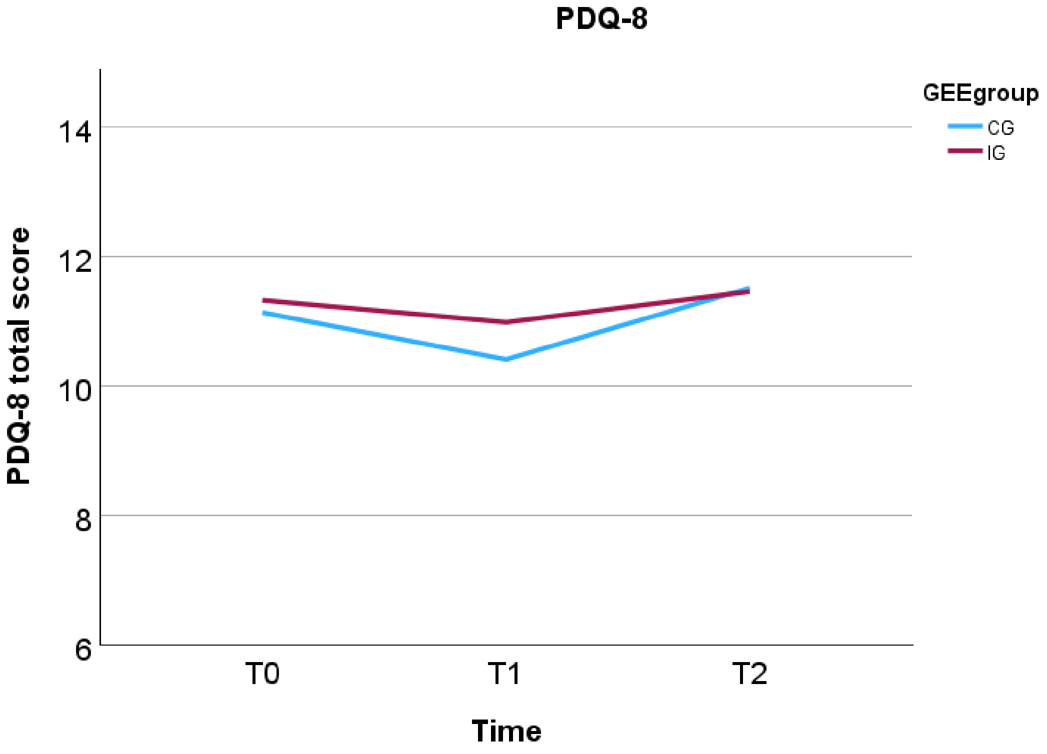


Fig 6.5. The predicted means of PDQ-8 across time

6.2.3.5. *Secondary Outcome— UCLA-3*

Similar to PDQ-8, UCLA-3 also documented a non-significant group by time interaction effect at T1 (β= -0.12, *p*= 0.84; see Table 6.14) and T2 (β= 0.35, *p*= 0.39). With a higher UCLA-3 score representing a higher degree of perceived loneliness, the predicted means showed IG participants experienced a gradual but smaller slope of increase in their sense of loneliness from T0 to T2 (see Fig. 6.6). While CG participants experienced a steeper increase at T1 but a slight decrease at T2, leading to an effect size of -0.1 to decrease experienced loneliness in IG participants at T1 but a 0.27 effect size increase upon uninstalling the VIPA intervention. A significant increase in perceived loneliness from within-group difference was identified for IG participants from T0 to T2, as shown in Table 6.15.

Table 6.14. *Intervention effect on UCLA-3*

	Groups					**The unadjusted GEE model for outcomes across time (Group* Time Effect)**		
Time	IG		CG		Effect size		95% CI	
	mean	SD	mean	SD	*d*	β	lower upper	*p*
UCLA-3		Scale range: 3-9						
T0	4.00	1.18	4.27	1.58				
T1	4.4	1.67	4.85	1.93	-0.10	-0.12	-1.29 1.05	0.841
T2	4.63	1.71	4.5	1.24	0.27	0.35	-0.44 1.14	0.388

Note. UCLA-3= UCLA three-item loneliness scale, a lower score represents a lower sense of loneliness; IG= Intervention Group; CG= Control Group; T0= Baseline; T1= immediately post-intervention (at week 8); T2= 4 weeks after intervention (at week 12)

Table 6.15. *Within group differences across intervention groups on UCLA-3*

	Time	Score differences	t/Z score	95% CI	*p*
				lower upper	
UCLA-3 total score					
IG*	T0-T1	0.4	-1.28	-0.20 1.06	0.201
	T0-T2	0.63	0.20	0.0048 1.20	0.047
CG	T0-T1	0.58	-1.08	-0.46 1.37	0.282
	T0-T2	0.23	-1.20	-0.21 0.76	0.232

Note. *: Wilcoxon Signed Ranks test, due to non-normal distribution; UCLA-3= UCLA three-item loneliness scale, a lower score represents a lower sense of loneliness; IG= Intervention Group; CG= Control Group; T0= Baseline; T1= immediately post-intervention (at week 8); T2= 4 weeks after intervention (at week 12)

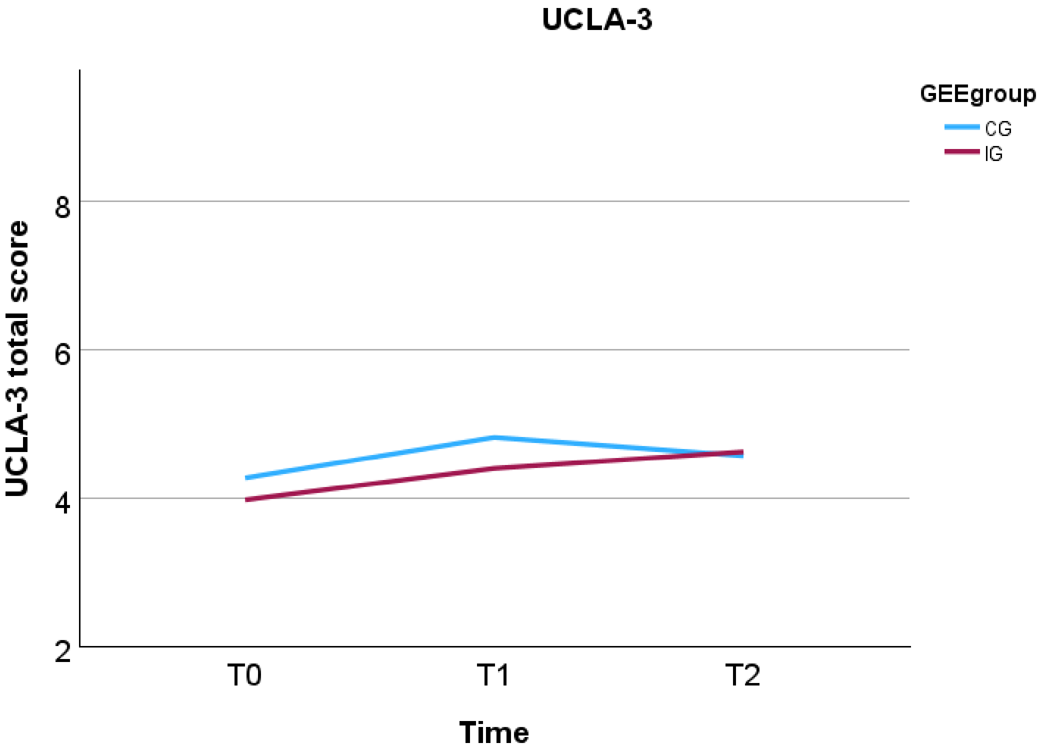


Fig 6.6. The predicted means of UCLA-3 across time

6.2.3.6. Sensitivity Analysis Result

Multiple imputation (MI), a statistical method to predict missing values from existing variables to restore the variability into the dataset (Sterne et al., 2009), was selected as the sensitivity analysis to examine the difference between MI and all observed case analysis. GEE-MI result (see Table 6.16) remains largely the same except for the emotional well-being domain in MHCSF. The once significant group by time interaction effect on the MHCSF emotional well-being domain identified at T1 ($\beta = -1.77$, $p < 0.05$) in GEE analysis turned non-significant after performing MI ($\beta = -1.42$, $p = 0.11$), suggesting IG participants might not experience a significant decrease in positive emotions after taking the missing data into account.

Table 6.16. *GEE model comparison for MHCSF sensitivity analysis*

Time	Group* Time Effect for GEE-MI model across time			Group* Time Effect for GEE model without imputation across time		
	β	95% CI lower upper	*p*	β	95% CI lower upper	*p*
MHCSF— Emotional well-being						
T1	-1.42	-3.16 0.32	0.11	-1.77	-3.26 -0.29	0.019
T2	-0.70	-2.61 1.22	0.48	-1.06	-2.87 0.75	0.25

Note. MHC-SF= Mental Health Continuum Short Form, a higher score represents better mental well-being; IG= Intervention Group; CG= Control Group; T0= Baseline; T1= immediately post-intervention (at week 8); T2= 4 weeks after intervention (at week 12)

Secondly, the significant increase in perceived loneliness on IG's UCLA-3 failed to yield consistent results among all 5 imputations from T0 to T2, as detailed in Table 6.17. 3 out of 5 imputations yield a non-significant within-group difference. In addition, due to SPSS's inability to present a pooled test result by default, the Bar procedure (Baranzini, 2018) was carried out to pool the imputation values. It resulted in a non-significant result with the pooled statistics.

Table 6.17. *Within group difference with MI for UCLA-3 on IG participants*

			95% CI		
	Time	t/Z score	lower	upper	*p*
UCLA-3 total score*					
No imputation	T0-T2	0.20	0.0048	1.20	0.047
Imputation 1	T0-T2	-2.51	0.25	1.33	0.012
Imputation 2	T0-T2	-1.90	-0.024	1.11	0.057
Imputation 3	T0-T2	-1.40	-0.18	1.02	0.161
Imputation 4	T0-T2	-0.71	-0.45	0.86	0.478
Imputation 5	T0-T2	-1.98	-0.048	1.13	0.048
Pooled imputation	T0-T2	-1.67	0.014	1.07	0.096

Note. *: Wilcoxon Signed Ranks test, due to non-normal distribution; UCLA-3= UCLA three-item loneliness scale, a lower score represents a lower sense of loneliness; IG= Intervention Group; CG= Control Group; T0= Baseline; T1= immediately post-intervention (at week 8); T2= 4 weeks after intervention (at week 12)

Finally, per protocol analysis was conducted for the 8 IG participants who achieved a VIPA usage of 7 commands/ day against the CG participants. The GEE analysis remains largely the same, except that the once non-significant comprehensibility domain turned into a significant decrease at T2 (β= -3.52, p= 0.011; Table 6.18). A greater effect size, 0.39, was also identified for the psychological well-being domain.

Table 6.18. *GEE analysis with per protocol analysis on SOC-13 and MHCSF*

	Groups					**The GEE model for outcomes across time (Group* Time Effect)**		
Time	IG		CG		Effect size		95% CI	
	mean	SD	mean	SD	*d*	β	lower upper	*p*
SOC-13 Comprehensibility								
T0	26.63	4.98	22.57	4.74				
T1	24.00	7.45	22.80	4.86	-0.63	-3.76	-8.40 0.89	0.11
T2	24.50	5.53	23.35	4.56	-0.76	-3.52	-6.25 -0.80	0.011
MHCSF Emotional well-being								
T0	9.88	3.31	9.09	3.29				
T1	8.13	4.09	9.75	2.81	-0.81	-2.26	-3.67 -0.85	0.002
T2	9.50	3.82	9.9	2.69	-0.42	-0.99	-3.03 1.05	0.34
MHCSF Psychological well-being								
T0	18.63	7.73	19.39	5.43				
T1	20.13	5.22	18.45	7.19	0.39	2.84	-0.28 5.96	0.074
T2	20.88	4.19	20.3	5.53	0.28	2.07	-1.56 5.69	0.26

Note. SOC-13= 13-item Sense of Coherence Scale, a higher score represents a higher sense of coherence; MHC-SF= Mental Health Continuum Short Form, a higher score represents better mental well-being; IG= Intervention Group; CG= Control Group; T0= Baseline; T1= 8-week post-test; T2= 12-week follow-up

6.2.4. VIPA Usage

A fair adherence rate of 30% but high retention rate of 79% was lodged from IG participants who fulfilled the seven successful primary commands per day. Primary commands were defined as voice commands initiated with the wake phrase, “Hey Siri, …” without counting the subsequent follow-up interaction with the VIPA. The averaged self-reported VIPA usage was 6.2 commands per day, with a higher usage among participants at week 1 (8.1; see Fig. 6.7), then stabilized at 6.5-5.5 commands/ day from week 2 till week 8. Every successful attempts was reportedly accompanied with 2-3 trials. Therefore, the actual VIPA usage was higher than the recorded data.

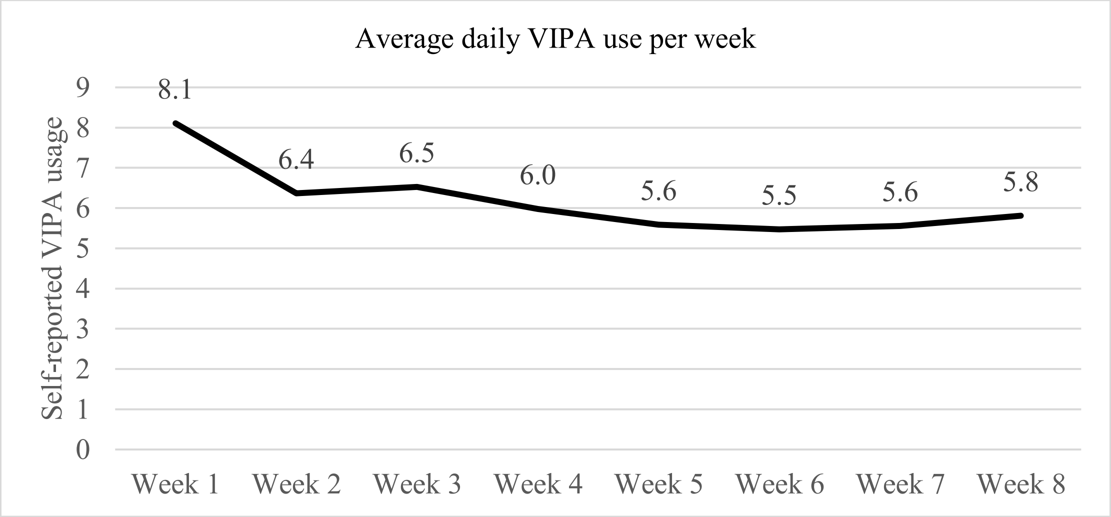


Fig 6.7. Average daily VIPA use per week

Moreover, significant Pearson's r correlations was identified between VIPA usage and SOC-13 comprehensibility domain (r= 0.56, p<.05; Table 6.19) and UCLA-3 score (r= -0.48, p<.05) at baseline.

Table 6.19. *Pearson r correlational between average VIPA usage and outcome variables*

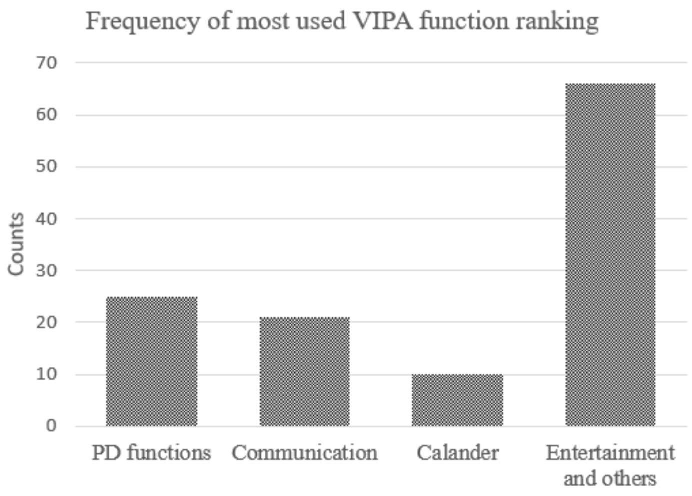
	SOC-13 COMP	**SOC-13 MAN**	**SOC-13 MEAN**	**MHCSF Total**	**MHCSF Emotional well-being**	**MHCSF Social well-being**	**MHCSF Psychological well-being**	**BRCS**	**UCLA-3**	**PDQ-8**	**Average VIPA daily usage**
SOC-13 Total	0.90^{**}	0.92^{**}	0.82^{**}	0.48^{**}	0.58^{**}	0.36^{*}	0.41^{**}	0.34^{*}	-0.50^{**}	-0.48^{**}	**0.45^{*}**
SOC-13 COM	—	0.78^{**}	0.57^{**}	0.32^{*}	0.45^{**}	0.24	0.24	0.33^{*}	-0.44^{**}	-0.39^{**}	**0.56^{*}**
SOC-13 MAN	—	—	0.65^{**}	0.45^{**}	0.59^{**}	0.36^{*}	0.34^{*}	0.29	-0.48^{**}	-0.54^{**}	0.43
SOC-13 MEAN	—	—	—	0.53^{**}	0.51^{**}	0.38^{**}	0.54^{**}	0.27	-0.41^{**}	-0.34^{*}	0.18
MHCSF Total	—	—	—	—	0.78^{**}	0.94^{**}	0.94^{**}	0.62^{**}	-0.25	-0.50^{**}	-0.10
MHCSF Emotional well-being	—	—	—	—	—	0.66^{**}	0.60^{**}	0.54^{**}	-0.29	-0.60^{**}	0.20
MHCSF Social well-being	—	—	—	—	—	—	0.81^{**}	0.61^{**}	-0.22	-0.41^{**}	-0.12
MHCSF Psychological well-being	—	—	—	—	—	—	—	0.51^{**}	-0.20	-0.41^{**}	-0.18
BRCS	—	—	—	—	—	—	—	—	-0.14	-0.26	0.04
UCLA-3	—	—	—	—	—	—	—	—	—	0.46^{**}	**-0.48^{*}**
PDQ-8	—	—	—	—	—	—	—	—	—	—	-0.33

Note. **: Significant at 0.01 level (2-tailed); *: Significant at 0.05 level (2-tailed); VIPA= Voice-Activated Intelligent Personal Assistant; BRCS= Brief Resilient Coping Scale; SOC-13= 13-item Sense of Coherence Scale; ; SOC COM= SOC-13 comprehensibility subdomain; SOC MAN= SOC-13 manageability subdomain; SOC MEAN= SOC-13 meaningfulness subdomain; UCLA-3= UCLA three-item loneliness scale; PDQ-8= Parkinson’s Disease Questionnaire; MHC-SF= Mental Health Continuum Short Form; H&Y scale= Hoehn & Yahr Scale H&Y scale for assessing severity of PD, higher level represents a higher PD progression, ranged from 1 to 5

6.2.5. Preferred VIPA Functionalities Usability

The user protocol was intended to introduce VIPA functionalities weekly, while participants reportedly used the intervention according to their likes and needs. Participants were invited to rank their most used functions weekly out of 4 categories: Parkinson function, communication, calendar, entertainment, and others (see Fig. 4.3).

Fig 6.8 documents the frequency of each function being ranked as the most used during the intervention period. Entertainment and others (e.g., podcast, music playing, and timer) were most frequently ranked as the most used function of the week (n=66) across the intervention period, followed by PD-related functions (n=25; medication scheduling, information searching, and nursing intervention installed), and communicative functions (n=21; e.g., sending messaging, making phone calls and virtual communication) being the third. Secondly, by transforming the ranking into a Likert scale (most used: 4 to least used: 1), Fig 6.9 summarizes the summative VIPA function scores from IG participants. Entertainment and others remained the highest-scored VIPA function (362), followed by communication (302), Calander (229), and PD-related functions (204).



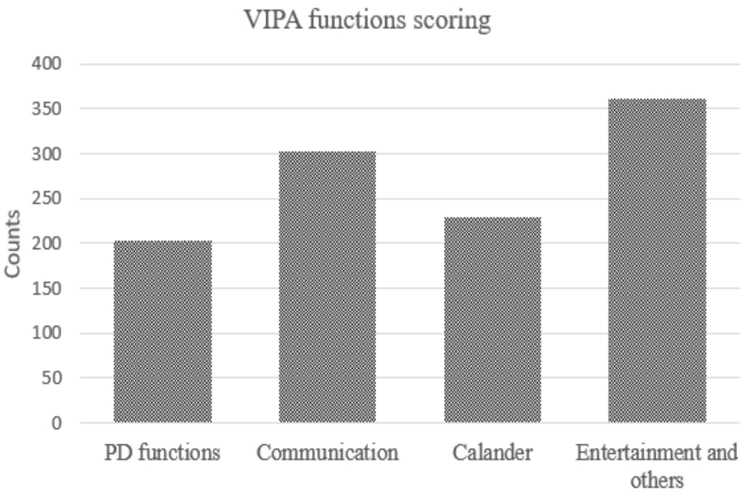


Fig 6.8. Frequency of the most used VIPA function ranking

Fig 6.9. VIPA functions scoring

6.2.6. *Usability of VIPA*

20 IG participants who used the VIPA were measured with the SUS, and a higher SUS score represents higher usability, with 100 as the maximum score. IG participants reported the intervention with moderate usability of an average 60.25 SUS score at post-test assessment, with 9 of them rating the intervention >70 score.(see Fig. 6.10).

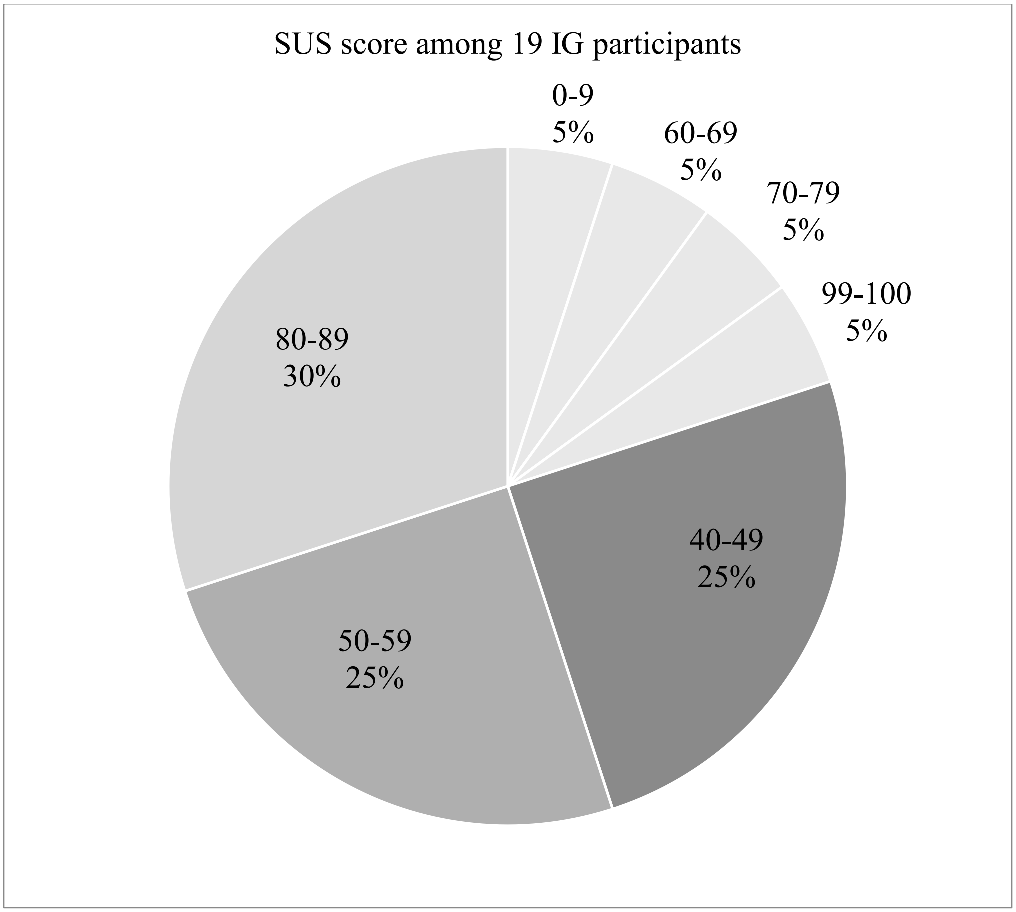


Fig 6.10. SUS score among 19 IG participants

Qualitative data was also collected from the technical enquiries during the intervention period. A total of 7 participants reported unfamiliarity with the command syntax, not knowing how to communicate with the VIPA efficiently in scheduling alarms, making appointments, recording, turning down the volume, or reading their WhatsApp messages. Secondly, 6 participants reported difficulties in VIPA's voice recognition, claiming they could not wake up the intervention, nor could it recognise their commands. Some participatns (n=4) also reported difficulties in operating the communal iPhone SE and subsequently lowered their intention to use. For example, Participant 19 was found setting their communal iPhone into flight mode during their intervention period, rendering the VIPA unresponsive and unable to execute their voice commands. After troubleshooting, 5 participants commented that the operation became smoother in general, and 4 participants appreciated the formulated user protocol and enjoyed VIPA features such as playing music, searching information, setting reminders, and communicating with others. Participant 3 regarded the VIPA as their caregiver to facilitate their medication taking. In addition, 6 participants reported no difficulties throughout the intervention period.

Participant 28 rated the intervention a 2.5 SUS score, lodging difficulties in operating and communicating with the intervention. They tried to verbally instruct the VIPA to read all their future incoming WhatsApp messages instead of manually setting the notification announcement in the settings. Therefore, the VIPA interpreted such commands as an attempt to send out messages. Secondly, they reported the VIPA would repeat its command. They later revealed they were experiencing memory decline due to medication titration and therefore refused the subsequent explanatory qualitative interview invite for further investigation.

6.3. Explanatory Qualitative Study

6.3.1. Demographic Data

Seven semi-structured, in-depth, face-to-face interviews were conducted with extreme case sampling from the intervention group participants in the previous pilot RCT, based on their changes (T0 to T1) in the SOC-13 total score from January 2024 to April 2024, ranging from 31 to 47 minutes. Selected participants' demographics were presented in Table 6.20. One participant declined the interview invitation due to their worsening memory because of medication titration.

Table 6.20. *Demographic background for in-depth interviews*

Participant ID	Gender	Age	H&Y level	Educational level
9	M	63	3	Secondary education
18	F	72	1	Primary education
23	F	68	4	Secondary education
14	F	62	3	Secondary education
24	M	65	1	Secondary education
3	M	65	3	Secondary education
2	F	68	3	Tertiary education

Note. H&Y scale= Hoehn & Yahr Scale H&Y scale for assessing severity of PD, higher level represents a higher PD progression, ranged from 1 to 5

Among the interviewees, four of them were lodged with an improved SOC (Table 6.21). Participant 3 was interviewed with the presence of their caregiver since they recently had knee surgery and presented with slurred speech that would require translation.

Table 6.21. *Intervention usage, SOC-13 differences, and interview notes*

Participant ID	VIPA usage times/ day	SOC-13 score Baseline (changes)	SUS score	Speech quality & presented PD symptoms
SOC-13 total score increased				
9	10	70(16)	80	Minimal hand tremor but with lower limb weakness. Comorbid with depression
18	1	57 (8)	80	Minimal PD symptoms; could participate in voluntary work daily and joined VIPA workshop before
23	0.8	50 (6)	50	Independent mobility but rely on an electric wheelchair for transportation.
14	4.3	57 (3)	55	ADL independent and living with a maid
SOC-13 total score decreased				
24	10.1	66 (-7)	42.5	Reported with memory decline (MoCA score 27) and noted with hand tremors, ADL largely independent and accompanied by son.
3	11.6	53 (-10)	80	Worked as the committee member of the PD self-help group
2	10.3	86 (-18)	40	ADL largely independent

Note. SOC-13= sense of coherence-13 items scale, 13-91 score, a higher score represents a higher sense of coherence; SUS= System Usability Scale, 100 maximum score, a higher score means higher usability.

6.3.2. Hybrid thematic analysis approach

The overarching theme was identified as "A promising tool to regain control over PD" and four themes were generated (Thematic structure as shown in Table 6.22 & Fig. 6.10). The first three, "symptoms severity as motivation to comprehend PD via VIPA," "an auxiliary home-alone remedy to manage PD symptoms," and "regaining control over PD," were generated deductively under the salutogenic framework. The last theme, "calling for a more motherly voice," was an inductive theme formulated for future VIPA designs to enhance user experience. A more detailed breakdown of how participants utilize VIPA was mapped out in Fig. 6.11.

Table 6.22. *Themes structure for explanatory qualitative interviews*

Themes	Subthemes	Categories
Symptoms severity as motivation to comprehend PD using the VIPA		1. Motivation to search
		2. Information appraisal
		3. Resource awareness
An auxiliary home-alone remedy to manage PD symptoms	**An auxiliary home-alone remedy**	4. Auxiliary nature
		5. Home-alone remedy
		6. Encyclopedic GRR
		7. SRR retrieval
		8. Gamification
	Symptoms coping in VIPA intervention	9. Hands-free voice activation
		10. Music entertainer
		11. Exercise coaching
		12. Secretarial functions
		13. Messenger and companionship
		14. Rekindled interest in music
	Insufficient PD friendliness	15. Suboptimal voice recognition
		16. Complex operation
		17. Response quality
Regaining control over PD	**Cultivating sense of control and sense of security**	18. Sense of control
		19. Sense of security
		20. Smart home butler
	Process of normalization	21. Social integration
		22. Intervention Goal
Calling for a more 'motherly' voice	**An empathetic and proactive motherly persona**	23. Motherly persona
		24. Physical assistance
	Better support system	25. Increased means of control
		26. Multiple sensory output
		27. Customizability/shortcut
		28. Intervention delivery

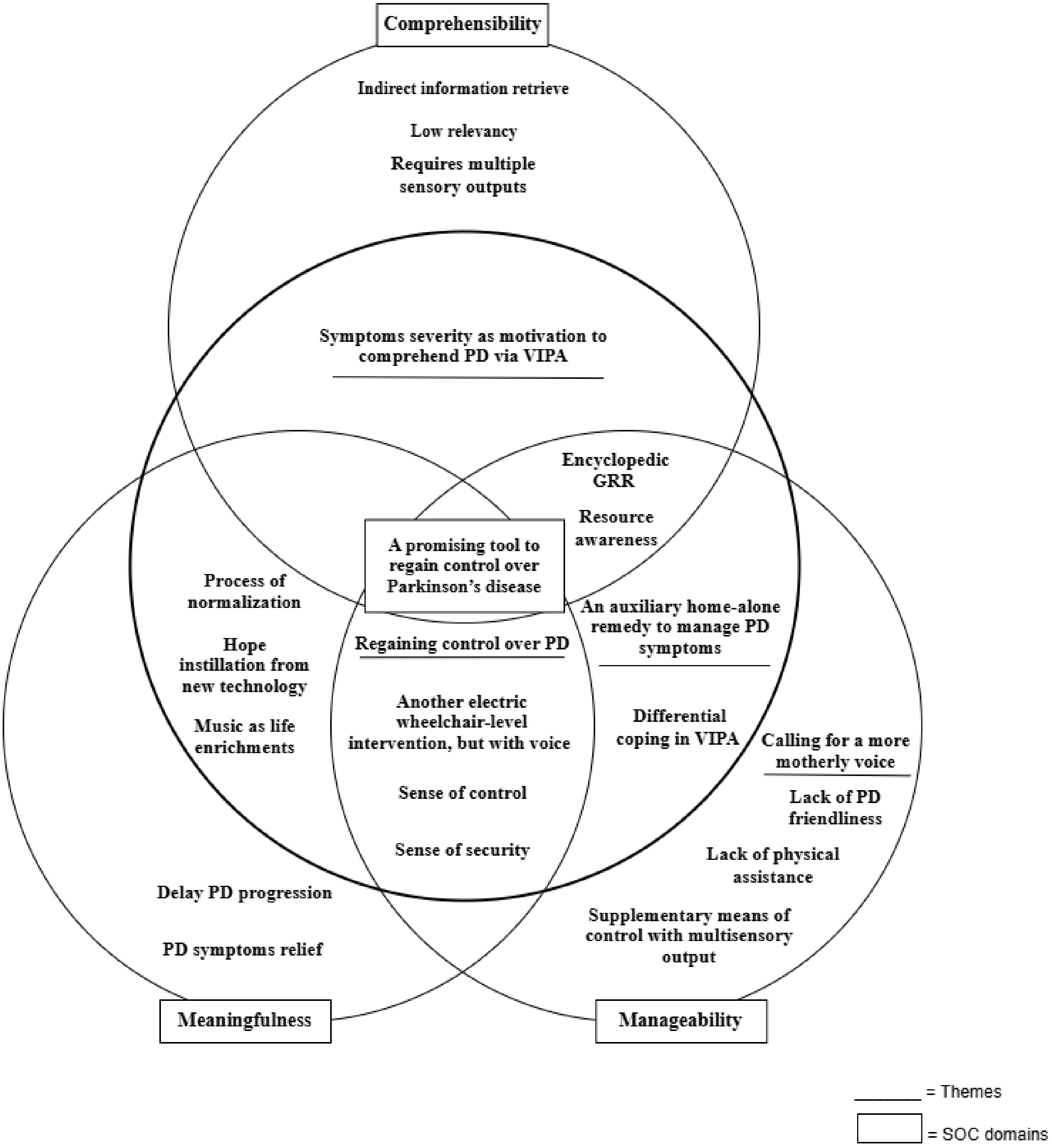


Fig. 6.11. Conceptual map of the current study

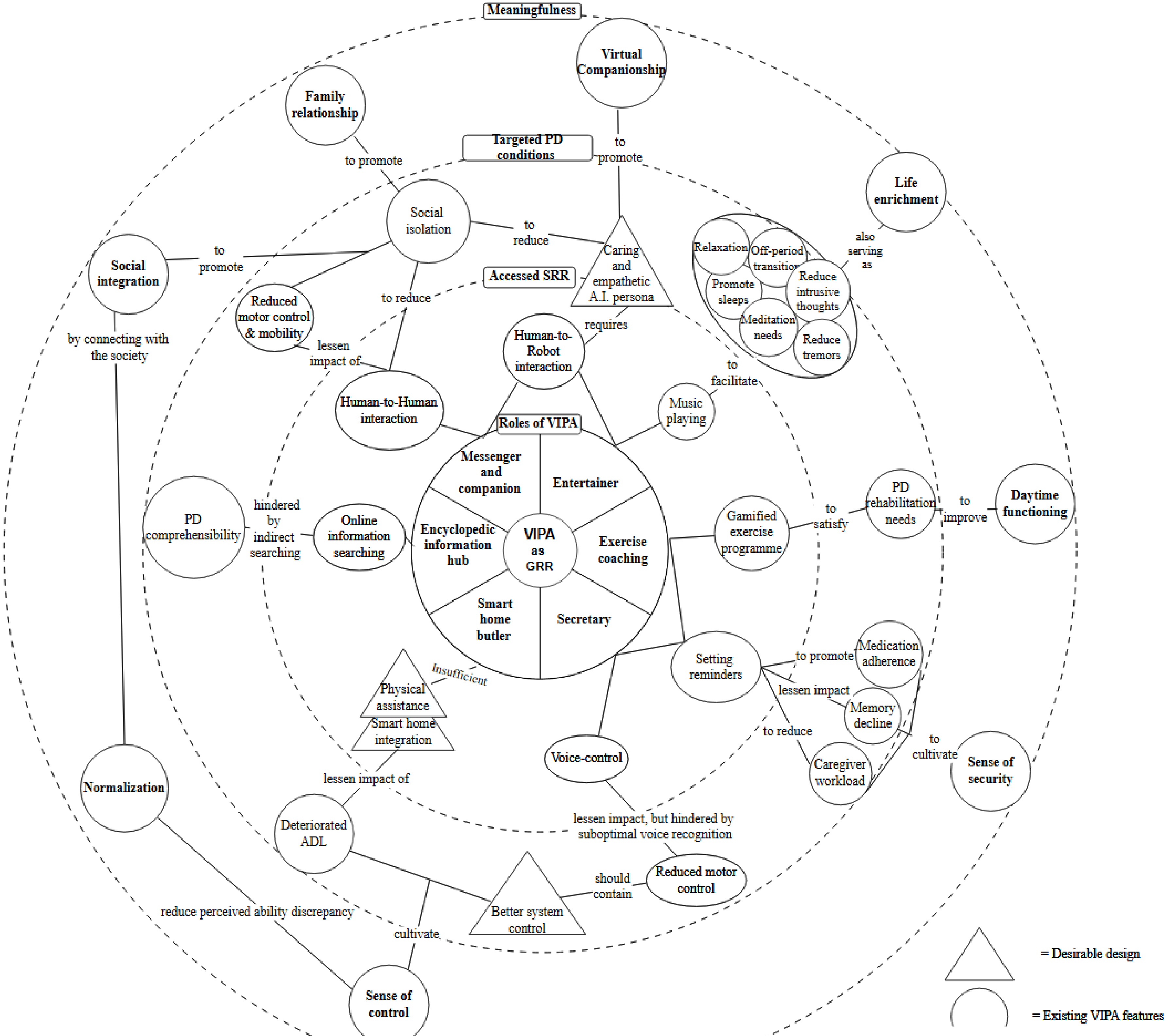


Fig 6.12. How PWP utilized the

6.3.2.1. Comprehensibility— Symptoms severity as motivation to comprehend PD via VIPA

Three categories of “motivation to search,” “information appraisal,” and “resource awareness” were identified within the comprehensibility domain to illustrate what motivated PWP to search for PD information via VIPA, how they appraised its quality, and how resource awareness could lead to behaviour change.

Participants were observed to regard the severity of their symptoms as a motivation to search for PD-related information, such as others’ disease journeys, medication regimens, or educational content.

> “I’d want to know more if (my PD situation) worsens in the future.”
>
> (Participant 18, F; H&Y level 1)
>
> “I wanted to search for similar disease history, but it’s difficult.”
>
> (Participant 9, M; H&Y level 3)

While online PD information was considered less relevant than their available resources, the mere exposure of such information was reportedly beneficial to their PD comprehensibility, stating, “The more I watch, the more I learn. (Participant 14.)”

> “I’ve tried searching, but I find the interaction between our association more relevant to our PD situation.”
>
> (Participant 9, M)

Before participants could attempt managing their PD symptoms and proceed into the manageability domain, they had to be aware of their PD condition and existing resources first. Should participants display a lack of understanding of their own PD situation, it became unclear to them how to manage their disease. Participant 18 claimed they could not think of anything the VIPA could assist with, as they did not know much about the disease. Secondly, successful identification and awareness of resources could lead to behavioural change. Participant 24 reportedly changed their exercise routine after searching for peer experience and watching tai chi videos created by health centers to improve their mental state. VIPA increased participants' community resource awareness, so that they could increase their social participation among participants. Participant 14 illustrated how the VIPA could alert them to upcoming community activities and reportedly improve their participation rate by 30%.

> "I need to know more about this before I can answer. I don't really know what my illness is at this moment."
>
> (Participant 18, F)
>
> "(I) searched PD symptoms, such as medication through it (VIPA), and improve from its advice… follows those tai chi exercises from PD health centers."
>
> (Participant 24, M)
>
> "You can at least be aware of these (community PD) events, and you can't join any if you don't."
>
> (Participant 14, F)

6.3.2.2. Manageability— An auxiliary home-alone remedy to manage PD symptoms

6.3.2.2.1. An auxiliary home-alone remedy

The VIPA was found to serve as participants' caregiver, companion, information source, and exercise coach in supplementing their existing resources. Participant 3 exemplified VIPA's auxiliary nature by utilizing it for medication reminders when their caregiver was out, and how the VIPA could lessen caregivers' workload.

> "I have a lot to think about when I'm at home, so I can ask it (VIPA) whenever I have queries. But if I'm out, I can ask my friends."

(Participant 18, F)

> "It could help my caregiver. It can help me and my caregiver (wife: "to reduce my workload")."

(Participant 3, M)

Secondly, the VIPA was deemed suitable for those with higher PD-related impairments and living alone. A sense of redundancy was noted among higher-functioning participants at an early stage of disease progression. They reportedly could perform certain VIPA functions, such as playing music, searching for information independently, but suggested the VIPA would be helpful to them should their situation deteriorate. Participants who engaged in frequent outdoor activities exhibited lower VIPA usage, while those who spent time at home used the VIPA to provide constructive home-based activities for boredom relief, such as exercising or playing music. While Participant 27 reported human-to-human interaction was irreplaceable in comparison to virtual communication with the VIPA.

> "It could enrich my life. I could watch and exercise when I was bored, not for an extended period, but at least I'm moving, and I can sing (along)."

(Participant 14, F)

> "Maybe I'd use it more if I stayed home, but not when I'm always out."
>
> "I can still perform everything well, so it wasn't exactly for me. But maybe I'd need it to take up more initiative later."
>
> "It only helps me a bit, but maybe it'd be more useful to me if my mental state deteriorates in the future."

(Participant 18, F)

> "It cannot fully replace (human interaction)… (I use it) to share my mood with it"

(Participant 27, F)

Participants summarized the VIPA as a highly accessible encyclopedia to search for desired information, such as contact numbers, PD information and educational content, or community resources. The VIPA differed from traditional radio in that it actively searches to pinpoint information for users, rather than passively receiving it.

> “It’s different from listening to the news on the radio. You can search for anything you want, such as pinpointing songs or information. It can search for you immediately.”
>
> (Participant 9, M)
>
> “For example, if I say “Parkinson’s disease exercise,” it’d help me to filter some (information) out.”
>
> “It’s less troublesome to use WhatsApp, as I don’t have to write everything. It can follow my instructions, like “call someone” and it’ll follow my order.”
>
> (Participant 14, F)

The online information retrieval process was deemed indirect, brief, and sometimes inconsistent. Participants were sometimes redirected to their’ smartphone to continue their search. Such searching redirection was considered counterintuitive, and the VIPA should be able to incorporate all functions and operate as a standalone product. Finally, positive feedback was identified between VIPA usage and participants’ manageability. The more they valued VIPA functions, the more motivated they were in utilizing them.

> “If I asked if there’s any good restaurant nearby, it’d tell me to search on the phone. But it could tell me where the nearby park is (directly).”
>
> “It’d be great if the VIPA could integrate all information from Google and phone, then tell us immediately.”
>
> “This encyclopaedia function can pop up any information whenever I want. The more it satisfied me, the more I expect from it.”
>
> (Participant 9, M)
>
> “(Laughs) I thought to myself, I wouldn’t need you if I (can) search on my phone.”
>
> (Participant 2, F)
>
> “I want to master it so that it can help me more.”
>
> (Participant 24, M)

6.3.2.2.2. Symptoms coping in VIPA intervention

Participants reported diverse use of the VIPA to mitigate their PD symptoms based on their needs. The voice activation feature could reportedly mitigate their hand tremors or stiffness during their off-period, allowing them to access different functions.

> "Your fingers will not be that nimble when you become stiff and could easily press the wrong buttons on phones."
>
> "The most important thing is to help me with WhatsApp and communicating."
>
> (Participant 14, F)
>
> "Chatting (with VIPA) is the most important, as I can perform other (functions) on phone or computer."
>
> (Participant 2, F)

Music was utilized to mitigate multiple motor and non-motor symptoms, facilitating sleep (Participant 3), providing distraction from intrusive thoughts (Participant 14) or tremors (Participant 3) during the off period, and offering PWP a meditative (Participant 9) or relaxation (Participant 24) experience.

> "It helps. For example, when my medication effects run out, I cannot make calls nor control my limbs to operate my phones. I could yell "Siri, find someone.""
>
> "At least it can play YouTube for me when I couldn't more. Telling it to play songs for me could relief my boredom"
>
> (Participant 14, F)
>
> "Its sound quality is much better than ordinary speakers, phones, or hi-fi speakers. You would feel like meditating."
>
> (Participant 9, M)
>
> "Listen to it before sleep… I'd sleep better.. easier to fall asleep."
>
> (Participant 23, F)

In addition, the VIPA could rekindle participants' interest in music to enrich their lives. Participants 9, 14, and 24 picked up a habit of listening to music with the VIPA to relieve their boredom at home because of how convenient the voice commands were and the voice quality of the accompanying speakers.

> "I have to manually press and pick (songs), but now I can just spontaneously call out "listen to songs" or "which channel has music?". Similar to news, it can search for me when I order him."
>
> (Participant 24, M; on why they rarely listen to music before study)

Another application of VIPA was serving as PWP's secretary to remind and relay incoming calls and messages, reducing the need for physical manipulation. Scheduling and timers for medication and cooking were used to enhance medication adherence, improve follow-up attendance, and promote household safety, compensating for memory decline and reducing stress associated with forgetfulness.

Secondly, both participants, 24 and 14, reported increased exercise duration during the intervention period (100% for Participant 24 and 20% for Participant 14) due to the VIPA's gamified exercise programme. The accolades unlocked by the VIPA could motivate them to keep exercising.

> "I have a bad memory, and it can remind me of my follow-ups or medication time."
> "Makes me less tired and allows me to finish my chores at home. I can't finish my chores without exercise as I would have hand tremors."
>
> (Participant 24, M)

The VIPA could also act as a messenger to relay phone calls and messages during participants' off periods or when they are inattentive to their phones. Participant 24 reported an improved family relationship as they were more attentive to incoming messages with the help of VIPA.

> "It was difficult for me to get my calls. It can help me with that and notify me."

> “Yes, it helps… (smiles) I wasn’t attentive to my phone before, but it reminds me on the phones.”
>
> (24, M; on whether announcing incoming messages could improve his family relationship)
>
> “It could also announce my WhatsApp, so I don’t have to press anything.”
>
> (Participant 14, F)

A varying degree of companionship was formed with the VIPA by the participants. It could take participants 2-7 weeks to bond with the intervention (see Table. 6.23). With two participants successfully bonded with the VIPA, some could only attain a state of connection as they consider the VIPA to be rigid and less natural than human interaction.

Table 6.23. *Participants' comments on VIPA intervention's companionship and social presence*

ID (Gender)	UCLA-3 score (baseline)	H&Y level	Time required to form companionship	Comments
9 (M)	3	3	2 weeks- friendship	- Can treat it as an A.I. friend. - It can immediately respond to my queries. - During the intervention period, I make it a habit of asking it to play music for me every morning.
24 (M)	3	1	3 weeks- friendship	- I see it as a friend after the second week. - I felt like someone was helping me. - It would listen to my unhappy experience and respond to me.
14 (F)	5	3	3 weeks- sense of connection	- It's a bit rigid. - Not as fluent as chatting with your friends. - Like chatting with a robot. - It's a bit weird when there's no one there; it'd be great if it could show its face on a monitor. - (It replied with) "I can't hear you" or something similar repeatedly, it's lack of novelty."
2 (F)	3	3	5 weeks- sense of connection	- I would not consider it as my friend because friends have interactions. There's only a little interaction with it. - I felt accompanied when I was doing my handcraft with it. - The jokes are repetitive and have little effect on me.
18 (F)	6	1	Late 7th week- sense of connection	- Chatting (with VIPA) is the most important function because you can do other (functions) on a phone and computer. - It can't answer my queries or achieve my expectations. - It should be more active, I have to initiate conversations (with it) all the time.
23 (F)	6	4	Failed to bond	- It can't hear me. - It'd be easier if I knew how to use it.
3 (M)	5	3	Failed to bond	- It has yet to become my friend. - Does it know how to speak Cantonese?

Note. UCLA-3= UCLA three-item loneliness scale, a lower score represents a lower sense of loneliness; H&Y scale= Hoehn & Yahr Scale H&Y scale for assessing severity of PD, higher level represents a higher PD progression, ranged from 1 to 5

6.3.2.2.3. Insufficient PD friendliness

The VIPA was considered by the participants to have suboptimal voice recognition accuracy and was complicated to control. Participants reported that every successful VIPA operation comes with 2-3 trials and errors. Participants were noted to have difficulties pronouncing English keywords, such as “Siri”, clearly enough for the VIPA to recognise. The expected accuracy should be 80%.

Participants were also observed with internalization upon these unsuccessful attempts. They attributed these attempts to their voice being too soft or unrecognizable by the VIPA. A sense of neglect was reported by Participant 14 due to the intervention’s life-like features, as if a real human ignored them. These undesirable emotions would gradually subside once they established communication with the VIPA.

> “(I have to repeat)2-3 times. Maybe because I’m soft-spoken and not that accurate.”
>
> (Participant 2, F)
>
> “I didn’t use it much because it could not listen to what I said. The problem is it can’t hear me, can’t talk to it.”
>
> “I don’t know (how it could be improved), all I know is I’m not loud enough, I’d need speak up but I’m out of breath”
>
> (Participant 23, F)
>
> “I tried getting closer to say, “Hey, Siri,” but it was still in vain. Maybe I pronounced its name wrong, so it couldn’t recognize me.”
>
> (Participant 24, M)
>
> “I’d be annoyed if it didn’t react. It’s like being ignored by someone… I’d feel better once it replied to me.”
>
> (Participant 14, F)

Secondly, participants experienced difficulties in accommodating its command syntax, controls, and learning functionalities. 3 participants (14, 2, 24) took the first 2 weeks to cope with the VIPA intervention initially, and it took Participant 14 another 2 weeks to familiarize themselves. Participants were noted to use more naturalistic communication wordings and styles to formulate their command syntax. For example, asking the VIPA (2, F) “Hey Siri, search for…” instead of following the command syntax understandable by the intervention. Participants reportedly changed their way of speaking with the VIPA to accommodate its way of communication and would require assistance from family members to wake up the VIPA.

> “I just changed my way of speaking and it helps.”
>
> (Participant 24, M; on how to cope with the VIPA)
>
> “Maybe my enunciation was inaccurate, my maid would also help to wake it up.”
>
> (Participant 14, F)

Finally, VIPA’s response content should be credible, non-repetitive, rich in content, and kept private. The repeated content in telling jokes and stories diminished participants’ intention to use. Its ability to cheer the users up gradually diminished as they noticed VIPA’s response became repetitive, predictable, and lacking variety. Participant 18 also doubted the credibility of the online information and commented that they should consult healthcare professionals.

> “We can talk to it, but it cannot let others know.”
>
> (Participant 14, F)
>
> “It cannot recite poems for me, not even the easy ones from Li Bai (famous Chinese poet)”
>
> (Participant 2, F)
>
> “It’s a disease, how could it help? I can only seek help from doctors or nurses.”
>
> (Participant 18, F)

6.3.2.3. Meaningfulness—Regaining control over PD

The “Another electric wheelchair-level intervention, but with voice” subtheme explored how the VIPA could cultivate a sense of control within participants; the “Process of normalization” illustrated how it could bridge the gap between participants and other citizens; and "Music as life enrichments" suggested how VIPA could rekindle their interest in music.

6.3.2.3.1. Cultivating sense of control and sense of security

The VIPA was likened to an electric wheelchair in cultivating a sense of security and control. Its voice activation feature could mitigate their motor symptoms and grant them comfort.

> "Just like when it's inconvenient for some PWP to walk, they'd use an electric wheelchair. With that, they can control wherever they want to go."
> "Some PWP has difficulties speaking, can't write, or even hold on to things. This VIPA? They can utilize their only speaking to have it follows their order. I believe it'd be a great psychological comfort and help to them."
>
> (Participant 9, M)
>
> "It's more convenient. I can just say it out without pressing anything for every function. I can even listen to others' conversations in real-time."
>
> (Participant 14, F)

Besides inducing a sense of control, a sense of security was also nurtured. Participant 24 was reportedly stressed over their declined memory (MoCA 27 at baseline). They highlighted that the reminding function could give them a sense of security and stress relief by assisting with their chores, promoting home safety, and reducing quarrels between family members by notifying them of incoming messages. Even though they experienced a decreased SOC-13 score at post-test, they were interviewed in a joyful mood when recalling the experience and claimed to continue using VIPA after the intervention period.

> "I don't have to remember everything nor worry I forgot any. So I'm more relaxed."
>
> (Participant 24, M)

6.3.2.3.2. Expectation of future applications

Participants expressed the intention for VIPA to be integrated with smart home electronics for more physical assistance, such as controlling their TVs, stoves, fridges, or rice cookers. Secondly, future VIPA could also look into aiding PWP's dressing and medication administration. Finally, the portability of the VIPA should be improved to increase its service coverage and enhance accessibility.

> "It'd be great if it could turn off the stove for me."
>
> (Participant 24, M)
>
> "It can't help me to get my medications."
>
> "If the intervention can unite home compliances such TV, fridge, and rice cooker into A.I. control, I believe it's the future development."
>
> (Participant 9, M)
>
> "If I installed it in the living room, I can't use it in the bedroom."
>
> "(I want it to help me) get dressed."
>
> (Participant 3, M)

6.3.2.3.3. Process of normalization

The VIPA could facilitate the process of normalization in mitigating PWP's disabling symptoms, such as hand tremors and rigidity. Both Participants, 14 and 24, also reported an increased participation in social activities during the intervention period. They later elaborated that the VIPA could connect them with the community and could bring them closer to other functioning individuals in society.

> "If it (the intervention) could recognize their (PWP) voice and deliver their desired information to them, it's equivalent to bring them closer to what could be normally done by others."

(Participant 9, M)

> "I've contacted others more often now and would always participate in those group walking exercises."

(Participant 24, M)

> "I'd rely on the intervention to read out my WhatsApp when I can't move my limbs. At least I'd know what activities were being held."
>
> "It's important for those who live alone, especially for those who live alone."
>
> "Important as in less lonely. At least they'd (other PWP) know what's happening outside."
>
> "At least (you) won't be that lonely If you know what happens outside. Sometimes, you're isolated from the outside world..."

(Participant 14, F; on the importance of VIPA)

Finally, participant 3 stated that the goal of the PD intervention was not to combat PD but to delay its progression and relieve discomfort. At the same time, the technologically imbued VIPA exceeded Participant 14's expectations and instilled hope in managing their PD situations, stating the learning difficulties could be outweighed by its potential benefits.

> "We can't fight it (PD), it usually wins. It's ok to delay and less the suffering."

(Participant 3, M)

> "I find it very useful, how should I put it, it's (better) than what I imagine. Technology has been developed so rapidly that it resembles a person interacting with and assisting you."
>
> "PWP shall not be discouraged by its difficulties and try it out. The recent technological advancement could help a lot in our situations."

(Participant 14, F)

6.3.2.4. Fourth theme— Calling for a more motherly VIPA

Besides setting up a smart home environment, participants envisioned a more customizable, empathetic, and proactive VIPA persona with multiple sensory outputs to capitalize on its salutogenic potential. Subthemes included in this section are “An empathetic and proactive motherly persona,” “supplementary means of control with multisensory output,” and “further support required in intervention delivery.”

6.3.2.4.1. An Empathetic and Proactive Motherly Persona

When some participants regarded the communication with the VIPA as unnatural or rigid, they elaborated on envisioning a more motherly A.I. persona that could take up more initiative in caring for them, “just like what a mother would (Participant 14)”. The VIPA could care for participants’ mental health by exploring their moods and providing brief counselling sessions. While the VIPA’s A.I. compartment was commented as not being 100% A.I. by Participant 9, the idea of adopting VIPA in the PD population is reported as “on the right track.”

> “If it’s as caring as a friend, it’d be best for it to speak from time to time without saying Hey, Siri.”
>
> (Participant 18, F)
>
> “For example, it could comfort me if I’m mad.”
> “It could also remind me to be careful walking or to remind us to rehydrate or take medications in case we missed it.
>
> (Participant 14, F; on how to design a more personable VIPA)
>
> “Because there should be an interaction between friends, it has little. If I ask it, “Are you happy?” it’d reply, “I’m happy, how about you?” asking me if I’m happy or not without asking me why I’m unhappy.”
>
> (Participant 2, F)
>
> “When it comes to robotic help, I’m hoping for 100% AI, but not “part of”. What you want is to provide us with a more convenient, quick connection, isn’t it?”
>
> (Participant 9, M)

6.3.2.4.2. Supplementary Means of Control with Multisensory Output

Coping with VIPA was found to be time consuming among participants, it reportedly took them weeks to familiarize themselves with the basic VIPA functions. For example, it took participant 24 a week to figure out how to use the note taking function without consulting the technical hotline. While participant 2 also reported they are not sure how to communicate with the VIPA intervention during the initial state of the intervention period.

"It took me a couple weeks to make it work in the beginning."

"The note taking function took me a week, it's a very long time"

(Participant 24, M)

"I was not used to it and have no idea what to say to it… for around two weeks"

(Participant 2, F)

In addition, although participant 3 was confident they were familiar with 90% of VIPA basic functions, they did not realize jokes telling or new broadcasting were one of the VIPA functions embedded in the user protocol.

"I am confident to use 90% of the basic functions"

(Participant 3, M)

"It could?"

(Participant 3, M; on asking whether they tried the joke telling function)

Although participants appreciated the voice activation of the VIPA, other means of control and display methods should be incorporated into future VIPA designs. Multiple sensory outputs were suggested by participants 9 and 18 to increase information comprehensibility and prolong memory retention. Moreover, despite Participant 23 experienced voice recognition difficulties, they still preferred voice control over traditional manual operation. They suggested that the microphone used in interviews could be adopted in VIPA to enhance recognition accuracy, while verbal control remained the preferred method.

> "I'd rather talk."
> (Participant 23, F; on whether they still prefer voice activation after experiencing difficulties)

> "I prefer having a hardcopy… I could remember more if it's face-to-face, not too much if it's spoken online… (if there's a monitor). It's a bit better, but (hardcopy) is still better… I could remember more (if there's a monitor)."
>
> (Participant 18, F)

> "I'm just fantasizing; what if the VIPA could be paired with a monitor, combining all the smartphone and smart speaker functions? That'd be perfect to show what's necessary on the screen and voice out the desired information."
>
> (Participant 9, M)

Secondly, customized shortcuts could be implemented to reduce linguistic barriers due to worsened dysarthria. Participants suggested using numbered commands (such as calling out one, two, or three) to replace lengthy and structured voice commands, as it was easier for them to enunciate numbers than words. Additionally, users could assign desirable VIPA functions to these functions as they deemed fit. Finally, participant 14 suggested the intervention should be capable of automatically detecting falls and reporting to their close relatives without the PWP issuing commands.

> "Numbers, we speak with more clarity in numbers… for example, 1 is brushing your teeth..2 and 3."
>
> (Participant 3, M)

> "To set some (functions) and let us press 1,2,3… for example 1 is what (functions), 2 is another, using 123 to replace (functions)"
>
> (Participant 23, F)

6.4. Conclusion

The pilot RCT identified the preliminary efficacy of the VIPA intervention with the largest beneficial effect size on PWP's psychological well-being and the meaningfulness domain within SOC-13. At the same time, the significant group by time interaction effect on emotional well-being suggested a decrease in positive emotions among IG participants. The explanatory qualitative interviews then explored the user perception of the VIPA intervention, where participants regarded the severity of their symptoms as their motivation to comprehend their illness; the VIPA intervention could serve as an auxiliary home-alone remedy to manage PD symptoms; and the VIPA intervention could promote their meaningfulness domain by aiding them to regain control over PD. Although a sense of abandonment was reported from unsuccessful voice commands, such negative emotion gradually subsided once the VIPA responded.

Chapter 7: Discussion

7.1.Introduction

This section discusses the findings of the current research. Section 7.2 discusses the PDQ-8 validation in the Chinese population against existing research. Section 7.3 discusses the applicability, acceptability, and feasibility of the VIPA intervention among the participants. Section 7.4 elaborates on the pilot RCT's preliminary efficacy and compliance rate with supplementary explanatory qualitative data. Section 7.5 focuses on the Phase 2b qualitative finding and further discusses the SOC components within the VIPA intervention. Finally, Section 7.6 discusses the limitations of the study.

7.2.Validation of the PDQ-8 in the Chinese Population

The translated traditional Chinese PDQ-8 demonstrated satisfactory reliability and validity among the participants in Hong Kong. The internal realibility, Cronbach's alpha, aligns with

The comparable Cronbach's alpha value to other PDQ validation studies in both Western (Stathis & Papadopoulos, 2022) and Eastern societies (Chen et al., 2017; Tan et al., 2007) suggested the translated Chinese PDQ-8 demonstrated a satisfactory internal reliability. Only the stigma item recorded an item-total correlation below the 0.3 threshold (Ebrahimi et al., 2013) but other satisfactory results are in line with the Singapore data (Tan et al., 2007). Due to the PDQ-8 sampling more items on PWP's motor symptoms(Martinez-Martin et al., 2014; Stathis & Papadopoulos, 2022). It could have contributed to the reduced item-total correlation for the stigma item.

Self-stigmatisation has a long history in the context of PD and has been extensively researched (Hanff et al., 2022; Nijhof, 1995). PWP's experienced stigma and was found to predict their motor symptoms and depression, while also serving as a key determinant of QOL (Hou et al., 2021; Ma et al., 2016). Even though deleting the item in question could improve the internal reliability, the alpha value would be 0.81. It was the only question that measured the stigma domain among PWP. Having the item removed could lower the scale's content validity (Köberich et al., 2013) and an essential QOL domain in the PD population. In addition, the satisfactory result on the mean inter-item correlation (Clark & Watson, 2016; Hajjar, 2018) also suggested that retaining the stigma item did not negatively impact the internal structure of the scale. Consequently, the stigma item was deemed essential and retained.

The criterion and convergent validity of the translated PDQ-8 were established through the recorded small to moderate correlation with other psychosocial constructs. Its significant correlation with the gold standard, EQ-5D-5L index score, agrees with the previous correlation research (Alvarado-Bolanos et al., 2015; Chen et al., 2018; Stathis & Papadopoulos, 2022). Secondly, the reported positive correlation between QOL and sense of coherence, as well as mental well-being, and a negative correlation with perceived loneliness, was consistent with previous findings. Studies have shown that lower QOL was associated with worsened depressive symptoms and SOC (Chen et al., 2017; Delgado, 2007; Kim et al., 2020). Well-being was not only considered important to older adults in communities (Giglio et al., 2015), and QOL has been regarded as synonymous with subjective well-being and human needs (Camfield & Skevington, 2008; Costanza et al., 2007). Thus highlighting the satisfactory convergent validity among the translated PDQ-8.

The reported non-significant correlation between our participants' QOL and their coping tendencies differed from existing evidence. Each subdomain of the PDQ-39, the unabridged version of the PDQ-8, was found to correlate with various coping strategies. Specifically, PWP in

Bucks and team study (Bucks et al., 2011) reported that more planful coping behaviours were found within participants with higher communication, bodily discomfort, and cognitive subdomain scores in PDQ-39. Those with lower subdomain scores on their stigma, emotional well-being, and social support tend to implement more avoidance coping strategies. The PDQ-8 is designed to be faster, more concise, and less burdensome than the original PDQ-39, serving as a means of examining the QOL of PWP (Jenkinson et al., 2024). It only extracts one item from each subdomain. Its multidimensionality (Hagell & Nilsson, 2009; Martinez-Martin et al., 2014) and the inability to examine each subdomain separately could contribute to the non-significant correlation between QOL and coping tendency.

For PDQ-8 summative scoring, there was no observable ceiling or floor effect, with normal distribution established upon removal of the outlier. The floor effect identified for motor symptoms items could be contributed by a relatively high percentage of our participants being at an early stage of their disease progression. Since 62.7% of the recruited PWP were at their 1-2 H&Y stage, they may not have experienced as many motor symptoms or physical concerns as their peers at later disease progression. Secondly, the data collected for the non-motor domain were in line with the cross-country PDQ-39 data (Jenkinson et al., 2003). Studies have identified floor effect up to 56.4% in social support, 15% in cognitions, 46.5% in communication, and 45% in the stigma domain. These data suggested the floor effect identified from the current study was likely not contributed by translation error or cultural effect.

Secondly, the increasing trend in the PDQ-SI documented (in H&Y level 1-3) agrees with the existing 5.8-7.4 minimally important difference from the Singapore study (Luo et al., 2009). The translated PDQ-8 was able to capture the QOL changes across PD progression levels. The current study's restricted range on participants' recruitment in the community center could contribute to the decrease in PDQ-SI for the participants at H&Y level 4. There was no participant assessed with a H&Y level 5, and over 60% of them were at H&Y level 1-2. Since no participants scored a zero, and no floor effect on the scale level, this suggested that the translated PDQ-8 could be implemented among PWP with early stages of disease progression. Future research could employ a more comprehensive sampling strategy to recruit more PWP at later stages of disease progression.

7.2.1. PDQ-8 Validation – Conclusion

This study established the reliability and validity of the translated PDQ-8 in the PD population in Hong Kong. The scale demonstrated satisfactory criterion and convergent validity when compared with other measures of QOL, and correlated with SOC, mental well-being, and perceived loneliness. Furthermore, the satisfactory internal reliability, mean inter-item correlation, and item-total correlations indicated a reliable internal structure. Although the stigma item had a lower item-total correlation, it was retained to maintain content validity in sampling all necessary QOL domains among PWP. The absence of floor and ceiling effects, along with the observed gradual increase in scores across early PD progression levels, further supported the suitability of the PDQ-8 in assessing the QOL of PWP.

7.3. VIPA Intervention Development – Applicability, Acceptability, and Feasibility

The VIPA user protocol was developed using a participatory approach. Focus groups and cognitive interviews with PWP were conducted to inform the design and explore how the VIPA intervention could best support their daily lives. By shifting PD care from physician-centred to client-centred, this participatory approach enhanced the clinical relevance of the research, promoted participation, and empowered PWP by involving them in the research development process (Morgan, 2015; van der Eijk et al., 2013).

7.3.1. Applicability of the VIPA Intervention

Exploratory interviews revealed that the VIPA could serve as PWP's information hub by linking them with the available resources and disease-related information in the community. Such interaction could also potentially enhance their comprehensibility of their disease and access to social activities, mitigating their social withdrawal due to insufficient support (Ahn et al., 2022).

Secondly, six assistive roles (secretary, caregiving, health advisor, messenger and companion, smart home butler, and entertainer) suggested that the VIPA interventions could provide a wide range of assistive functionalities for PWP. The anticipated VIPA applications agree with the current VIPA research trend in promoting self-management, administering exercises, or delivering health information to nurture social well-being and reduce caregivers' workload (Quinn et al., 2024; Saripalle & Patel, 2024).

Based on the findings in the explanatory study (chapter 6.3), PWP had a more assistive-inclined intention to utilize the VIPA intervention than older adults. O'Brien et al. (2022) Synthesised 8 themes of VIPA usage, ranking entertainment, reminders, and education as the top 3 most mentioned VIPA functions, with health and well-being being the least mentioned. Such entertainment-focused findings also resonated with Budd (2020) qualitative study on the psychological promoting properties of VIPA, with hedonic functions being the most used functions.

Based on the collected qualitative data, the mentioned frequency of VIPA functions could indicate their perceived importance in content analysis (Vaismoradi et al., 2013). The more mentions it was recorded, the more important the VIPA function was to the PD population. Although the usage tendency observed among older adults differed from PWP, our participants valued health-related VIPA functions more. The most mentioned secretarial and caregiving features indicated different assistive needs for the PD population. Duffy et al. (2021) also reported similar observations in utilizing VIPA to address PD-related symptoms in the UK, signifying a different VIPA implementation approach for the PD population to manage their symptoms, signifying a different prioritization in VIPA functioning for the PD population. Instead of the generic entertainer for older adults, PWP prefers the assistive role of VIPA to negate the impact of PD symptoms.

Finally, the traditional one-size-fits-all approach to intervention usage cut-off may not be appropriate for VIPA intervention among PWP. Given the unique symptoms and clinical profile experienced by each individual with PD (Bloem et al., 2021), participants exhibited diverse coping strategies, using the VIPA intervention according to their specific needs and symptoms. For example, an individual with advanced PD progression on the H&Y scale experiencing hand tremors and muscle stiffness may primarily use the VIPA's voice activation and voice-to-text function. In contrast, someone experiencing memory decline may focus on scheduling and alarm setting, while someone experiencing sleep disturbance may listen to music at night to aid sleep. Future VIPA research could investigate optimal therapeutic usage frequency for prominent PD symptoms, such as cardinal motor symptoms, memory decline, or sleep disturbance.

7.3.2. Acceptability of the VIPA Intervention— Companionship

The acceptability of the VIPA intervention was reflected in the degree to which participants felt a sense of companionship with the device. The first evidence that participants recognised the VIPA's lifelike characteristics was their unconscious use of social cues, such as saying *please* to the VIPA during cognitive interviews (even when not required for voice commands). This tendency to generalise human-to-human interaction to human-to-robot research has been observed in previous technology studies and can enhance the perceived usefulness of such applications (Hassanein & Head, 2007; Nass & Moon, 2000).

While some IG participants reportedly considered VIPA their friends, not everyone shared such a strong bond. Although overseas PWP and older adults were also noted with similar companionships (Astell & Clayton, 2024; Duffy et al., 2021; Park & Kim, 2022), some participants only established a sense of connection with the intervention. While it has been theorised that perceived loneliness could affect the degree of anthropomorphisation (Epley et al., 2007), participants with a higher UCLA-3 score at baseline did not bond with the VIPA more than their peers.

Although a cathartic experience was noted during the intervention period, the bonding with VIPA for some participants was obstructed by its unnaturalistic, if not rigid, communication and its limited social presence. Instead of mimicking an approachable and lifelike figure that could encourage liking (Wu et al., 2017), participants were required to adhere to its predefined and rigid prompting structures without adequate emotional support. The desired VIPA persona for the PD population was envisioned by the participants as empathetic, proactive, and resembling a 'motherly' figure to improve its emotional appeal.

There was also a mismatch between VIPA's persona and its communication style. Referencing the theory of transactional analysis (Berne, 1996), the personality's ego states can be categorised into parental, adult, or child. The VIPA primarily adopted a subordinate adult ego state in serving PWP, or a child ego state in responding to users with humorous responses. Differing from the perception of VIPA as an assistant or friend among Chinese VIPA users (Wu et al., 2019), participants in the current study expected a more parental role for the VIPA, seeking emotional support or advice for their daily lives, in addition to being their equal.

Because emotional appeal, such as companionship, was one of the qualities sought after by VIPA users and significantly associated with their intention to buy (Ling et al., 2021; O'Brien et al., 2020). Given generally low user satisfaction with the VIPA (Yoon et al., 2022), this study's finding that approximately half (55%) of the IG participants rated the VIPA's usability at 50/100 or higher suggests fair usability. Future VIPA persona should emulate a nurturing 'motherly' role to enhance user intention and foster robot-to-human companionship. This could be achieved by initiating conversations spontaneously, providing personalised and relevant recommendations, demonstrating emotional awareness, and offering brief counselling or referrals to appropriate services when needed. Furthermore, response content should be less repetitive and more comprehensive. The VIPA should also respond in a way that suggests a similar social standing as the user to avoid a sense of top-down, one-way communication. If future VIPA designs meet these expectations, the device could play a more proactive role in the daily lives of PWP, moving beyond its current auxiliary function. Integrating advanced language models, such as ChatGPT, could also enhance the VIPA's ability to mimic natural interpersonal communication.

7.3.3. Feasibility of the VIPA Intervention

Technical issues and feedback during the intervention indicated that the participants experienced difficulties adapting to the VIPA. While the on-site training and support proved sufficient for cognitive interview participants in the university lab, the single training session was insufficient for the 8-week pilot RCT and was cognitively demanding. Usability scores indicated that 40% of the participants reported an above average SUS score of 70 (Vlachogianni & Tselios, 2022). The moderate usability reported from participants was similar to how the general public perceives Microsoft Excel (Kortum & Bangor, 2013), which is often used without complete comprehension of its advanced formulas or features. The participants thus reported confidence in mastering basic VIPA functions without fully comprehending its capabilities. The participants shared that they only learned about potential therapeutic functions, such as news reporting or joke telling, after post-intervention peer sharing or during the interviews.

The suboptimal PD-friendliness of the VIPA increased technical barriers and reduced intention of participants to use the intervention. Yoon et al. (Yoon et al., 2022) emphasised the importance of user-friendliness for improving the VIPA user experience. This study extended this concept to PD-friendliness, which it defined as the degree to which the intervention could be integrated into the lives of PWP. While studies have shown the feasibility of using smart speakers to support speech therapy for native English speakers who stammer or adults with intellectual disabilities (Bleakley et al., 2022; Smith et al., 2021), the voice recognition in this study did not achieve the 90% accuracy or effective interaction reported in other VIPA studies involving non-native English speaking, such as those conducted in Arabic (Salah et al., 2023) and the disabled users in Italian (Masina et al., 2020). Similar to older Korean adults, the participants in this study experienced greater-than-usual difficulties communicating with the

VIPA due to its complex command structure and poor voice recognition (Kim & Choudhury, 2021).

The mixed Cantonese and English command structure created additional voice recognition challenges. Insufficient English proficiency also posed a barrier for some participants. This was consistent with another VIPA study that identified Chinese accents as having the second-highest error rate among six non-English languages for command input (Shafei & Tan, 2022). While this VIPA system was intended primarily for communication in Cantonese, it required occasional English terms. Participants who were unfamiliar with the pronunciation of key English words, such as *Siri*, *podcast*, or *YouTube*, experienced difficulties activating the device or accessing certain functions as they were unable to clearly pronounce such terms.

To enhance the feasibility of future VIPA interventions, the participants suggested improvements to training, hardware, and media output for future designs. Regarding hardware, they recommended supplementary accessories to address suboptimal voice recognition and simplify the command structure. Specifically, they suggested incorporating an external microphone to improve voice reception, operating the system exclusively in the users' native language to eliminate language barriers, and using numerical shortcuts instead of lengthy commands. For media output, the participants suggested a multimedia approach by including a separate display monitor to provide simultaneous audio and visual information during searches. These recommendations were supported by previous research, which indicated that information transmitted through audio was perceived as more credible, while textual displays enhanced memory retention (Gaiser & Utz, 2023; Leroy & Kauchak, 2019). Such supplementary accessories could enrich the VIPA user experience.

Finally, the participants suggested more frequent, shorter training sessions with mid-term evaluations and return demonstrations. They felt that the single hour-long training session on the installation day was insufficient for mastering the VIPA intervention, and that it could take weeks to become comfortable with it. A longer, segmented training approach with mid-term evaluations would improve their comprehensibility towards the intervention. Personalised training is considered essential in VIPA studies and is particularly appreciated by older adults (Esquivel et al., 2024; Hanley & Azenkot, 2021). Instead of the single hour-long training session used in this study, which was too cognitively demanding, future research should consider incorporating weekly face-to-face training sessions, each focusing on a single VIPA function, combined with mid-term evaluations to assess progress.

7.4.Phase 2a: Pilot RCT

This study provides preliminary evidence of the efficacy of the VIPA intervention for PWP.

7.4.1. Preliminary Efficacy on Emotional Well-being

The significant GEE result among participants' emotional well-being indicated there was a decrease in their positive emotions. It may have stemmed from a sense of abandonment experienced by the participants when interacting with the VIPA, with their emotional well-being score gradually improved at follow-up assessment. Inconclusive evidence was observed among previous single-group or quasi-experimental VIPA studies. They either yielded a significant decrease in depression domain (Park & Kim, 2022) or had no additional benefits among older adults (Kim, 2023).

The explanatory qualitative findings suggested that this preliminary effect on emotional well-being may be related to the design and implementation of the VIPA. The participants were observed internalising their unsuccessful VIPA command attempts, reflecting these frustrations in their own speech patterns (e.g. slurred or soft-spoken speech). Similar frustration, hesitation, and doubt have been observed when users interact with other technological interventions, such as social robots or mobile applications, without adequate support (Piculell et al., 2021; Wilson et al., 2020). Such unsuccessful VIPA communication may induce a sense of inadequacy, reminding PWP of their physical limitations (Vann-Ward et al., 2017).

Furthermore, the VIPA's high social presence, while conducive to companionship, induced a sense of abandonment upon failed interaction attempts. Some participants reported forming a bond with the VIPA due to its helpfulness and resourcefulness. However, others who struggled with communication experienced a sense of abandonment when their attempts failed, as if a real person was ignoring them. A similar sense of rejection was reported by individuals with affective disorders when communicating with conversation agents when they were interrupted mid-conversation (Maharjan et al., 2022). These results suggest that a high social presence, without adequate support and well-executed implementation, can transform the potential benefits of companionship into feelings of abandonment and rejection.

7.4.2. Preliminary Efficacy on Comprehensibility

The observed decreasing trend and negative effect size on comprehensibility may be related to information overload and the measurement method. Secondly, such a decrease could mask the therapeutic effect on the meaningfulness and manageability domain. The increased variance suggested that the therapeutic effect of the VIPA on participants' SOC-13 could be masked by the negative effect size documented in the comprehensibility subdomain.

The average SOC-13 total score of 60.19 from the current study at baseline was slightly less than that of other PWP with mild to moderate disease progression (65.8) (Rosengren et al., 2016). A decrease in comprehensibility suggests that PWP perceive their surrounding stimuli as more random and unexplained than before (Eriksson & Contu, 2022). The method of measurement may also have contributed to the observed decrease in comprehensibility. Of the five items that explored comprehensibility (Antonovsky, 1987), Item 6 enquired about the extent to which the respondent considers themselves to be in a foreign situation and is hesitant about how to respond.

The literature suggests that information overload in older adults is primarily caused by technology (Benselin & Ragsdell, 2016), and making sense of a technological intervention is crucial for comprehensibility (Piculell et al., 2021). Therefore, the complexity of the VIPA intervention may have contributed to a decrease in comprehensibility. The participants' uncertainty on the VIPA and their lengthened coping period could have negatively impacted the efficacy of the intervention.

The participants also questioned the credibility and relevance of the online information they accessed through the VIPA and criticised its indirect search method. While some participants praised the VIPA's accessibility in locating and filtering desirable information, others were reluctant to use it for PD-related searches, considering the presented information less credible and suspecting it of originating from the research team rather than directly from the internet. They expressed greater trust in healthcare professionals. Just as a VIPA can supplement the existing resources of PWP, online PD information can complement professional care. PWP in Sweden have been shown to primarily acquire disease information online, with higher knowledge levels correlating with greater satisfaction with neurologist visits (Riggare et al., 2019). As the participants in this study noted, online PD information can sometimes be less relevant than existing community resources. According to the definition of salutogenic comprehensibility, perceived random, unexplained, or unexpected information can negatively impact comprehensibility (Antonovsky, 1987; Eriksson & Contu, 2022). Future VIPA research could integrate the existing resources of PWP to improve search quality, thereby enhancing comprehensibility.

The indirect search process presented a barrier to information access. The VIPA sometimes redirected the enquiries of the participants from the smart speaker to their linked smartphones for further searching. The participants described this as counterintuitive, as they would not need the VIPA if they could easily search on their phones. This reduced accessibility may have also contributed to decreased comprehensibility.

Finally, the significant GEE result on the comprehensibility domain from the per protocol analysis could be attributed to the reduced sample size. A small sample size in GEE could lead to an inflated Type I error (Wang et al., 2016). Therefore, future research should first aim to increase adherence among IG participants and then examine its efficacy in a full-scale RCT.

7.4.3. Positive Efficacy on Meaningfulness and Psychological Well-being

A similar small positive effect size of the VIPA intervention was observed for both meaningfulness and psychological well-being, highlighting the importance of fostering a sense of control and environmental mastery in PWP. The minimum participant number for future RCTs in examining the efficacy of VIPA on PWP's meaningfulness and psychological well-being would require 434 participants ($d = 0.27$, $\alpha = 0.05$, $1-\beta = 0.8$). However, the Bonferroni method should be implemented to account for the increased type I error if future RCTs replicate the 5-

measuring-outcomes research design (Vickerstaff et al., 2019). The required sample size calculated with the adjusted p value would be 646 PWP (d=0.27, α= 0.01, power= 0.8). During the explanatory qualitative interviews, the participants valued the VIPA's assistive nature, noting that the goal of PD intervention is not to cure the disease but to alleviate their discomfort. They likened the VIPA to an electric wheelchair, helping them regain control over their condition. Because of the diverse and often disabling motor and non-motor symptoms of PD, difficulties in manipulating traditional electronic devices can lead to decreased interpersonal contact, reduced exercise, and increased stress. The VIPA addressed these challenges by providing access to information, facilitating social participation, and assisting with daily tasks through voice commands, bypassing motor difficulties and bring them one step closer to ability possessed by healthy individuals through normalisation.

A recent scoping review (Zarotti et al., 2024) on the sense of control experienced by PWP indicated that psychosocial interventions can positively influence their locus of control, mastery, self-efficacy, and overall perceived control. The VIPA functioned similarly to an educational intervention, but instead of simply disseminating information, it is a resource-based device focused on nurturing environmental mastery and autonomy, key components of psychological well-being. It connected PWP with available resources, enabling independent symptom management and potentially reducing the workload of caregivers.

7.4.4. Missing Data Management

Following Jakobsen et al.'s (Jakobsen et al., 2017) practical guide for handling missing data in RCTs, analysis with all observed data was recommended. The 13.19% missing data rate fell between the ignorable (5%) and substantial (40%) thresholds, and the non-significant result from Little’s Missing Completely at Random (MCAR) test suggested the data was MCAR, independent of both observed and unobserved values. MI was considered an appropriate and conservative approach to handling missing data by inflating the standard error and contributing to overall variance. It could generate an unbiased GEE result under the MCAR situation by factoring in the uncertainty from the original dataset(Sterne et al., 2009; Twisk & de Vente, 2002; Van Ginkel et al., 2020). Therefore, the conflicting result from the sensitivity analysis requires careful examination.

Secondly, the exact values of the missing data were unidentifiable even under the MCAR situation, leading to a reduced statistical power (Jakobsen et al., 2017; Sterne et al., 2009). The implementation of MI could affect the analysis result on VIPA’s efficacy. A more robust RCT with the recommended sample size calculated in Chapter 7.4.3 was required for better efficacy interpretation.

7.4.5. Reasons for Low Intervention Compliance and VIPA Target Population

As discussed in Section 7.4.2, the decrease in comprehensibility may be related to the difficulties that the participants experienced in using the VIPA intervention. The self-reported VIPA usage of 6.2 commands/ day was slightly lower than the 8.51 commands per day reported in other VIPA research among older adults with low technology use (Pradhan et al., 2020), but it did exceed the five commands per week observed in a Korean study (Park & Kim, 2022). As suggested in Section 7.3.1, the traditional one-size-fits-all intervention dosage may not be appropriate for PWP. The optimal VIPA usage should be assessed case-by-case.

The VIPA intervention was considered most suitable for PWP with high impairment levels or those living alone. High-functioning participants sometimes found the device redundant. With over half of the participants in the early stages of PD, those with better functional abilities felt that they could accomplish some VIPA functions, such as scheduling, phone calls, and information searching, on their computers, reducing their perceived need for the intervention at their current stage of PD progression. They suggested that they would become more reliant on the VIPA as their PD situation deteriorated. As VIPAs are considered approachable, accessible, and natural for disabled individuals (Pradhan et al., 2018), these user experiences suggest the intervention may be most beneficial for those with low technology literacy and those with moderate to high levels of PD progression and severe functional impairment.

7.5. Connecting the User Experience of VIPA Intervention with the Salutogenic Model

Within the salutogenic framework, the VIPA intervention served as a Generalized Resistance Resource (GRR) for PWP, enabling access to desired Specific Resistance Resources (SRR), such as online information and assistive functions. Antonovsky (1993) emphasised on autonomy and self-reliance in ageing. Salutogenesis in the digital age is believed to guide the development of health-promoting interventions, nurture well-being, and generate new GRR and SRR (Saboga-Nunes et al., 2022). By fulfilling the six assistive roles identified in the exploratory qualitative interviews—providing a range of utilities to facilitate coping and access SRR (e.g. specific health information online or a family member's phone number) through voice commands—the VIPA aligns with the salutogenic narrative as a GRR for PWP (Antonovsky, 1979, 1987; M. B. Mittelmark et al., 2017).

Secondly, the explanatory qualitative results suggested that the VIPA contributed to the SOC of PWP across all three domains (comprehensibility, manageability, and meaningfulness) by serving as a GRR for the participants to access the SRR they deemed necessary. PD symptom severity was identified as a motivator for seeking PD information through the intervention. The participants used the VIPA in diverse ways to address their individual needs, illustrating how the intervention cultivated a sense of control and security through normalisation. They reported that the VIPA promoted their social functioning by connecting them with society (through communicative functions) and mitigating their disabling symptoms (through voice-activation).

7.5.1. Comprehending PD Using the VIPA

The use of VIPA guided participants with their disease comprehension and management. At the same time, comprehensibility is considered a prerequisite for manageability, as one must first understand their situation before attempting to cope with it (M. B. Mittelmark et al., 2017). The current research findings added to the missing link between such transitions. Both active and passive coping strategies were observed among the interviewed participants. When some actively search for PD-related information via the VIPA. Others were hesitant about how the VIPA could aid them due to their inability to grasp their disease progress or symptoms. Similar to the positive association identified between education levels and active coping among PWP (Prins et al., 2023). PD-related knowledge is also crucial in PWP's coping methods and should be further explored.

7.5.2. Using VIPA to Lessen the Impact of PD Symptoms

By serving as participants' auxiliary resources, the VIPA could alleviate caregivers' burden and promote autonomy. Secretarial and caregiving functions, such as itinerary management, reminders for medications, or mood regulation, could benefit PWP at a later stage of their disease progression with moderate to high impairment, without inducing a sense of redundancy. In addition, homebound PWP, due to their disabling symptoms, are considered underrepresented in PD research despite their low QOL (Fleisher et al., 2020). Findings suggested the VIPA would be best suited for these populations and call for future efficacy studies.

Secondly, the VIPA could appeal to both of PWP's problem-focused and emotion-focused needs in either resolving stressful situations or providing emotional regulation (Ben-Zur, 2020). The differences between the observed coping behaviours among participants in the current study and those in previous research could be attributed to technological advancements. Salutogenic scholar advocated that new GRR and SRR could be generated in the technological era (Saboga-Nunes et al., 2022). PWP previously adopted emotional regulation to cope with both motor and non-motor symptoms, such as muscle rigidity, tremors, or the perceived loss of control (Frazier, 2000).

Instead, participants utilized a more problem-focused approach with the VIPA in handling PD symptoms. For example, the voice-to-text feature was reported to lessen the hindrance of their hand tremors and to replace physical operations, such as setting reminders for their declining memory. Whereas, participants' emotional needs, such as companionship or mood regulation, could be partially regulated through music and human-to-robot communication. With a recent review pointing out the lack of self-management interventions for the PD population (Milne-Ives et al., 2022). The VIPA developed in the past decades is particularly valuable in allowing PWP to finally bypass their disabling symptoms without resorting to only emotionally-focused coping.

Finally, the qualitative data suggested the reciprocal relationship between VIPA usage and participants' satisfaction. Such a relationship was exemplified when the participants yearned to learn more about VIPA to further assist their life after recognising its salutogenic effects. According to the salutogenesis theory, if an individual identifies a GRR that caters to their needs, it contributes to a better SOC, which in turn further encourages the use of the said GRR (Antonovsky, 1979; Hochwälder, 2019; Super et al., 2016). Therefore, future salutogenic research should factor in PWP's user satisfaction when designing interventions with adequate PD-friendliness to reduce undesirable emotions and maximise their therapeutic effect.

7.5.3. Regaining Control and Cultivating Meaningfulness of PD Among PWP

Previous studies highlighted the importance of sense of control among PWP. In addition to the mediating effect between stigma and emotional well-being(Verity et al., 2020). PWP also reported feelings of surrendering control to their medications to keep their symptoms at bay (Eccles et al., 2011). The VIPA thus serves as a valuable alternative to mitigate the impact of symptoms on their lives. By providing PWP alternative means to access resources through voice activations. The VIPA could reduce the impact of their PD symptoms and initiate the process of normalization, bringing PWP one step closer to healthy individuals in society.

7.6.Ethical consideration

Future VIPA design could adopt the ethic by design framework (Brey & Dainow, 2024) to better fit the A.I. era. The framework covered areas such as well-being, human agency, fairness, privacy, and accountability, which are applicable to the PD population, as shown in Table 7.1.

Table 7.1. *Ethic by design for future VIPA*

Ethics by design domain	Future VIPA design
Well-being	Better assistive accessories to enhance PD friendliness 1. External microphone 2. Smart home integration 3. More empathetic and spontaneous
Human agency	To ensure PWP's autonomy 1. Avoid making decisions for users Only to advise on available resources or health information
Fairness	To enhance digital equity 1. A standalone system that is independent of any smartphone operating system 2. Segmented training regime with a peer support system to promote comprehensibility and usability 3. Ongoing consent for PWP with risk of cognitive decline
Privacy	To ensure data security 1. All collected data should be anonymized 2. Only to collect intervention usage or accessed functions 3. Only authorized research personnel could access related data

Note* Ethic by design framework adopted from Brey and Dainow (2024)

The possibility of designing a more PD-friendly VIPA with a more motherly A.I. to minimise induced undesirable emotions among participants is discussed in Chapter 7.3.3. It also leads to the human agency domain, where the question arises of how to ensure participants' autonomy while increasing the intervention's involvement in their lives. Although PWP reportedly longed for a more motherly A.I. persona, future VIPA should maintain boundaries and serve as PWP's auxiliary resources to support their existing needs or locate available services. The goal of such boundaries is to ensure that VIPA will only assist its users by advising on their options, but not decision making (Brey & Dainow, 2024).

The fairness domain aligns with the definition of digital equity, encompassing access, usage, and engagement with digital health (WHO, 2022a). Firstly, future VIPA should be a standalone intervention without pairing to a specific smartphone operating system to ensure its accessibility. Secondly, a better training regime and inviting skilled PWP to join as peer supporters could not only enhance the comprehensibility and usability of the intervention (discussed in Chapter 7.3.3) but also keep them engaged with the VIPA. As reported by the participants, peer experience sharing could shed light on how to utilize the therapeutic functions of the intervention effectively.

Secondly, future VIPA should adopt a flexible and ongoing consent to accommodate the risk of cognitive decline among PWP. With around one-tenth of PWP suffering from MCI, and their dementia prevalence is on the rise (Aarsland, 2016; Savica et al., 2018). The VIPA demonstrated promising potential in mitigating their memory decline with assistive functions such as reminders and timers. It raised concerns about how to ensure the ongoing consent among those with cognitive issues and how to design an ethical VIPA intervention. Consent among dementia is considered an ongoing process with flexible approaches (Pyer & Ward, 2024). Based on the FDA’s 2023 recommendation (FDA, 2023b). Future VIPA research should include PWP with dementia who are not mentally fit for consent. Researchers should obtain consent from participants' legally authorized representative and preferably with the assent from the participants prior to the research. Meanwhile, to account for the decline in cognitive functioning during the intervention period. Cognitive screening could be integrated within the VIPA system. For example, if the once cognitively intact participants failed the brief cognitive screening from the Integrated Care for Older People (WHO, 2024), which consists of a short-term memory recall and orientation test, as asked by the VIPA. It could alert the caregivers and recheck when both parties agree to continue with the research.

Finally, to ensure participants' privacy in future VIPA research. The intervention shall not retain personal data such as the messages sent or the conversations they shared. Instead, researchers could collect the functions accessed, usage frequency, and number of unsuccessful attempts. An ethically designed VIPA could safeguard participants' rights and ensure intervention coverage, benefiting different subgroups of the PD population.

7.7.Limitation of the Study

This study has a number of limitations. Due to the commercial nature of the Apple HomePod mini, only a limited degree of customisation was allowed, and no accessible user log could be used for data analysis. Although the inability to access the VIPA user log safeguarded the participants' privacy, only the self-reported VIPA usage could be collected. In addition, during the intervention period, the Apple HomePod mini was the only available VIPA that supported Cantonese. Some standard VIPA features, such as grocery shopping, were also unavailable in Hong Kong. Consequently, this study was unable to examine how these SRRs facilitated the SOC of the participants.

Secondly, the current pilot RCT was designed to examine the preliminary efficacy of the VIPA in the PD population to prepare for future full scale RCT. The relatively small sample size was not powered to examine the group difference of an effect size of 0.27.

The exclusion criteria of this study resulted in a restricted range of participants. PWP with a moca score >21, hearing disability, severe voice impairment, or Level 5 on the H&Y scale were excluded from the pilot RCT. This exclusion reduced the generalisability and transferability of the findings to the entire population of PWP. In addition, it remains unclear whether the participants with cognitive impairments were able to understand and complete the translated PDQ-8.

7.8.Conclusion

The VIPA demonstrated satisfactory applicability, acceptability, and feasibility on the participants during the intervention period. The applicability of the VIPA was exemplified in the themes generated from the explorative study, *All-in-one information hub* and *Versatile role of VIPA*, which illustrated what the participants expected from the VIPA. As well as becoming an information hub to access existing community resources and online information, the participants also valued the VIPA's assistive functions. The VIPA served in six assistive roles to facilitate the daily lives of PWP: secretary, caregiver, health advisor, messenger and companion, smart home butler, and entertainer. Within the salutogenic framework, a well-developed VIPA should be able to serve as a Generalized Resistance Resources (GRR), enabling PWP to access the assistive functions (Specific Resistance Resources; SRRs) and thereby manage their daily lives.

In terms of acceptability, the VIPA fostered a sense of companionship with some participants, who recognised the lifelike features of the VIPA and generalised human-to-human social cues when interacting with it. In the explanatory interviews, some participants revealed that they had successfully bonded with their VIPA and regarded it as their A.I. friend. To further refine the interaction between the VIPA and PWP, some participants suggested that a more empathetic, spontaneous, and 'motherly' VIPA could provide emotional support and help them manage their PD symptoms.

The VIPA also demonstrated feasibility within the PD population, with the participants using it differentially to manage their symptoms. Usability scores were comparable to those for Excel software. Technical support training sessions were necessary to address the participants' technical questions and ensure smooth implementation. The most common technical challenges experienced by the participants were suboptimal voice recognition and the complexity of the command structure. These issues, particularly the bilingual command structure and the impact of PD on voice recognition, sometimes led to communication difficulties with the VIPA.

The participants also offered suggestions for improving the VIPA's PD-friendliness and for minimising negative emotional responses. Unsuccessful attempts at interaction sometimes resulted in feelings of abandonment, reflected in a temporary adverse effect on participants in the GEE model. This effect typically subsided after successful interactions. To enhance the VIPA's functionality, some participants suggested supplementary accessories such as an external microphone to improve voice recognition, an additional display monitor to complement the audio output, and segmented training sessions with return demonstrations to help them familiarise themselves with the VIPA.

The explanatory qualitative interviews explored the user experience of PWP through a salutogenic lens on how the VIPA could nurture participants' SOC. The theme *of Symptom severity as motivation to comprehend PD via VIPA* revealed that PD symptom severity could motivate participants to search for PD-related information, leading to symptom management in the manageability domain. The theme *An auxiliary home-alone remedy to manage PD symptoms* described how the participants regard the newly implemented intervention as their auxiliary resources to satisfy both of their problem-focused and emotion-focused coping needs, advancing from their previously emotion-focused dominant coping attempts. Finally, the VIPA was likened to a wheelchair in regaining control over participants' disease and would be appropriate for homebound moderate to severe PWP. The intervention's reported therapeutic effect on the environmental mastery and autonomy of PWP, by lessening their caregivers' workload, was reflected in the small effect size observed in both the psychological well-being and meaningfulness domains.

Chapter 8: Significance of the study

8.1. Introduction

The current thesis contributed to the body of knowledge by translating a valid and reliable traditional Chinese PDQ-8 for clinician use. This thesis study is the first to apply and examine the preliminary efficacy of the VIPA intervention and its salutogenic potential from PWP's point of view. The following sections will discuss the significance of the VIPA intervention across PD practice, research, and policy levels. Section 8.2 focuses on the practice implication generated from the current study in recruiting peer volunteers and refining future interventions through smart home integrations. Section 8.3 highlighted the significance of the current research in developing insight into the salutogenic research, setting up a more objective screening assessment of PWP's speech qualities, and contributing a validated PDQ-8 to support local PD QOL studies. Finally, Section 8.4 demonstrates how the VIPA intervention is positioned at the policy level when applied to society.

8.2. Study Significance to the Practice

8.2.1. Introducing a Peer Support System to Future VIPA Intervention Delivery

Given the relatively complex control and the vast collection of assistive functions, PWP's technological literacy is essential in mastering the intervention. Besides a more refined and segmented training section suggested in section 7.3.3, peer support could also be integrated to facilitate intervention delivery. Because participants were instructed not to share their experiences during the intervention to avoid possible contamination, Participant 14 mentioned she only realized what the VIPA is capable of after completing the intervention and shared their experience with another VIPA user. They reportedly felt it was a waste of VIPA's potential when they did not utilize VIPA to its full potential. Such an experience aligns with a systematic review of online peer support, which found that interaction with peers was unique and unreplaceable by other parties (Gerritzen et al., 2022). In the case of the current study, the first-hand experience of other VIPA users provided valuable insight from another perspective for Participant 14 on how the intervention could aid them instead of learning it from the researcher or reading the user protocol.

Therefore, instead of forming the technical support team only with research staff, future studies should invite PWP with previous VIPA experience to manage their PD symptoms. PWP could learn the necessary techniques for operating the VIPA and gain insight into how the intervention could assist their lives.

8.2.2. Usability and Accessibility Improvements

The current study also contributed to the design and delivery of future VIPA interventions. Based on the motivation-hygiene theory in management (Herzberg, 2015), the absence of hygiene factors could induce a sense of dissatisfaction. Functionalities such as better voice recognition, intuitive control, and search information quality were deemed necessary by PWP and affected their intention to use the VIPA intervention. These fundamental features should be addressed to avoid inducing undesirable emotions among users. Tailor-made accessories should be paired with the existing VIPA design to improve PD friendliness. As discussed in section 7.3.3, an external microphone, a more intuitive command structure, a native language interface, and a PD database integrated with their existing resources from NGOs could satisfy these hygiene factors.

Secondly, a more motherly A.I. persona and smart home integration can serve as a motivator to encourage intervention usage. The former appeals to PWP emotion-focused coping (Ben-Zur, 2020) by initiating spontaneous conversations, being empathetic, and making recommendations based on their schedules, just like their mother would. A more empathetic persona could nurture a therapeutic companionship between VIPA and PWP. In contrast, smart home integration targets PWP's problem-focused needs in expanding their control zone. Participants expressed intention to utilize the VIPA to control other smart electronic devices in completing their chores or administrating medications to manage their PD symptoms better.

The suggestions of integrating smart home control in VIPA were also consistent with existing qualitative findings. When VIPA was advocated to act as an environmental controlling unit, but it has not been refined in decades (Noda, 2018). At the same time, smart home electronics could potentially empower the PD population, but require more feasibility evidence for support (Simonet & Noyce, 2021). Smart home integration proposed by participants could be seen as an extension of their zone of control, further nurturing their psychological well-being, especially in the environmental mastery domain.

8.3. Significance of the Study in PD VIPA Research

8.3.1. More Objective Screening Process for Voice Quality

The current study contributed to the VIPA research in how specialized speech screening was required in future research. A more objective speech assessment was required to examine PWP's speech quality. Due to the decreased dopaminergic storage capacity, the "OFF period" experienced by PWP represents the time interval when their medications begin to wear off in between their dosages, and they experience increased symptom severity as opposed to their well-maintained ON period after taking their medications (Stacy et al., 2005). Recruited participants were noted to report their voice quality during their ON period instead of their most affected OFF period in the speech quality self-assessments. Scholars suggested PD technological intervention on socialization would be suitable for the H&Y scale level 4 or below (Stănică et al., 2019). The current research indicated that for VIPA, what dictated the intervention's suitability was their speech quality during OFF periods. The voice quality changes between the ON and OFF periods posed difficulty in operating the VIPA in the current study, which could originate from the phonetic deficits observed during the OFF period (Goberman et al., 2002). For example, Participant 3 reported a slightly slurred, soft-spoken voice that did not require any repetition during screening (level 1 in MDS-UPDRS item 2.1). Still, they were presented with slurred and incomprehensible speech during their post-intervention interviews and required their partner to translate. Future VIPA research could integrate an automatic speech assessment programme (Tsanas et al., 2013)in assessing PWP's voice quality across both ON and OFF periods and partner with speech therapists in providing adequate linguistic support to support PWP use of VIPA during their OFF period to facilitate the transition to ON period.

8.3.2. Sense of Control within the PD Salutogenic Framework

Quantitatively, our research identified the preliminary effect size to calculate the required sample size for future full-scale RCT, studying the efficacy of VIPA intervention in the meaningfulness domain. The current study also contributes to the SOC research by providing evidence on the once ambiguous and theoretical SOC framework with qualitative results in both meaningfulness and comprehensibility domains. Firstly, the literature on the meaningfulness domain manifests within the PD population was ambiguous. Our data signified that the experienced sense of control and environmental mastery in regaining control over their disease was a crucial motivator for the applied VIPA intervention and was appreciated by the participants. Participant 3 mentioned their intervention goal was never to cure PD but to ease their symptoms. To quote Participant 9, “Voice is all they have,” what VIPA could do to PWP is to bypass their disabling PD symptoms and allow them to replace complex manipulation with voice commands. This discovery could guide future salutogenic PD interventions to target the meaningfulness domain. In addition, existing evidence also highlighted how PWP’s perceived control could mediate the relationship between stigma and emotional well-being (Verity et al., 2020). The VIPA demonstrated its salutogenic potential as a standalone technological intervention that could nurture PWP’s sense of control to achieve a state of well-being. Therefore, future salutogenic VIPA research could explore how smart home integration could benefit PWP by further expanding the zone of control.

Secondly, qualitative data from explanatory agrees with the theory that comprehensibility is a prerequisite in coping with stimuli, positioning before their manageability (M. Mittelmark et al., 2017). Participants were found searching for online PD information based on their symptom severity to search for disease information and possible self-management techniques such as tai chi exercises to improve their situations. Participant 24 exemplified their experience by searching for tai chi exercises to manage their symptoms and reportedly doubled their weekly exercise amount afterward. The current study brings valuable knowledge on how SOC occurs within the PD population and how it could lead to behaviour change.

Thirdly, the current study identified that VIPA could become a platform (GRR) for assistive functions (SRR) for PWP to manage their symptoms. The VIPA’s voice-activation feature pooled all the assistive SRRs into a single compliance and could be accessed with a simple voice command. As illustrated in Fig. 6.12, participants had regarded music playing as a multipurpose tool to target their motor and non-motor symptoms, the fitness apps as a gamified experience in collecting exercising accolades, and utilizing the secretarial functions in making reminders and scheduling follow-ups. On the other hand, participants were noted seeking emotional support from the VIPA. The anticipated empathetic and motherly A.I. persona discussed in section 7.3.2 could further facilitate PWP's manageability. Future VIPA research could integrate more validated nursing interventions into the VIPA system to maximize its salutogenic potential in serving as a GRR.

Finally, the current study also contributed a validated QOL measurement, PDQ-8, to facilitate local PD QOL studies. The translation of PDQ-8 for the Chinese population provides a quick, rapid scale to examine QOL among PWP. It was less burdensome to users than the original 39-item scales (Jenkinson et al., 2024), allowing PWP to complete it within minutes without professional help. Moreover, the PDQ-8 is also one of the most widely adapted QOL scales available in over 80 languages and included in the International Consortium for Health Outcomes Measurement's set for PD clinical studies outcomes (De Roos et al., 2017; Jenkinson et al., 2024). Our validation not only provided a valid, reliable, yet simple QOL measuring process but also allowing local researcher to compare their PWP QOL data with international research

8.4. Significance of the Current Study to PD Policy

The VIPA is a standalone electronic compliance that requires less healthcare professionals' input and was recommended by participants into home-alone PWP during their later stage of disease progression. Quoting the participant, "Voice is all they have," implementing voice-activation intervention within the PD population could promote their social functioning and maintain social contact with the community. Should the government provide subsidies for installing VIPA for those PWP in need and offer the aforementioned VIPA training with technical support, it could bypass their impairing motor symptoms to connect with society. After all,

Moreover, VIPA could serve as PWP's information hub for accessing available resources and information similar to the social prescribing process (WHO, 2023). The VIPA could take the initiative in allocating suitable resources to PWP without relying on professional involvement, thereby nurturing self-agency within PWP under the Subramanian et al. (2021) wellness strategy model.

8.5. Conclusion

The novelty of the current study is to develop a technological intervention based on the SOC framework. The VIPA intervention could serve as a platform (GRR) in hosting assistive functions (SRR), such as voice-to-text, interpersonal communication, entertainment, or setting medication reminders.

Secondly, recommendations were also made to signify the significance of the current study across practice, research, and policy levels. Not only could peer volunteers be recruited into the technical support team in future VIPA research to facilitate intervention delivery and share their insight with fellow PWP, but future VIPA research could further explore PWP's meaningfulness domain in how to nurture their sense of control. Finally, governmental subsidies could increase the VIPA prevalence for PWP in need and possibly integrate the concept of social prescribing into the VIPA framework to better connect PWP with existing community resources.

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Appendix 1: Systematic review on PD technological interventions

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REVIEW ARTICLE

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Effectiveness of technological interventions on psychosocial well-being and perception of technological interventions among people with Parkinson's disease: A systematic review

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Abstract

Objectives: The increasing number of technological interventions related to Parkinson's disease (PD) signifies growing research interest in the PD technological domain. It remains unknown how these interventions could affect the psychosocial health of people with PD. This systematic review aims to explore how technological interventions affect people with PD psychosocial well-being and their perception towards these interventions.

Method: A systematic review was conducted using Cochrane Library®, Embase®, IEEE Xplore Digital Library®, PsycInfo®, PubMed® and Web of Science® databases following PRISMA guidelines. Two individual assessors conducted quality appraisals using the Mixed Method Appraisal Tool. Both quantitative narrative and qualitative thematic synthesis were adopted to analyse the extracted data.

Results: This review included 27 articles with 752 people with PD, with seven categories of technologies implemented in physical rehabilitation. Qualitative findings indicated the overarching theme of coping with technological intervention. Three themes were identified: user perception of intervention design and functional appropriateness, attitude shift and coping, and perceived benefits from technological interventions. Unsuccessful coping attempts and overcomplicated intervention designs induced negative emotions and affected the psychosocial well-being of people with PD.

Conclusions: Although most PD technological interventions focused on physical rehabilitation, people with PD reported a psychosocial gain in improved autonomy and reinforced social relationships during the intervention period. A better rewardability intervention design was considered more satisfying and could promote self-acceptance rather than stress-inducing. Interventions' technological complexity should match participants' expectations and technological literacy to facilitate the coping process with the intervention for people with PD. More research would be required to quantify the reported psychosocial gain and examine the technological literacy of people with PD when designing a more appropriate intervention regime.

KEYWORDS

digital health, Parkinson's disease, psychological well-being

1 | INTRODUCTION

The prevalence of Parkinson's disease (PD) has doubled to 6.1 million individuals worldwide in recent years.[1] People with PD not only experience a wide range of motor and non-motor symptoms but also comorbidity with psychiatric disorders.[2] They experience worsening psychosocial symptoms along their disease progression, which could lead to reduced social activities and social seclusion.[3] The self-reported loneliness of people with PD not only documented how it affected their depressive and sleep dysfunction symptoms' severity,[3,4] but also how it could induce self-stigmatisation, a persistent obstacle in PD history.[5,6]

The construct of psychosocial well-being often overlaps with the quality of life (QoL) construct, as the World Health Organization (WHO) defined the latter as a multi-dimensional construct that spanned across physical, psychological and social domains in how an individual would evaluate their position in life based on their goals, expectations and concerns.[7,8] Ambiguity often leads to varied definitions across the literature[9] when QoL is considered synonymous with subjective well-being[10] or subjective well-being with additional human needs.[11] Well-being involves psychological, social and emotional well-being domains, as established in the early 90s.[12–14] It includes an individual's optimal functioning on personal and societal levels, emphasising positive effects and avoiding undesirable emotions[15] and could serve as a protective factor for both motor and non-motor PD symptoms.[16]

Conventional non-pharmacological interventions supporting people with PD primarily focus on physical rehabilitation[17] to slow down PD progression or as symptom relief. With recent technological advancements, technology elements have been imbued within PD research for multidisciplinary telemedicine, wearable remote sensor monitoring, virtual reality (VR) gait training, exergaming in physical therapy or exoskeletons and robotic gait assistance for neurorehabilitation.[18] These elements could benefit the physical and cognitive functions among people with PD who are over 65 years old.[19] A meta-analysis revealed that the combination of Nintendo Wii and physiotherapy was more effective in promoting balance and QoL than traditional rehabilitation alone.[20] Other reviews identified different technological applications, such as wearable devices[21,22] and VR rehabilitation[23] that could also promote QoL and enhance physical attributes, such as stride length, gait and balance, without noticeable adverse effects.

Practice impact

The current review identified the potential psychosocial benefits of implementing technological physical rehabilitative interventions among PD populations. To support the adaptation of the interventions, professional supports and introductory sessions could be provided, and involving people with PD to co-design and develop the interventions could also be considered.

While the efficacy of technological intervention on the physical attributes of people with PD has been extensively researched in technological PD interventions, their other focal point, QoL, unavoidably overlaps with the physical domain, leading to an inconclusive efficacy within the psychosocial domain. In addition, with only one review that briefly examined the usability of VR training for stroke patients and people with PD,[24] how people with PD perceive these technological interventions and their efficacy within psychosocial well-being remains unknown in the literature. This review aimed to explore how technological interventions affect the psychosocial well-being of people with PD and how people with PD feel about these interventions.

2 | METHODS

2.1 | Literature search

Five databases were selected for the current review, namely Embase, MEDLINE, Web of Science, PsycInfo and CENTRAL from Cochrane Library with e-publications ahead of their printings. These databases were systematically searched in November 2021 using the Population, Intervention, Comparison and Outcome (PICO) search strategy. Additional Medical Subject Headings (MeSH) for PubMed were used. Search keywords and their synonyms were shown in Table 1.

2.2 | Screening and eligibility criteria

Articles were required to fit the following inclusion criteria in the current review: (1) have people with PD as their target population; (2) quantitative, qualitative or mixed-method study design; (3) primary research with technological intervention; (4) involves at least one method to explore user perception or psychosocial well-being of people with PD; (5) available full-text; (6) published between 2000 and 2022. The current review focused on research after 2000 since the technological PD research trend has been steadily growing since the late 2000s, and more were published after 2016.[25]

Articles were excluded if the following criteria were met: (1) involved technological intervention that solely acted as a platform for professionals to provide therapy; (2) involved in medication titration; (3) brain stimulation studies; (4) grey literature, such as conference papers, presentations or posters; (5) not written in English; and (6) study protocol.

2.3 | Data extraction

The title and abstract of each article were screened by the researcher, followed by a subsequent full-text screening. A manual search included three articles with embedded qualitative elements[26–28] from the key journal (*Sensor*) and Google Scholar since the user perception related to the psychosocial well-being domains of people with PD was not explicitly stated in the abstract. Data were extracted from the eligible literature for further analysis: (1) the basic information (first author, publishing year and location), (2) study design, (3) demographic data of participants, (4) details of intervention (dosage, duration and frequency), (5) related psychosocial domains and (6) result.

2.4 | Quality appraisal

A Mixed Method Appraisal Tool (MMAT version 2018)[29] was used to evaluate the quality of the selected paper. The MMAT is considered a unique and promising tool[30] that allows investigators to appraise quantitative, qualitative and mixed-method studies using the same appraisal tool. The MMAT recorded a moderately replicable to perfect consensus inter-rater reliability in its previous version. Two reviewers (L.T.K. and T.M,K) appraised the quality of each article independently based on the following procedures. Researchers completed the two screening

TABLE 1 Search keywords and strategy for databases and MeSH term for PubMed.

Categories	Keywords and synonyms
Population (P)	
Target population AND	aged [MeSH] OR aged[Title/Abstract] OR older adults[Title/Abstract] OR Senior[Title/Abstract] OR over age 60[Title/Abstract] OR over age 65[Title/Abstract] OR elderly[Title/Abstract] OR Young-old [Title/Abstract] OR old-old[Title/Abstract] OR long-term care[Title/Abstract] OR late life[Title/Abstract] OR old age[Title/Abstract] OR older people [Title/Abstract]
Condition	Parkinson Disease[MeSH] OR Parkinson Disease[Title/Abstract] OR parkinsonism [Title/Abstract] OR parkinson's disease[Title/Abstract] OR Parkinson[Title/Abstract] OR parkinsonian syndromes [Title/Abstract]
Intervention (I)	Wearable Electronic Devices [MeSH] OR wearable technology[Title/Abstract] OR wearable sensors[Title/Abstract] OR wearable[Title/Abstract] OR technology[Title/Abstract] OR technologies[Title/Abstract] OR technological intervention[Title/Abstract] OR Robotics[Title/Abstract] OR Robotic[Title/Abstract] OR Robots[Title/Abstract] OR Robot [Title/Abstract] OR social robots[Title/Abstract] OR surgical robots[Title/Abstract] OR assistive robots[Title/Abstract] OR Robotic system[Title/Abstract] OR Virtual reality[Title/Abstract] OR VR[Title/Abstract] OR Augmented reality[Title/Abstract] OR AR[Title/Abstract]
Outcome (O)	psychosocial well-being[Title/Abstract] OR psychosocial wellbeing[Title/Abstract] OR psychological well-being[Title/Abstract] OR psychological wellbeing[Title/Abstract] OR Subjective well-being[Title/Abstract] OR Subjective wellbeing[Title/Abstract] OR social well-being[Title/Abstract] OR social wellbeing[Title/Abstract] OR Life satisfaction[Title/Abstract] OR Happiness[Title/Abstract] OR Quality of life[Title/Abstract] OR social connectedness[Title/Abstract]
Combination	P AND I AND O

questions and then categorised articles into three main categories: qualitative, mixed-method and quantitative study design to appraise their respective criteria.[31]

Quality assessment identified a good fit between research designs and questions. The MMAT rating ranged from 25% to 100% (25% for each criterion passed). Twenty-five studies passed more than three assessment criteria. One study that scored 25% was a case study of a PD patient, hence the relatively high risk of bias. Eight studies utilised various qualitative research elements, from open-ended questions within the questionnaire to individual semi-structured interviews with purposeful sampling. Only three studies were classified as mixed-method or qualitative studies according to the standards of the MMAT. All inter-rater discrepancies were discussed until consensus was reached, and no paper was excluded due to low-quality ratings.[29]

2.5 | Data analysis

A mixed-method data synthesis approach was adopted to clarify how complex interventions could serve the PD population.[32] A thematic synthesis approach proposed by Thomas and Harden[33] was adopted to synthesise the appropriateness, acceptability and perceived effectiveness from extracted qualitative data and which aimed for conceptual saturation. The process started with inductive free coding on selected articles, without hierarchical structure, in order to understand the phenomenon without the constraint of the research objectives. Similar codes were then grouped for descriptive themes and revisited for consistency and interpretation. Finally, analytical themes were synthesised based on the research objectives that were established on the primary data, but also with a fresh perspective and understanding of the reviewed topic.[34]

With most of the included articles ($n=24$) having integrated QoL measurements, eight QoL and five different emotional well-being measurements were implemented to assess the subjective well-being domains of people with PD. Meta-analysis was not feasible for synthesising quantitative data due to the wide variety of implemented psychometric tools. Therefore, due to high heterogeneity, a narrative synthesis was adopted to analyse quantitative data.[35]

Ethics statement is not applicable for the current review as it only involves published journal articles.

3 | RESULTS

The systematic search of six databases retrieved 336 publications. A further 14 papers were included from the key journal (*Sensor*) and Google Scholar. After removing duplications, 265 studies' abstracts and titles were screened for eligibility. Forty-nine journals were successfully extracted for full-text review, and 27 studies fulfilled the inclusion criteria. The screening process is illustrated with the PRISMA flow chart[36] shown in Figure 1.

3.1 | Overview of reviewed articles

Twenty-seven studies across 13 countries published from 2010 to 2022 were selected for this review. There were 24 quantitative studies, two qualitative studies and one mixed-method study, with 12 being pilot studies or case reports. The majority of the reviewed articles were published from 2018 onward ($n=19$), and the interventions lasted an average of 6.4 weeks. About half of the studies were completed in Europe ($n=13$), while a few studies were done in North America ($n=5$), Asia ($n=5$) and South America ($n=4$). Different technologies were used in these studies: gaming applications ($n=8$); gait and balance training ($n=8$); wearable devices ($n=4$); mobile applications ($n=3$); telehealth system ($n=2$); metronome ($n=1$); social robot ($n=1$); and VR/AR technology ($n=11$). Extracted data are presented in Table 2.

The 27 studies involved 752 participants, with a sample size ranging from 1 to 110 and a mean participant count of 28. The mean age of people with PD ranged from 61 to 74.5 years old, and 50% of participants were male. Twenty-two studies adopted the Hoehn and Yahr staging scale[66] to assess the motor functioning of their participants.

3.2 | Thematic synthesis of qualitative data

'Coping with PD technological interventions' was identified as the overarching theme of the current review. Three psychosocial well-being-related themes were identified throughout the coping process: user perception of intervention design and functional appropriateness, attitude shift during coping attempts and the perceived psychosocial benefits from technological interventions.

3.3 | Users' perception of the intervention design and functional appropriateness

Functional appropriateness represents the ability of an intervention to execute its intended usage.[37] Before people with PD come into contact with the technological interventions, they will form an expectation of its intended use, design and duration. An appropriately designed intervention

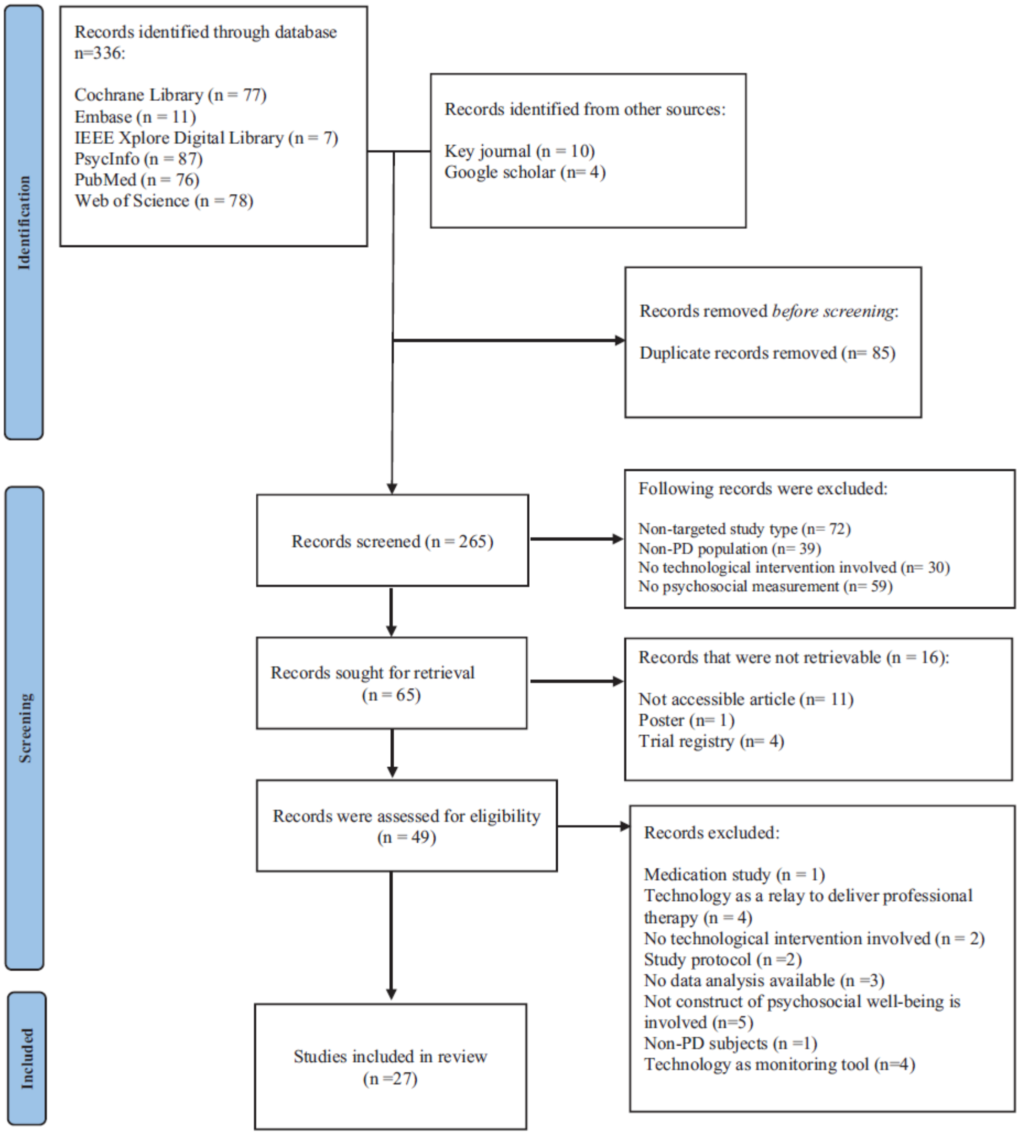

FIGURE 1 PRISMA flow chart.

could induce a sense of satisfaction or reduce negative emotions when using underachieved interventions.

Intervention design and module duration were of concern among people with PD. An overcomplicated design led to a sense of frustration, struggle and annoyance. People with PD stated that using a social robot for medication sorting was 'overkill' when a smartphone would be considered 'sufficient' for medicine management.[28] On the operational aspect, people with PD were confused by the feedback mechanism should it lack sufficient elaboration or provide contradictory audio and visual performance evaluations within an AI-assisted home exercise program.[38] On the contrary, if the intervention presented high reliability, high privacy and was easy to learn and operate, people with PD would be pleased with their overall experience and rate the intervention with a high satisfaction rating.[38]

Intervention duration was explored in exergaming studies by Campo-Prieto et al.[26] and van Beek et al.[39] where

TABLE 2 Psychosocial-related user perception and effectiveness of PD technological intervention.

Authors, years, place and setting	Study design	Sample	Intervention	Related well-being domains	Perception	Effectiveness
Wearable device						
Cochen De Cock et al.[48] France Setting: Community—Home based	Quantitative non-RCT with pre–post design	Total participants: 45 Mean age: 65 Male: 56% MDS-UPDRS-III: ≥1 and <3	Smartphone application and a wearable sensor (BeatWalk) for gait rehabilitation by modifying music tempo to induce spontaneous gait Duration: 4 weeks Frequency: 5 days/week	SubWB- Positive emotion -Measured at T0: Baseline T1: Week 4	More neutral responses were noted on user enjoyment	EQ-5D: QoL score significantly improved (mean score: 9.14 at T0; 7.86 at T1, $p=0.05$) LARS: and degree of apathy was significantly decreased (mean score: -7.3 at T0; -9.0 at T1. $p=0.02$) BDI and PAS: No significant differences ($p=$ 0.91 & 0.57 respectively)
Tunur et al.[42] USA Setting: Community	Quantitative non-RCT with pre–post design	Total participants: 7 Mean age: 69 Male: 43% H and Y stage: >3	AR dancing application (moving through glass) with google glass to improve mobility and balance Duration: 3 weeks Frequency: Daily	SubWB- Positive and negative emotion -Measured at T0: Baseline T1: Week 3	Participants would regard using the application as an enjoyable experience and identified positive effects from intervention Barriers identified as confusing instructions, difficult controls and uncomfortable to wear	PDQL and BDI: No significant differences (statistic not shown)
Hermanns et al.[40] USA Setting: Community	Quantitative descriptive with pre–post design	Total participants: 5 Mean age: 73 Male: 60% H and Y stage: 1–4	The combination of a physical activity tracker (Fitbit Alta HR) and a tablet (iPad) to view exercise videos and access online support group Duration: 12 weeks Frequency: Three times/week	SocWB- Social integration PWB- Positive relations with other -Measured at T0: Baseline T1: Week 12	Reported with negative evaluation, such as 'terrible', 'do not like it' or 'never very good at it' if people with Parkinson's disease fail to master the operation techniques Themes identified: *Encouragement* Messages shared were inspiring, courage and hope inducing among peers *Support* This theme was most prominent in regards on using a tracker and doing physical activity, thinking of a workaround themselves *Group participations* If all participants were more involved, it could enhance the likability of the intervention Frustration was noted if people with Parkinson's disease cannot participate in such social interaction	FACT-G: No significant difference identified in total score and the following subscales (Wilcoxon signed-rank tests. $p > 0.05$) Physical well-being Social/ Family well-being Emotional well-being Functional well-being
Volpe et al.[54] Canada Setting: Clinical	Quantitative RCT with pre–post and follow-up design	Total participants: 40 G1 Mean age: 66.5 G2 Mean age: 69.6 Male: 40% H and Y stage: ≥2	Wearable Proprioceptive Stabiliser (EquistasiH) with combination of physiotherapy for rehabilitation of postural instability Duration: 2 months Frequency of wearing the intervention: 1–3 weeks: 6 days/week 4–8 weeks: 5 days/week G1: active device G2: Inactive device	No WB-related subdomain scores were reported from PDQ-39 -Measured at T0: Baseline T1: Weeks 8–9 T2: Week 16		PDQ-39: G1 has a significant improvement on QoL score from T0–T1 (-48.8%, $p=0.004$) and improvement retained at T2 in G1 ($p=0.039$)

TABLE 2 (Continued)

Authors, years, place and setting	Study design	Sample	Intervention	Related well-being domains	Perception	Effectiveness
Mobile apps						
Kim et al.[49] Korea Setting: Community	Quantitative non-RCT with pre–post design	Total participants: 21 Mean age: 72.4 Male: 19% H and Y stage: 1–4	A mobile application to facilitate exercise, including stretching, aerobic, balance and coordination and vocal exercises Duration: 8 weeks Frequency: Duration set by therapist	SubWB- Satisfaction Negative emotion -Measured at T0: Baseline T1: Week 8	Positive responses on self-reported usability questionnaire, such as 'satisfaction', 'role expectation for rehabilitation' and 'adequate difficulty' were noted from participants	GDS—short form: Significant improvements ($p=0.04$) in depression PDQ-39: Significant improvements in total score ($p=0.02$), but non-significant change in emotional well-being domain ($p=0.93$)
Campo-Prieto et al.[26] Spain Setting: Community	Qualitative study	Total participants: 4 Mean age: 62.2 Male: 75% H and Y stage: 2	An immersive virtual environment accessed by HTC Vive ProTM for physical rehabilitation Duration: Two sessions in 2 weeks Frequency: Not specified	SubWB- Satisfaction	GEQ scores highlighted positive items Positive response from Satisfaction Ad Hoc Questionnaire includes the intervention being entertaining and fun, realistic motivating and relaxing One respondent replied that is their best experience to date while some other also claim the intervention period was too short	
Ginis et al.[55] Belgium Setting: Community	Quantitative RCT with pre–post and follow-up design	Total participants: 40 Mean age: Not specified Male: Not specified H and Y stage: 2–3	CuPiD system, a smartphone device with two built in applications, ABF-gait (audio biofeedback) and FOG-cue (instrumented cueing) G1: CuPiD training G2: Control training Duration: 6 weeks Frequency: Three times/week	EWB- Balance of positive and negative emotions -Measured at T0: Baseline T1: Week 6 T2: Week 10		SF-36: Reported with significant time by group effect ($F_{(2,108)}=1.58$, $p<0.05$, $\eta^2=0.06$) on physical health domain. QoL maintained in intervention group but noted deterioration for control among people with Parkinson's disease No significant difference on mental health subdomain score for both groups ($p=0.75$)
Gaming						
van Beek et al.[39] Switzerland Setting: Community	Quantitative descriptive with pre–post design	Total participants: 10 Mean age: 65.4 Male: 70% H and Y stages: 2–4	Exergaming (Leap Motion Controller) Dexterity Intervention with augmented VR Duration: 4 weeks Frequency: Two time/week	SubWB- Positive emotion -Measured at T0: Baseline T1: Week 4	Participants were noted with generally positive impressions and enjoyed the interactive elements of the intervention, but a high level of concentration was required because of intervention's difficult level The low sensitivity of the device was reported by people with Parkinson's disease and two of them wished the intervention to last longer	PDQ-39: Significant time × group interaction effect in total ($F_{(1,8)}=8.53$, $p=0.02$, $\eta^2=0.52$)score for poor dexterity participants, while no significant improvement could be found with good dexterity participants ($p=0.93$) No subjective well-being/ social subdomain scores of PDQ-39 was reported

(Continues)

TABLE 2 (Continued)

Authors, years, place and setting	Study design	Sample	Intervention	Related well-being domains	Perception	Effectiveness
Sánchez-Herrera-Baeza et al.[27] Spain Setting: Community	Mixed methods	Total participants: 6 Mean age: 74.5 Male: 83% H and Y stage: 1–4	Serious gaming (immersive VR) with leap motion to improve the function of upper extremities Duration: 6 weeks Frequency: Three times/week	PWB- 1. Personal growth 2. Positive relations with other 3. Autonomy SocWB- Social integration SubWB- 1. Negative emotions 2. Satisfaction	Psychological: Participant feels awkward, nervous, at fear and surprised during the adaptation period, but gradually becoming more comfortable participants believed the intervention is more of a mental challenge than a physical one, it improved their mental and cognitive state more than the targeted physical state Social: The intervention encouraged participants to share their experience among themselves, provide mutual support and facing the intervention together Barriers and facilitators: Overcoming challenges would give them a sense of satisfaction, become more competent on daily living and bring them closer to their family. But failed to do so would lead to sense of frustration Nervousness and tension were noted as they wish to do their best. Boredom experienced was originated from the monotonous intervention design	Participants showed a high degree of satisfaction with CSQ-8. (mean of 3.66/4)
Nuic et al.[41] France Setting: Not specified	Quantitative non-RCT with pre–post and follow-up design	Total participants: 10 (with FOG and/or postural instability) Mean age: 64.2 Male: 50% H and Y stage: ≥3	A customised videogame hosted in Kinect system, where participants would response to visual/auditory cues Duration: 9 weeks Frequency: Three sessions/week	SubWB- Positive emotion -Measured at T0: Baseline T1: 9th session T2: 18th session T3: Week 12	Seven out of 10 participants rated the game as amusing	EPN-31: Non-significant change ($\chi^2(5)=3.08$, $p=0.69$) identified in participants' negative affect, with their positive affects decreasing over time ($F_{(5,45)}=1.88$, p-0.11) PDQ-39SI: Non-significant change in QoL ($p=0.13$) No subjective well-being/ social subdomain scores of PDQ-39SI was reported
Alves et al.[47] Brazil Setting: Laboratories	Quantitative non-RCT with pre–post and follow-up design	Total participants: 27 Mean age: 61 Male: 93% H and Y stage: 1	Motor and cognitive games that hosted on Xbox Kinect and Nintendo Wii G1: Nintendo Wii™ G2: Xbox Kinect™ G3: Control group (no rehabilitation) Duration: 5 weeks Frequency: Two sessions/week	SubWB- Negative emotion -Measured at T0: Baseline T1: Week 1 T2: Week 5		BAI: G1 were noted with significantly decreased anxiety levels from T0-T1 ($F_{(2,19)}=3.76$, $p=0.045$) and sustained till follow-up ($p=0.031$) G2 failed to improve anxiety level ($p \geq 0.05$, power= 0.112) WHOQOL-OLD: No significant difference on QoL among all three groups ($p \geq 0.05$, power $= 0.102$)

TABLE 2 (Continued)

Authors, years, place and setting	Study design	Sample	Intervention	Related well-being domains	Perception	Effectiveness
Ferraz et al.[56] Brazil Setting: Community	Quantitative RCT with pre–post design	Total participants: 62 Mean age: 69 Male: 60% H and Y stage: 2–3	Exergaming with Xbox 360 Kinect, containing a series of mini games Duration: 8 weeks Frequency: Three sessions/week G1: Functional training G2: Bicycle exercise, G3: Exergaming Goal: Walking capacity	SubWB- Negative emotion -Measured at T0: Baseline T1: Week 8		GDS: No significant difference across all groups ($p > 0.05$) G1: EQ-5D: Significantly improved total score ($p = 0.014$) PDQ-39: No significant difference ($p = 0.069$) G3: EQ-5D: No significant difference ($p = 0.31$) PDQ-39: Significantly improved total score ($p = 0.004$) No subjective well-being/ social subdomain scores of PDQ-39 was reported
Pompeu et al.[57] Brazil Setting: Community	Quantitative non-RCT with pre–post design	Total participants: 7 Mean age: 72 Male: 86% H and Y Stage: 2–3	Using Kinect games for motor and cognitive training, includes elements of balancing and postural adjustments Duration: 6 weeks Frequency: Three sessions/week	No WB-related subdomain scores were reported from PDQ-39 -Measured at T0: Baseline T1: Week 6		PDQ-39: Improved total mean score (T0= 27.8 T1= 22.34)
Santos et al.[58] Brazil Setting: Community	Quantitative RCT with pre–post design	Total participants: 45 Mean age: 64.3 Male: 76% H and Y Stage: 1–3	Virtual rehabilitation (VR) with Nintendo Wii Duration: 8 weeks Frequency: Two sessions/week G1: Nintendo Wii G2: Conventional Exercises G3: Nintendo Wii + Conventional Exercises	No WB-related subdomain scores were reported from PDQ-39 -Measured at T0: Baseline T1: Week 8		PDQ-39: Significantly improved QoL among all groups ($p < 0.05$). But no significant between group difference ($p = 0.331$)
Yuan et al.[58] Taiwan Setting: Clinical	Quantitative RCT with pre–post and follow-up design	Total participants: 24 G1 Mean age: 67.8 G2 Mean age: 66.5 Male: 46% H and Y stages: 1–3	Customised interactive video game-based (IVGB) training (XaviX entertainment system) on balance Duration: 12 weeks Frequency: 3 days/week Gp1: 6-week intervention + 6-week control phase (no exercise) Gp2: 6-week control phase + 6-week intervention	SubWB- SF-36 -Measured at T0: Baseline T1: Week 6 T2: Week 12		SF-36: No significant difference observed between all subscales ($p > 0.02$) after adjusting alpha value to .0031 with Bonferroni method

(Continues)

TABLE 2 (Continued)

Authors, years, place and setting	Study design	Sample	Intervention	Related well-being domains	Perception	Effectiveness
Telehealth						
Chatto et al.[38] Georgia	Quantitative descriptive with pre–post design	Participant: 67 years old Female H and Y Stage: 2 Setting: Community	System for Technology-Augmented Rehabilitation and Training (START) incorporated with an AI assistant that would provide guidance and feedback to participants when they were doing home exercise program Duration: 4 months Frequency: N.A.	PWB- Self-acceptance SubWB- Satisfaction -Measured at T0: Baseline T1: Week 4 T2: Week 16	Noted with high satisfaction on intervention system and it is easy to learn, operate and timing saving nature, praising its reliability and privacy Reported being pleased with her overall experience but would be discouraged from her perceived poor performance and being confused with the feedback mechanism during the semi-structured interview	PDQ-39: Scores decreased slightly from 30 to 25 (T1 and T2), indicating an improvement in her overall quality of life from T0 No subjective well-being/ social subdomain scores of PDQ-39 was reported
Isernia et al.[43] Italy Setting: Community	Quantitative non-RCT with pre–post and follow-up design	Total participants: 62 Mean age: 66.8 Male: 54.8 H and Y stage: = <2	The Human Empowerment Aging and Disability (HEAD) tele-rehab program (VR) contain videos to improve balance, strength of upper and lower extremities and cognitive aspect, such as memory and dual-task capabilities Duration (clinic): 1 month Frequency (clinic): three times/ week Duration (home): 1 months Frequency (home): 5 times/week G1: HEAD Program G2: Usual Care	SubWB- Positive and negative emotions -Measured at T0: Baseline T1: Week 4 (end of ClinicHead) T2: Week 16 (end of HomeHead) T3: Week 28		SF-12: Significantly improved mental health subscale from T0 to T1 (t = 2.18, df = 29, $p = 0.029$) PANAS: Significant improvement on positive affect from T0 to T1 (t = 2.35, df = 30, $p = 0.019$)
Training						
Brandin-De la Cruz et al.[60] Spain	Quantitative non-RCT with pre–post design	Total participants: 12 Mean age: 68.8 Male: 58% H and Y stage: Not specified Setting: Clinical—inpatient	Immersive VR and antigravity treadmill training for gait rehabilitation Duration: 4 weeks Frequency: Three sessions/week	SubWB-Satisfaction SF-36 -Measured at T0: Baseline T1: Week 4	7/9 participants reported being 'very satisfied' with the training on a 5-point Likert scale, while the others rated the intervention as 'quite satisfied'	SF-36: Significant differences associated with small-medium effect sizes on physical functioning ($p = 0.027$, d = 0.4), role physical ($p = 0.049$, d = 0.6), and bodily pain ($p = 0.018$, d = 0.5). But no significant change in mental health ($p = 0.212$, d = 0.4) and social functioning ($p = 0.263$, d = 0.4) subscale

TABLE 2 (Continued)

Authors, years, place and setting	Study design	Sample	Intervention	Related well-being domains	Perception	Effectiveness
Capecci et al.[61] Italy	Quantitative RCT with pre–post design	Total participants: 110 Mean age: 67.6 Male: 45% H and Y stage: ≥2 Setting: Community	Robot-assisted gait training (G-EO system) for gait rehabilitation Duration: 4 weeks Frequency: 5 days/week G1: Robot-assisted gait training G2: Treadmill training	No WB-related subdomain scores were reported from PDQ-39 -Measured at T0: Baseline T1: Week 4		PDQ-39: Significant time effect (F = 41.9, $p < 0.0001$), but non-significant group by time effect (F = 1.6, $p = 0.2$)
Lo et al.[45] USA Setting: Community	Quantitative non-RCT with pre–post design	Total participants: 4 with FOG Mean age: 63.3 Male: 75% H and Y stage: Not specified	Robot-assisted treadmill (exoskeleton) training to reduce FOG episodes and improving gait Duration: 5 weeks Frequency: Two sessions/week	SubWB SocWB -Measured at T0: Baseline T1: Week 5		PDQ-39: No meaningful changes in Communication subscale Meaningful effect size changes on Emotional well-being (d = -0.56) and Social Support (d = -0.52) domains. These improvements were described as 'unexpected' by authors
Paker et al.[62] Turkey Setting: Community	Quantitative non-RCT with pre–post and follow-up design	Total participants: 12 Mean age: 65.5 Male: 50% H and Y stage: 1–3	Robotic treadmill training on the functional mobility and walking capacity in the ambulatory participants Duration: 5 weeks Frequency: Two session/week	No WB-related subdomain scores were reported from PDQ-39 -Measured at T0: Baseline T1: Week 5 T2: Week 12		PDQ: Total score was significantly improved at T1 ($p = 0.03$), while the improvement did not sustain to week T2 ($p = 0.0117$) HADS: Only measured at baseline
Wang et al.[63] China Setting: Clinical—inpatient	Quantitative non-RCT with pre–post and follow-up design	Total participants: 52 G1 Mean age: 60.1 G2: Mean age: 62 Male: 56% H and Y stage: 1–3	C-Mill (augmented reality treadmill) gait training Goal: To improves walking adaptability Duration: 1 week Frequency: Daily G1: Postural instability/gait difficulty group G2: Non postural instability/gait difficulty group	No WB-related subdomain scores were reported from PDQL -Measured at T0: Baseline T1: Week 1 T2: Week 12		PDQL: Only G2 reported with significant improvement ($p = 0.021$), no between group difference could be identified ($p = 0.378$)
Yang et al.[64] Taiwan Setting: Community—Home based	Quantitative RCT with pre–post and follow-up design	Total participants: 23 G1 Mean age: 72.5 G2 Mean age: 75.4 Male: 74% H and Y stages: 2–3	VR balance training system Duration: 6 weeks Frequency: Two session/week G1: VR balance training G2: Conventional training	No WB-related subdomain scores were reported from PDQ-39 -Measured at T0: Baseline T1: Week 6 T2: Week 8		PDQ-39: Significant improvement on total score for both groups and retained till T2 (T1 < T0, $p = 0.047$; T2 < T0, $p = 0.022$) No significant group by time effect could be identified ($p = 0.806$).

(Continues)

TABLE 2 (Continued)

Authors, years, place and setting	Study design	Sample	Intervention	Related well-being domains	Perception	Effectiveness
Pilleri et al.[65] Italy Setting: Laboratory	Quantitative non-RCT with pre–post design	Total participants: 20 Median age: 64.5 Male: Not specified H and Y stage: 2.5–4	An over-ground motor driven footboards that would move at a stable speed, and can be adjusted according to participants' ability Duration: 3 weeks Frequency: 5 days/week	No WB-related subdomain scores were reported from PDQ-8 -Measured at T0: Baseline T1: Week 3		PDQ-8: Significantly improved total score ($p=0.033$)
Pazzaglia et al.[44] Italy Setting: Community	Quantitative RCT with pre–post study design	Total participants: 51 Mean age: 71 Male: 69% H and Y stage: Not specified	VR rehabilitation, with Each VR session consisted of multiple exercises Duration: 6 weeks Frequency: Three sessions/week G1: Virtual reality program G2: Conventional Program	SubWB- Balance of positive and negative emotions -Measured at T0: Baseline T1: Week 6		SF-36: Significant improvement on the mental composite score in G1 ($p=0.037$)
Robot						
Wilson et al.[28] USA	Qualitative study	Total participants: 10 Mean age: Not specified Male: Not specified Stage: Early to moderate Setting: Not specified	Social robot with medication sorting abilities Duration: One time Frequency: N.A.	SubWB- Negative emotion	Generally reported with negative reactions; for example, of frustration, confusion and struggle when operating the robot Considered using social robot for medication sorting is an overkill Annoyance was noted from the lack of assistance provided	
Other						
Elston et al.[46] UK	Quantitative RCT with cross-over and 'wash-out' period design	Total participants: 42 Mean age: 71.5 Male: 67% H and Y stage: 2–4 Setting: Community	Portable electronic metronome as acoustic cueing to improve mobility and ADL Duration: 10 weeks Frequency: N.A. G1: Early group G2: Late group	SubWB -Measured at T0: Baseline T1: Week 4 T2: Week 10 T3: Week 14		SF-36: Subjective meaningful change identified in role limitation (emotion) but non-significant group by time interaction on all subdomains ($p>0.25$) PDQ-39: Non-significant group by time interaction across all psychosocial domains ($p>0.1$) and reduced QOL in the emotion domain (score increased by 0.83)

Abbreviations: BAI, Beck Anxiety Inventory; BDI, Depression Inventory; CSQ-8, Client Satisfaction Questionnaire; EPN-31, Positive and Negative Emotionality Questionnaire; EQ-5D, EuroQol-5 Dimension; FACT-G, functional assessment of cancer therapy—general; GDS, Geriatric Depression Scale; GEQ, Game Experience Questionnaire (postgame module); H&Y, Hoehn & Yahr; HADS, Hospital Anxiety and Depression Scale; LARS, Lille Apathy Rating Scale; PANAS, positive affect and negative affect schedule; PAS, Parkinson Anxiety Scale; PDQ, Parkinson's Disease Questionnaire; PDQL, Parkinson's Disease Quality of Life Questionnaire; PWB, psychological well-being; SF, Short Form Health Survey; SocWB, social well-being; SubWB, subjective well-being; WHOQOLOLD, World Health Organization Quality of Life for Older Persons.

intervention duration was set between 10 and 30 min per session. Ten out of 13 participants were satisfied with the session duration, and the remaining indicated a preference for an extended session, showing that participants appreciated appropriately designed interventions.

3.4 | Attitude shift during coping attempts

3.4.1 | Initial emotional responses

Undesirable emotions were shown in people with PD upon the initial contact with the technological interventions when they failed to achieve their intended use. Poor performance evaluation in task-based interventions was reported to cause people with PD nervousness, tension and discouragement, as participants wanted to excel in the intervention study or achieve a higher score.[27,38] In addition, frustration was reported in the activity tracking study by Hermann et al.[40] if participants failed to engage in online social interaction via the embedded online support group. Awkwardness, fear, boredom and frustration were also reported from people with PD when they tried a series of VR gaming interventions.[27] In contrast, pleasant feelings were also identified, where people with PD found interventions amusing and enjoyable in gaming.[39,41] and AR dancing.[42]

3.4.2 | Barriers that were encountered

Technological difficulties encountered by people with PD were focused on system operation, levels of difficulties and cognitive demand. People with PD found it challenging to navigate the intervention system if the system had poor hardware sensitivity or confusing instructions, and feedback was given. Technical support was required from fellow participants and researchers for possible workarounds/guidance.[28,38–40,42]

In addition, people with PD regarded VR gaming interventions as more cognitively demanding than the intended physical challenges and were more of a mental challenge than physical rehabilitation.[27] Similar mental challenges were observed in the exergaming intervention, where participants claimed the intervention required a high concentration level due to its difficulty setting.[39]

3.4.3 | Attitude shift

If people with PD successfully overcame the aforementioned challenges and transitioned through the initial adaptation period, the reported nervousness and awkward feelings gradually subsided as they became comfortable and experienced in managing the intervention.[27] Similar scenarios were also found in the activity tracking study,[40] where people with PD initially evaluated the intervention negatively when they failed to cope with the intervention (through iPad) but had no problems working through it once they figured it out.

3.5 | Perceived psychosocial benefits from technological interventions

3.5.1 | Social support

Improved peer interactions and relationships were identified from the reviewed articles. People with PD experienced a sense of satisfaction and were closer to their family after overcoming the previously mentioned technological and cognitive challenges.[27] The activity tracking study by Hermann et al. encouraged people with PD to share their experience of performing physical activities with fellow participants in their virtual support group.[40] Prosocial behaviours were expressed through peer encouragement and support. These peer interactions were described as inspiring, hope-inducing and supportive.

During the VR gaming study, mutual support among participants was observed by the sharing of their experiences of overcoming challenges and comparing scores with each other.[27] Such interactive features between the exergaming intervention and people with PD were highly valued.[39]

3.5.2 | Autonomy

From the VR gaming intervention,[27] people with PD asserted that the intervention had more effect on mental and cognitive state than physical attributes, and it promoted their autonomy by helping them become more competent in daily living.

3.6 | Effectiveness on improving psychosocial well-being

3.6.1 | Emotional well-being

The positive and negative emotional feelings of people with PD were the most quantitatively measured psychosocial domain among the reviewed articles and were often embedded into QoL scales. Among the 24 studies measuring QoL, 14 utilised the PD Questionnaire (PDQ; $n = 14$), and six adopted the Short Form-12 and 36 (SF-12 and SF-36). While only nine (four RCTs; four non-RCTs; one descriptive study) reported the psychosocial subscale of the QoL scale, three (one RCT and two non-RCTs) documented the following significant subdomain changes (see Table 3).

The VR rehabilitation conducted by Isernia et al.[43] and Pazzaglia et al.[44] significantly improved mental composite scores in the SF-12 and SF-36, respectively. It was suggested that VR rehabilitation could be integrated with telerehabilitation and retain its beneficial effect (although the interventions usually had a small effect size) until follow-up[43] and was considered more effective than the conventional regime[44] In addition to the significant QoL improvement recorded by Isernia et al.,[43] they also identified a significant correlation between participants' positive mood and intervention adherence and a small effect size on the Positive Affect and Negative Affect Scale.

Other meaningful changes in QoL were documented in treadmill training,[45] where a small-to-moderate effect size (−.49 to −.56) was reported across the PDQ-39's emotional and social subdomains among four participants. The authors further noted that such psychosocial subdomain improvements were unexpected. Although there was no significant difference between the SF-36 and PDQ-39 scores in a metronome RCT study,[46] the reported subjective clinically improved SF-36 emotion (role limitation) domain suggested possible mental health benefits that warrant a larger scale RCT for confirmation.

Among the other eight reviewed studies measuring depressive and anxiety symptoms in people with PD, four studies recorded significant mood improvements after using the interventions. A significant reduction of anxiety symptoms was observed in the motor and cognitive gaming intervention, and such effect was sustained for 1 month after the five-week intervention.[47] This effect was only observed within the Nintendo Wii but not in the Xbox Kinect group. Another wearable intervention in a gait rehabilitation study, BeatWalk, significantly reduced the apathy level (via the Lille Apathy Rating Scale) of people with PD, but not Beck's Depression Inventory nor the Parkinson Anxiety Scale score.[48] Finally, a pilot mhealth exercise study identified a reduction in depressive symptoms in the Geriatric Depression Scale—short form.[49]

3.6.2 | Social well-being

Social well-being improvements were also highlighted in the reviewed qualitative data. Two studies explored the perks of encouraged social interaction among people with PD.[27,40] The integration of social interaction induced a sense of unity and mutual support among people with PD and their families, through face-to-face sharing[27] or via online support groups.[40]

4 | DISCUSSION

Almost all the reviewed studies (26 out of 27) focused on physical rehabilitation, while psychosocial well-being was not set as the focus of the investigation. Developing and implementing interventions that aim to improve the psychosocial well-being of people with PD has not yet been fully explored, but both quantitative and qualitative data showed promising results of using technological intervention to promote psychosocial well-being among people with PD, even if they were focused on physical rehabilitation.

4.1 | Unexpected effect on psychosocial well-being

Quantitatively speaking, there was limited data about psychosocial well-being among people with PD. Although the current review was able to identify potential therapeutic effects from technological interventions, they predominately targeted physical rehabilitation and measured emotional well-being within QoL scales or a few other psychometric scales on emotions. There is a lack of quantitative evidence on the effect of these technological interventions on the psychological and social well-being domains of people with PD. Therefore, no conclusive statement could be drawn on their therapeutic impact on the psychosocial well-being of people with PD. Future psychosocial research among the PD population could capitalise on this research gap in designing psychosocial-oriented technological PD interventions and address this lack of unified psychosocial measurements by adopting psychosocial-orientated scales, such as the Mental Health Continuum Short Form,[14] to explore and quantify their interventions' psychosocial effectiveness comprehensively.

Secondly, the reviewed qualitative data complemented the existing quantitative psychosocial improvements by capturing the attitude shift of people with PD during the adaptation period. In addition, the unexpected psychosocial improvements in this review echoed another systematic review, which suggested multidisciplinary physical rehabilitation therapy targeting mobility and activities of daily living can significantly reduce depressive and anxiety symptoms among people with PD.[2]

This social well-being promoting nature also aligns with a recent review reporting interactive social elements in technological interventions that could benefit community-dwelling older adults.[67] At the same time, more evidence is required to compare the effectiveness of online and offline communication modes on social well-being among people with PD.

TABLE 3 Psychosocial improvements identified from reviewed articles.

Reviewed articles	Study type	Scales adopted	Effectiveness
Wearable device			
Cochen De Cock et al.[48]	Quantitative non-randomised	1. EQ5-D 2. LARS	1. Overall QoL score significantly improved 2. Degree of apathy was significantly decreased
Volpe et al.[54]	Quantitative RCT	PDQ-39:	Significant improvement on overall QoL score
Mobile apps			
Kim et al.[49]	Quantitative non-randomised	1. GDS—short form 2. PDQ-39	1. Significantly reduced in depressive symptoms 2. Significantly improved total score, but not emotional well-being subdomain
Ginis et al.[55]	Quantitative RCT	SF-36	Significant time by group effect on physical health domain, but no significant difference on mental health subdomain
Gaming			
van Beek et al.[39]	Quantitative descriptive	PDQ-39	Significant time × group interaction effect in total score for poor dexterity participants
Alves et al.[47]	Quantitative non-randomised	1. BAI	1. Significantly reduced anxiety levels in Nintendo Wii™ group till follow-up
Ferraz et al.[56]	Quantitative RCT	1. EQ-5D 2. PDQ-39	Functional training group: 1. Significantly improved total score 2. Non-significant changes Exergaming group: 1. Non-significant changes 2. Significantly improved total score
Pompeu et al.[57]	Quantitative non-randomised	PDQ-39	Improved total score
Santos et al.[58]	Quantitative RCT	PDQ-39	Significantly improved QOL across all groups
Telehealth			
Chatto et al.[38]	Quantitative descriptive	PDQ-39	Improved QOL score on one participant
Isernia et al.[43]	Quantitative non-randomised	1. SF-12 2. PANAS	1. Significantly improved mental health subscale 2. Significantly improved positive affect
Training			
Brandín-De la Cruz et al.[60]	Quantitative non-randomised	SF-36	Significant differences documented in physical domains, but not mental health subscale
Capecci et al.[61]	Quantitative RCT	PDQ-39	Total score decreased by 15%
Lo et al.[45]	Quantitative non-randomised	PDQ-39	Meaningful effect size changes on Emotional well-being and Social Support domains, but not in Communication subscale
Paker et al.[62]	Quantitative non-randomised	PDQ	Significantly improved overall score
Wang et al.[63]	Quantitative non-randomised	PDQL	Only non-postural instability/ gait difficulty group reported with significant improvement
Yang et al.[64]	Quantitative RCT	PDQ-39	Significantly improved total score for both groups with pairwise comparisons
Pilleri et al.[65]	Quantitative non-randomised	PDQ-8	Significantly improved total score
Pazzaglia et al.[44]	Quantitative RCT	SF-36	Significantly improved mental composite score
Metronome			
Elston et al.[46]	Quantitative RCT	1. SF-36	1. Subjective meaningful change in role limitation (emotion)

Abbreviations: BAI, Beck Anxiety Inventory; EQ-5D, EuroQol-5 Dimension; GDS, Geriatric Depression Scale; LARS, Lille Apathy Rating Scale; PANAS, positive affect and negative affect schedule; PDQ, Parkinson's Disease Questionnaire; PDQL, Parkinson's Disease Quality of Life Questionnaire; SF, Short Form Health Survey.

In addition, a VR rehabilitation study[27] highlighted the psychological well-being gained from its participants. Participants reported their autonomy would be promoted alongside improved performance in activities of daily living, and the intervention would improve their mental and cognitive state more than the intended physical attributes, echoing the extracted quantitative data. The authors from the robot-assisted treadmill training described the PDQ-39 mental and social subscale improvements as unexpected.[45] However, without reporting the applied psychosocial-related QoL subdomains, previous studies missed the opportunity to quantify the reported psychosocial gain from technological interventions, making it impossible to make a conclusive statement on the effectiveness of these interventions on psychosocial well-being.

4.2 | Factors affecting the psychosocial well-being of people with Parkinson's disease

4.2.1 | Coping with intervention

The coping process with technological intervention has been identified as the psychosocial well-being determining factor. A recent systematic review conducted by Sevcenko and Lindgren[24] briefly mentioned that an unsuccessful implementation of VR physical training among stroke and PD older adults could have originated from participants' negative preconceptions. This review resonated with their findings and further delineates that undesirable emotions developed during the adaptation period could transition into a more positive side upon successful coping. Whether an intervention could be successfully implemented should not be solely based on the preconception but on participants' technological literacy, available technical support and intervention design.

4.2.2 | Technological literacy

Despite the rapid technological advancement in PD research, the lack of intervention on the technological illiteracy of people with PD has been stressed among scholars[50] and stays true among selected articles. Technological literacy has been described as the ability of an individual to operate, manage, assess and make sense of a given technology and is categorised into awareness, praxis (training and practices) and phronesis (technological competence).[51] An individual has to be aware of and familiar with the use and functionalities of the technology to become competent.[52]

Participants who experienced technical difficulties in the reviewed articles displayed a lack of computing knowledge and the necessary skills to operate the interventions. They remained at the first two levels of technological literacy (awareness and praxis), requiring technical support from others due to not being aware of the latest technological trends or not being familiarised with the system navigation. For example, people with PD who reportedly grew up using punch cards instead of computers and were unfamiliar with the implemented smart tablet[40] or had difficulties comprehending the instructions for operating social robots and Google Glass.[28,42] Negative psychosocial influences, such as frustration, struggle and annoyance, would persist without appropriate intervention.[28]

Some people with PD were noted to exhibit phronesis levels of technological literacy in some rare incidents and took the advisory role of guiding their peers in need.[40] Technology-literate individuals were believed to be more comfortable and objective with technology, resulting in fewer negative emotions when interacting with technological products.[51] Noteworthy, such actions can simultaneously facilitate peer support and promote social well-being among people with PD.

The gap between the technological literacy of people with PD and the technological demand of the implemented intervention could contribute to a prolonged adaptation, undesirable emotions and a reduced possibility of people with PD mastering the intervention. Future research should therefore provide sufficient technical support from research staff, or adopt 'training the trainer' to promote peer support among people with PD and enhance the capability and technological literacy among people with PD in navigating the intervention.

4.2.3 | Intervention rewardability and design

The complexity and rewardability of the intervention would also affect the psychological well-being of people with PD. Good intervention performance would induce a sense of achievement and encourage self-acceptance, and the improved activities of daily living could also grant them a sense of autonomy.[27,38] Some task-based interventions were considered by people with PD to be stress-inducing, resulting in undesirable emotions or discouragement due to poor performance.[27,38]

The extracted user reviews also generated insight into designing a more PD-friendly intervention. People with PD considered having professional supervision, setting introductory sessions,[27,39] and a more progressive module duration according to the ability of people with PD[42] should help reduce the adaptation period. By gradually increasing the module duration as the subject progresses, researchers can create a task-based intervention with fitting difficulties, maintaining an appropriate intervention difficulty. Interventions should be challenging enough to achieve the intended physical rehabilitation goal and induce a sense of achievement instead of discouraging people with PD. Future research could take in recommendations from people with PD, or consider adopting the co-design approach by involving people with PD in the intervention development, improving the existing practices, maximising the intended therapeutic outcomes,[53] and empowering the involved people with PD.

4.3 | Limitations

4.3.1 | Quality of selected studies

Due to the heterogeneity of the reviewed papers, the current review adopted a narrative synthesis but not a meta-analysis approach. Therefore, no effect size can be calculated. In addition, due to the relatively small sample size (44% of the reviewed articles were pilot studies, $n=12$) and limited amount of the data presented, there is a possibility that the current review cannot fully capture the psychosocial effect of the selected technological interventions.

Although qualitative data were extracted and synthesised into reported themes, the level of evidence was of low quality. Thus, a rigorous qualitative methodological approach was not adopted and such studies cannot be classified as mixed-method design by the standards of the MMAT, leading to reduced trustworthiness for qualitative data. More sophisticated qualitative methodology and empirical studies (e.g. large-scale RCT) would be required to examine the effectiveness of PD technological intervention.

5 | CONCLUSIONS

This systematic review identified the rising trend in exploring how technological intervention could interfere with the psychological well-being of people with PD, summarised the users' perception of using technological interventions, and examined the potential effects of these interventions on the psychosocial well-being of people with PD.

We identified *coping with the technological intervention* as an overarching theme, where the user perception of intervention design and functional appropriateness, attitude shift during coping attempts and the perceived psychosocial benefits from technological interventions were linked to the psychosocial well-being of people with PD. Technological interventions specific to PD have the capability of enhancing the psychosocial well-being of people with PD and are worth further investigation. The technological literacy of people with PD, and intervention design could be considered before implementing technological interventions in order to shorten the adaptation period and reduce undesirable emotions among people with PD.

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CONFLICT OF INTEREST STATEMENT

No conflicts of interest declared.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Appendix 2. Information sheet and consent form

Information sheet for interviews

<u>資料文件</u>

透過聲控虛擬助理來提高柏金遜症人士的心理健康— 一項隨機對照試驗

邀請你參加由香港理工大學護理學院梁綺雯教授主持的上述項目。該項目已經獲得香港理工大學人類道德倫理小組委員會 (HSESC)(或其代表) 的批准 (HSESC 參考編號：HSEARS20221107005)。 該項目的目的是評估聲控虛擬助理對患有柏金遜症人士的心理影響。

您將被邀請參加一個需時 120 分鐘的訪談，以協助設計聲控虛擬助理用戶指南以及所需訓練內容。主持人將提出一系列問題有關閣下對日常科技應用，應如何使用及親身體驗聲控虛擬，誠邀您根據個人經驗和觀點回答問題。在訪談中，我們將進行語音錄製，但不會記錄你的個人識別資料 (例如香港身份證號)，你還將被分配一個參考編號（例如 A 參與者，B 參與者等）以隱藏你的身份。只有經過培訓的研究團隊才能使用這些語音檔案。

訪談不應導致任何不適，但如果你在培訓期間感到不舒服，亦有權在此過程之前或過程中退出研究，而不會受到任何形式的處罰。每位參與者將獲得 HK$ 100 現金券作為謝禮，以彌補閣下的交通費用以及訪談所需時間。

您在項目中提供的信息是研究數據。可以識別出您的任何研究數據稱為個人數據（例如，您的姓名或手機號碼)。個人數據不包括已刪除身份的數據（匿名數據)。我們將在研究中盡可能減少對個人數據的使用。研究人員，他的團隊和合作者將可以使用個人數據和研究數據研究。香港理工大學的負責成員可以被授予監視和/或審核研究的權限。

與您有關的所有信息將被保密。所有信息都將使用密碼保存在安全的系統中，並且只有劉天倫先生和相關人士可以取用。收集到的信息將保存 7 年，直到 2029 年。香港理工大學採取了合理的預防措施，以防止丟失，盜用，未經授權的訪問或破壞您提供的信息。

如果你對本研究有任何其他疑問，可聯絡劉天倫先生(共同研究員) (電子郵件：terence.lau@)。

如果您對本研究的進行有任何投訴，可以書面形式與香港理工大學人類倫理小組委員會秘書莫小姐 (電子郵件：cherrie.mok@)聯繫，以明確說明負責人、部門、這項研究以及 HSESC 參考編號。

感謝你有興趣參與這項研究。

香港理工大學護理學院
教授 梁綺雯博士
首席研究員

Information sheet for pilot RCT

資料文件

透過聲控虛擬助理來提高柏金遜症人士的心理健康— 一項隨機對照試驗

邀請你參加由香港理工大學護理學院梁綺雯教授主持的上述項目。該項目已經獲得香港理工大學人類道德倫理小組委員會 (HSESC)(或其代表) 的批准 (HSESC 參考編號：HSEARS20221107005)。該項目的目的是評估聲控虛擬助理對患有柏金遜症人士的心理影響。

於第一期的研究中， 您將被邀請參加下列兩個項目:

一個需時 120 分鐘的訪談，以協助設計聲控虛擬助理用戶指南以及所需訓練內容。主持人將提出一系列問題有關閣下對日常科技應用，應如何使用及親身體驗聲控虛擬，誠邀您根據個人經驗和觀點回答問題。在訪談中，我們將進行語音錄製，但不會記錄你的個人識別資料 (例如香港身份證號)，你還將被分配一個參考編號（例如 A 參與者，B 參與者等）以隱藏你的身份。只有經過培訓的研究團隊才能使用這些語音檔案。

並在需時約 60 分鐘的過程中評價一系列與研究相關的內容及量表的適切性，以協助完善量表設計。您只需根據個人經驗和觀點回答問題即可。我們將不會記錄你的個人識別資料 (例如香港身份證號)，你還將被分配一個參考編號（例如 A 參與者，B 參與者等）以隱藏你的身份。只有經過培訓的研究團隊才能使用這些文件。

於第二期的研究中，你將被隨機分為干預組 (IG) 或對照組 (CG)。如果你在干預組，將被邀請參加為期 8 週的聲控虛擬助理研究，研究人員會於每週進行一次技術支援。如果你在對照組，你只需按照日常生活即可。每名參加者亦會在研究開展前、後(第八週)、及第十二週進行一次問卷調查。

於為時 45 分鐘的問卷調查中，我們將詢問你一系列有關心理一致感及心理健康的一系列問題。但不會記錄你的個人識別資料 (例如香港身份證號)。你還將被分配一個參考編號以隱藏你的身份。

使用控虛擬助理或進行問卷調查不應導致任何不適，但如果你在培訓期間感到不舒服，亦有權在此過程之前或過程中退出研究，而不會受到任何形式的處罰。每位參與者將獲得合共 HK$250 現金券（於完成第一及第三次問卷調查時分批發放）作為謝禮，以彌補閣下的交通費用以及研究所需時間。

您在項目中提供的信息是研究數據。可以識別出您的任何研究數據稱為個人數據（例如，您的姓名或手機號碼）。個人數據不包括已刪除身份的數據（匿名數據）。我們將在研究中盡可能減少對個人數據的使用。研究人員，他的團隊和合作者將可以使用個人數據和研究數據研究。香港理工大學的負責成員可以被授予監視和/或審核研究的權限。

與您有關的所有信息將被保密。所有信息都將使用密碼保存在安全的系統中，並且只有劉天倫先生和相關人士可以取用。收集到的信息將保存 7 年，直到 2029 年。香港理工大學採取了合理的預防措施，以防止丟失，盜用，未經授權的訪問或破壞您提供的信息。

如果你對本研究有任何其他疑問，可聯絡劉天倫先生(共同研究員)　(電子郵件：terence.lau@　　　　　)。

如果您對本研究的進行有任何投訴，可以書面形式與香港理工大學人類倫理小組委員會秘書莫小姐 (電子郵件：cherrie.mok@　　　　　)聯繫，以明確說明負責人、部門、這項研究以及 HSESC 參考編號。

感謝你有興趣參與這項研究。

香港理工大學護理學院

教授 梁綺雯博士
首席研究員

Consent form

Reference no. _________

參與研究同意書

透過聲控虛擬助理來提高柏金遜症人士的心理健康—
一項隨機對照試驗

(HSESC 參考編號：HSEARS20221107005)

本人同意參與由香港理工大學護理學院梁綺雯教授開展的第一期研究。

本人知悉此研究所得的資料可能被用作日後的研究及發表，但本人的私隱權利將得以保留，即本人的個人資料不會被公開。

研究人員已向本人清楚解釋列在所附資料文件上的研究程序，本人明瞭當中涉及的利益及風險；本人自願參與研究項目。

本人知悉本人有權就程序的任何部分提出疑問，並有權隨時退出而不受任何懲處。

參加者姓名 ______________________________

參加者簽名 ______________________________

研究員姓名 Prof. Angela Y.M. Leung

研究員簽名 ______________________________

日期 ______________________________

Appendix 3. Questionnaire (Cantonese version)

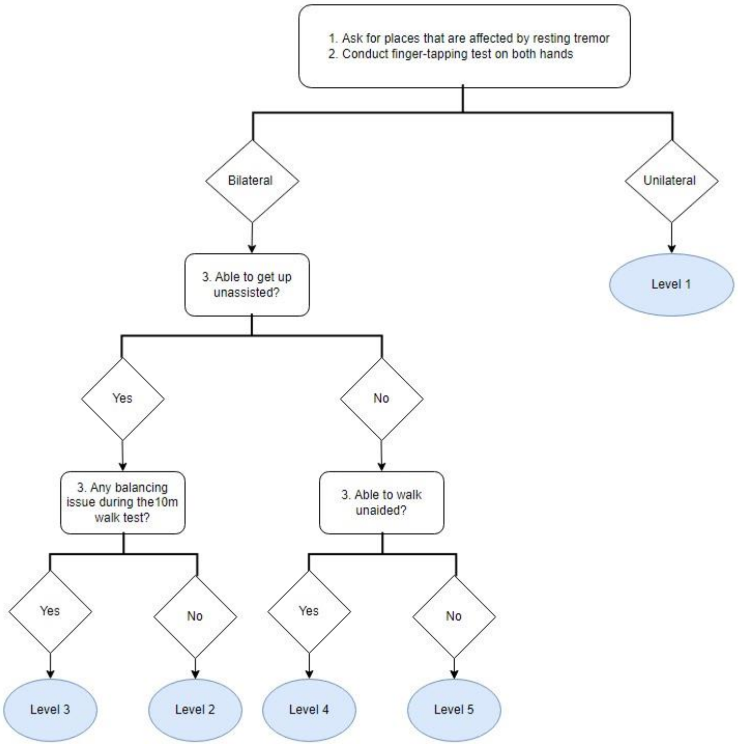
Screening logistic (for assessor use)

1. **評估員**
2. **參加者編號**
    a. 如參加者不能閱讀或利用廣東話溝通，就不符合所有研究條件，篩查結束
    b. 如只能閱讀中文字或沒有 wifi 的參加者不能參加主研究 (pilot RCT)
    c. 只要居住在社區便可參加主研究
    d. 現正使用智能喇叭的參加者不能參與主研究，但可以參加 PDQ 問卷調查

背景資料，請根據參加者目前狀況回答	是/有	否/沒有
3. 能透過廣東話溝通		
4. 能閱讀中文字		
5. 有沒有家居 wifi		
6. 居住在社區		
7. 過去有沒有使用過智能喇叭		
8. 現時有沒有使用任何類型的智能喇叭		

9. **請完成 MoCA 評估並填上總分**
    a. 如參加者擁有 12 年或以下學歷，加一分
    b. 如 MoCA 總分低於 21，則不符合所有研究條件，篩查結束

10. **評估柏金遜症狀-H&Y Scale**
    a. 請根據下列流程圖進行評估
    b. Wheelchair-bound/ Bedridden (Level 5) 者不能參加主研究



11. 給予 MDS-UPDRS item 2.1 問卷給參加者。
   a. 4 分的參加者不能參加主研究

12. 準備好音叉 （512 HZ）（Rinne test （512 HZ））
   a. 解釋：而家會同你進行一次簡單聽力測試，我會先放一支音叉係你左邊的耳仔後面，讓您感受到震動，麻煩你用手覆蓋右耳，並係聽唔到聲音後話俾我聽。之後我會將同一支音叉放到你的左耳旁邊，同樣地請在聲音消失後話俾我聽。
   b. 先消毒音叉接觸位置
   c. 左右耳亦須完成
   d. 兩個 -ve result 的參加者不能參加主研究

Demographic

13. 未來八星期會否離開香港？
   a. 會
      i. 請寫下何時方便開始研究（未來 8 星期也在香港）
   b. 不會

14. 性別
   a. 男性
   b. 女性

15. 年齡（以整歲計）

16. 確診柏金遜症時的年齡（以整歲計）

17. 現時的居住情況

- a. 獨居
- b. 與伴侶同住
- c. 與家傭同住
- d. 與伴侶及家傭同住
- e. 其他

18. 婚姻狀況

- a. 從未結婚
- b. 已婚
- c. 同居
- d. 離婚/分居
- e. 喪偶

19. 現時的工作情況

- a. 有全職/兼職工作，包括自己做生意
  - i. 從事的職業
  - ii. 經理或行政人員
  - iii. 漁農業熟練工人
  - iv. 專業人員
  - v. 工藝或有關人員
  - vi. 輔助專業人員
  - vii. 機台及機器操作員或裝配員
  - viii. 文員及其他文書支援人員
  - ix. 非技術工人
  - x. 服務工作或商店銷售人員
  - xi. 其他（請註明）
- b. 沒有工作
  - i. 下列哪項最能形容您現時狀況？
  - ii. 退休人士
  - iii. 家庭成員的主要照顧者
  - iv. 失業/待業
  - v. 因疾病、殘疾/ 慢性疾病而不能工作
  - vi. 家庭主婦/料理家務人士
  - vii. 其他（請註明）:___

20. 教育程度

- a. 未受正式教育/幼稚園
- b. 工業學院/ 職業訓練學院
- c. 小學程度（小一至小六）
- d. 大專：(非學位課程/副學士學位課程）
- e. 初中程度（中一至中三）
- f. 大學：(學士學位課程）

  g. 高中程度（中四至中六/七）
  h. 大學：(碩士/ 博士學位課程）
  i. 毅進文憑課程

21. **你有足夠的金錢來滿足你的需求嗎？**

  a. 一點也沒有
  b. 少許
  c. 一般
  d. 大部分
  e. 十分足夠

22. **你有被確診下列的健康問題嗎？（可選多項）**

  a. 沒有
  b. 癌症
  c. 高血壓
  d. 抑鬱
  e. 肥胖症
  f. 焦慮
  g. 糖尿病
  h. 慢性阻塞性肺疾病
  i. 其他長期或精神病:___

23. **你現時使用的手機型號**

  a. Apple（蘋果）
  b. Android（安卓）

Appendix 4. VIPA user protocol

香港理工大學護理學院

透過聲控虛擬助理來提高柏金遜症人士的心理健康— 一項隨機對照試驗

《 聲控虛擬助理用戶指南》－精華篇

Photo by James Yarema on Unsplash

引言

相較於詳盡版的用戶指南，精華篇濃縮了各個章節的語音指令，方便大家閱讀。如希望重溫基本操作 或獲得詳細解說、常見問題、疑難排解或使用例子時則可以參考詳盡版的用戶指南。

由於參與研究的柏友將會在不同時段使用聲控虛擬助理，因此為了準確量度出聲控虛擬助理對大家精神健康的效能，請不要和其他柏友分享指南內容。

如出現任何疑問時，請先參考詳盡版用戶指南中的常見問題及疑難排解（第 2 – 12 頁)。若果問題仍然持續，請 whatsapp 研究熱線電話： 95016842。研究人員亦會在每週與大家聯絡

目錄

基本操作

請在使用時將智能喇叭接上電源， 並確保手機已充電。你可以透過說出「喂 Siri 」來喚醒手機及智能喇叭裏的聲控虛擬助理。

用戶指南說明

我們在此指南中使用了不同圖示，來代表手機與智能喇叭的語音指令

1. 當看見 📱 圖案時代表此指令只適用於智能手機
2. 當看見 🔊 圖案時代表此指令可在智能喇叭使用

由於聲控虛擬助理將記住你的聲線，請透過說出**「喂 Siri 」**來喚醒聲控虛擬助理，並等候智能喇叭**亮起燈後**才說出指令內容

語音方程式

由於聲控虛擬助理只能認出固定關鍵詞，因此請跟從我們提供的口令說出語音指令

若他向你作出跟進查詢或要求你確認事項時，你只需直接回答便可（並不需再次說出「喂 siri」)，例如「好」或「唔好」。

若在發出指令時發現錯誤，請等待他完成回應後，從頭再說一次指令。你同時亦可隨時透過「喂 siri，停」來取消動作。

例子： 🔊 **喂 Siri,【通訊軟件名稱】 俾 【聯絡人姓名】 話【訊息內容】**

括號**【 】**代表你可以作出修改的內容

你可以對智能喇叭說**「喂 siri，whatsapp 俾研究熱線，話我開始研究」**。他會重複內容並詢問是否傳送訊息，你只需直接回答「好」或者「唔好」便可。

同時我們已將大家的名稱設定為「參加者」並記著你的聲線，若然聲控虛擬助理詢問是誰在使用時，請回答「**參加者**」。

第一周－柏金遜症狀

日期:

請在這周內 每天使用 10 次或以上下列的語音指令，並在每晚於進度記錄表中，記錄你今天說出「喂 Siri... 」的次數。

每日簡報／預測

在每天起床後獲得今天的天氣及行程

🔊（對智能喇叭說）「喂 Siri，我今日有咩做」

搜尋新聞

📱（對智能手機說）「喂 Siri，今日有咩新聞」

在晚上獲得明天的天氣及行程

🔊「喂 Siri，我聽日有咩做」

藥物響鬧功能

聲控虛擬助理會在每天的食藥時間提醒大家

如何設定新鬧鐘

語音方程式：

1. 🔊**喂 siri，較 【鬧鐘時間】鬧鐘，叫做【事件】**
2. 🔊**喂 siri，聽朝【起床時間】 叫醒我**

例子

1. 🔊**喂 siri，較每日晏晝 4 點鬧鐘，叫做夠鐘食藥**
2. 🔊**喂 siri，較夜晚 7 點半鬧鐘，叫做散步**

註：為每個鬧鐘命名可減低忘記設置鬧鐘原因的機會

如何更改鬧鐘

語音方程式：

1. 🔊**喂 siri，我有咩鬧鐘**
2. 🔊**喂 siri，將【原本鬧鐘時間】鬧鐘改成【新時間或名稱】**
3. 🔊**喂 siri，熄咗【鬧鐘時間】嘅鬧鐘**
4. 🔊**喂 siri，將夜晚散步鬧鐘改做夜晚 8 點**

與此同時，你亦可以自行於手機上修改鬧鐘

當鬧鐘響起來後的處理方法

1. 你可以說🔊「**喂 Siri，延遲鬧鐘**」來暫停並延遲鬧鐘 8 分鐘
2. 說🔊「**喂 Siri，停止**」來關掉鬧鐘。

當出現手震或說話困難時

在手機上打開軟件 / apps

語音方程式：📱**喂 Siri，打開　【軟件名稱】**

例子

1. 📱**喂 Siri，打開鬧鐘**
2. 📱**喂 Siri，打開 youtube**

資料搜尋

透過聲控虛擬助理在手機搜尋資訊時，可說

語音方程式: **喂 siri，幫我搵 【資料內容】；或直接說出問題**

如果聲控虛擬助理搜尋到大量相關資訊時，會把資料投放至電話上，你只需點擊合適選項，聲控虛擬助理便會將你帶到維基百科網頁或 Google 繼續瀏覽。

例子:

1. **喂 Siri，幫我搵復康會資料。**
2. **喂 Siri，國際金融中心有幾高?**

若聲控虛擬助理未能理解指令，可將其修改為**喂 siri，幫我上網搵 【資料內容】**

<u>希望搜尋不懂發音的英文字時</u>

字希望聲控虛擬助理代為搜尋，可選擇將字母逐個讀出

例子： 喂 Siri，幫我搵 lemon

<u>社區資訊例子</u>

1. **「喂 Siri，幫我搵柏金遜照顧者課程」**
2. **「喂 Siri，幫我搵柏金遜講座」**

減少膳食中的鹽 (鈉) 和糖

加強教師對鹽及糖的認識及培訓，以及制定更多「低鹽低. 糖」的食譜與學前機構分享，並鼓勵學前機構互相…

cfs.gov.hk

降低食物中鹽和糖的措施 - 立法會

2017年11月14日 ... 士而言，市場上是否有足夠和合乎其經濟考慮的低鹽低糖食品可 ... 享」平台，互相分享…

legco.gov.hk

顯示Google結果

我喺網上搵到呢啲結果。

現實導向例子

1. 🔊 「喂 Siri，**今日幾多號／今日農曆幾多號**」
2. 🔊 「喂 Siri，**而家幾點／幾多度**」
3. 🔊 「喂 Siri，**幾時係【節日名稱】」(例如幾時農曆新年)**
4. 🔊 「喂 Siri， **11 乘 23 係幾多？」(亦可計算其他算式)**
5. 🔊 **「喂 siri，今日【股票名稱】係點」**
6. 🔊 「喂 Siri，**今日恒生指數係點？」**

註：由於搜尋的財經資訊有機會出現延遲，因此只應作為參考。有需要時須向專業人士／網頁查詢

生活知識例子

你亦可在搜尋資訊時加入網頁／組織名稱，增加搜尋的準確度

1. 📱 **「喂 Siri，幫我搵衛生署建議嘅每日鹽分攝取量」**
2. 📱 **「喂 Siri，幫我搵衛生署低鹽煮食方法 / 低鹽食物。」**
3. 📱 **「喂 Siri，幫我搵衛生署嘅血壓資料 / 兩份生果，三份蔬菜」**
4. 📱 **「喂 Siri，幫我搵獅子相」**
5. 📱 **「喂 Siri，2 百蚊日圓即係幾多港紙」**
6. 🔊 **「喂 siri，1 加侖水有幾多／一安士即係幾多？」**
7. 🔊 **「喂 siri，五吋有幾多 cm？」**

歷史或興趣資訊例子

🔊/📱 **「喂 Siri，幫我搵秦始皇生平」**

備忘錄／錄音功能

聲控虛擬助理具有將語音轉換成文字的功能，此功能可幫助因手震而未能流暢打字的柏友將事情立即記低。

備忘錄

語音方程式： 🔊 **喂 siri，幫我寫低 【記錄內容】**

註：如聲控虛擬助理未能記下全部內容時，請先說出「喂 siri」並等候聲控虛擬助理的回應，然後才說出內容。

如何打開備忘錄

你可以在手機主畫面找尋備忘錄 app 來讀取剛才記錄下來的資料，或透過以下語音指令尋找或查看筆記

1. 📱 **「喂 Siri，打開備忘錄 」**
2. 📱 **「喂 Siri，幫我搵 【記錄內容】嘅備忘錄」**

例子：🔊 **「喂 Siri，幫我搵買生果嘅備忘錄」**

如何讀出備忘錄

1. 🔊 **「喂 Siri，讀返頭先嘅備忘錄」**
2. 🔊 **喂 siri，讀 【記錄內容】嘅備忘錄**

例子：🔊 **「喂 Siri，讀買生果嘅備忘錄」**

錄音功能

📱 **「喂 Siri，幫我錄音」**

聲控虛擬助理便會自動透過電話進行錄音，你只需跟從螢幕指示便可。

如何播放錄音

1. 📱 **「喂 Siri，播頭先段錄音」**來播放最新錄音。

2. 📱 **「喂 Siri，打開錄音」**來打開錄音機 app。

生活應用

除了可以作為筆記使用外，聲控虛擬助理亦可協助因僵硬而出現說話問題的柏友。聲控虛擬助理可將你的語音存下或轉錄成文字，再加大聲量地重複內容。

流程圖

1. 先靠近聲控虛擬助理或手機慢慢地說出

🔊 **「喂 Siri，幫我寫低 【記錄內容】」**

2. 再將聲控虛擬助理音量較大

🔊 **「喂 Siri，較到最大聲」**

3. 然後要求聲控虛擬助理讀出剛剛完成的筆記

🔊 **「喂 Siri，讀返頭先嘅備忘錄」**

這樣聲控虛擬助理便會大聲地重覆你剛才的說話。

第二周 - 柏金遜症狀（續）

日期:

請在這周內 每天使用 10 次或以上下列的語音指令，並在每晚於進度記錄表中記錄你今天說出「喂 Siri... 」的次數。

恆常運動

如何搜尋教學影片

語音方程式:

📱喂 siri，係 youtube 搵 **【機構名稱】【影片內容】**

聲控虛擬助理會將影片傳送到手機中， 屆時只要點選合適影片便可

例子

1. 📱 **「喂 Siri，係 youtube 搵衛生署耆樂 起動 心肺功能篇」**
2. 📱 **「喂 Siri，係 youtube 搵衛生署 十分鐘 活力操」**
3. 📱 **「喂 Siri，係 youtube 搵衛生署 長者保健運動」**

同時你亦可搜尋其他合適自己的教學影片配合你的活動情況（例如八段錦、太極、健步行等）。各位在運動前應做好熱身運動，並量力而為。在感到不適時應停止運動並尋求協助。

如何設置運動計時

語音方程式: **喂 siri，幫我計時 【時間】**

例子: 🔊 **「喂 Siri，幫我計時 15 分鐘」**

當計時器響起來後的處理方法

說 🔊 **「喂 Siri，停止」**來叫停響鬧

資料搜尋－運動篇

同時你亦可配合早前學習的資料搜尋功能，透過聲控虛擬助理找尋運動資訊

例如：📱 **「喂 Siri，幫我搵衛生署健步行」**

配合其他智能產品

手機

連接的手機擁有計步器功能，你可以在平日運動 / 外出時攜帶電話，他會自動紀錄大家的步數及卡路里消耗。

回家後，你可以說📱 **「喂 Siri，打開健身」**檢查當日的健康資料。

智能手錶

若配合 apple watch 使用，你將能於健身 app 中獲取更多及更準確的維生指數，並記錄運動情況。同時聲控虛擬助理亦可每 15 分鐘提醒大家站起來，減少久坐的情況。

在晚上感到難以入睡時

1. 跟聲控虛擬助理交談
    - a. 🔊 **「喂 Siri，我失眠」**
    - b. 🔊 **「喂 Siri，數綿羊」**
2. 叫他播放平靜、放鬆的背景音樂協助入睡
    - a. 🔊 **「喂 Siri，播森林聲」**
    - b. 🔊 **「喂 Siri，播海洋聲」**
    - c. 🔊 **「喂 Siri，播落雨聲」**
    - d. 🔊 **「喂 Siri，播輕鬆音樂」**
    - e. 📱 **「喂 Siri，係 youtube 搵輕鬆音樂」**

出現步態僵硬/凍步時

1. 我們根據美國的柏金遜基金會列出的步態僵硬應對方法整合在聲控虛擬助理中，只要你說出

🔊 **「喂 Siri，我凍步」**，聲控虛擬助理便會說出應對方法。

2. 說🔊 **「喂 Siri，播音樂」**，讓你可以配合拍子繼續走路。

感到情緒低落時

1. 🔊 **「喂 Siri，講啲鼓勵金句」，來**獲得不同的鼓勵金句
2. 🔊 **「喂 Siri，最近公園係邊到」**，到附近公園散心
3. 跟聲控虛擬助理交談，他會嘗試開解你或提供其他舒緩方法
    - **a.** 🔊 **「喂 Siri，我唔開心／我傷心」**
4. 尋找其他團體的靜觀呼吸片段
    - **a.** 📱 **「喂 Siri，係 youtube 搵新生會靜觀呼吸練習」**
5. **宗教支援**
    - **a.** (天主教) 📱 **「喂 Siri，幫我係 youtube 搵神父講道／聖詩」**
    - **b.** （佛教） 📱 **「喂 Siri，幫我係 youtube 搵佛經」**

尋求幫助

1. 若然情緒未能好轉，你可以與家人、朋友傾訴或
    - a. 🔊 **「喂 Siri，幫我打俾 【聯絡人名稱】」**
2. 尋找最近的醫院或電緊急求助熱線獲得專業協助
    - a. 🔊 **「喂 Siri，最近嘅醫生／醫院係邊」**
    - **b.** 🔊 **「喂 Siri，幫我打 999」（只應在緊急時使用）**

你亦可使用 🔊 **「喂 Siri，停止打電話」**來取消動作。

第三週－通訊及聊天功能

日期:

請在這周內 每天使用 10 次或以上下列的語音指令，並在每晚於進度記錄表中記錄你今天說出「喂 Siri... 」的次數。

語音通話

如何查看聯絡人電話

聲控虛擬助理能在你的通訊錄尋找聯絡人電話

語音方程式: 🔊 **「喂 Siri，搵　【通訊錄內的名稱】嘅電話」**

例子: 🔊 **「喂 Siri，搵研究熱線嘅電話」**

如何致電或回覆別人

語音方程式: **喂** 🔊 **Siri，打俾**　【通訊錄內的名稱】 / 【讀出電話號碼】

例子

1. 🔊 **「喂 Siri，打俾亞仔」**
2. 🔊 **「喂 Siri，打俾 12345678」**
3. 🔊 **「喂 Siri，打翻俾上一個電話」**

結束通話及音量調整

通話過程中，你可以按下喇叭上的「＋」 或「 － 」 來調較音量。

你只要說出 🔊 **「喂 Siri，收線」**便可結束通話

當有來電時

1. 🔊 **「喂 Siri，聽電話」**
2. 🔊 **「喂 Siri，拒絕來電 / 電話」**
3. 🔊 **「喂 Siri，邊個打電話嚟? 」**

查詢未接來電

🔊 **「喂 Siri，頭先邊個打嚟」**

緊急求助

若出現家居意外或其他緊急情況而需要求助時，可跟聲控虛擬助理說出以下語音指令救助或致電親屬

1. 🔊 **「喂 Siri，打俾家姐 」**
2. 🔊 **「喂 Siri，打 999 」（只應在緊急時使用）**
3. 🔊 **「喂 Siri，幫我報警 」（只應在緊急時使用）**

文字短訊功能

適用通訊軟件： whatsapp / 微信 / 文字短訊（SMS 及 imessage）

查看短訊

方程式： 🔊 「喂 Siri，讀出 【通訊軟件名稱】 」

例子

1. 🔊 **「喂 Siri，讀出最新 whatsapp」**
2. 🔊 **「喂 Siri，讀出 【聯絡人姓名】的 whatsapp」**
3. 🔊 **「喂 Siri，我有咩未讀 whatsapp」**

如何回覆短訊

當聲控虛擬助理說出最新訊息後，會問你是否回覆，這時只需回答

🔊 **「喂 Siri，回覆 【通短訊內容】 」**

回覆其他聯絡人短訊

🔊 **「喂 Siri，回覆 【聯絡人姓名】 【通訊軟件名稱】 話【通短訊內容】」**

例子： 🔊 **「喂 Siri，回覆研究熱線 whatsapp 話我開始研究啦」**

發送短訊

方程式： 🔊 **喂 Siri， 【通訊軟件名稱】 俾【聯絡人姓名】， 話【訊息內容】**

例子： 🔊 喂 Siri， whatsapp 俾陳大文， 話聽日出嚟食飯？

1. 你可以說出「問號」來輸入「？」
2. 完成短訊後，聲控虛擬助理會重複短訊，如沒有問題的話，回答「冇錯 / 係」便可，否則說「唔係」並再次說出短訊內容

為聯絡人設置暱稱

1. 🔊 「喂 Siri，陳美麗係我家姐」，然後你便可簡化指令為
2. 🔊 「喂 Siri，打俾家姐」

視像通話

語音方程式： 📱 喂 Siri， 【通訊軟件名稱】 視像通話 【聯絡人姓名】

例子： 📱 「喂 Siri， whatsapp 視像通話小明」

智能聊天功能

你可透過下列指令進行聊天。聲控虛擬助理能夠根據你的聊天內容作出相應回答，因此你可以多作不同嘗試來與他互動。

1. 🔊「喂 Siri，你叫咩名」
2. 🔊「喂 Siri，你識做咩嘢」
3. 🔊「喂 Siri， Siri 代表咩意思」
4. 🔊「喂 Siri，你鍾意咩嘢 / 動物 / 地方？」
5. 🔊「喂 Siri，我鍾意【說出你喜愛的東西 / 動物 / 地方】」
6. 🔊「喂 Siri，你同機械人有咩分別」
7. 🔊「喂 Siri，你最近點樣」
8. 🔊「喂 Siri，擲銀仔」
9. 🔊「喂 Siri，抽啤牌」

<u>說故事及笑話</u>

1. 🔊「喂 Siri，講個笑話我聽」
2. 🔊「喂 Siri， Rap 俾我聽」
3. 🔊「喂 Siri，講急口令我聽」
4. 🔊「喂 Siri，講個故仔我聽 / 鬼故我聽」
5. 🔊「喂 Siri，寫首詩」

若然你希望他繼續說下去，亦可以說出 🔊「喂 Siri，講多個」

第四週 - 行程管理及導航功能

日期:

你可以透過聲控虛擬助理來管理日常的行程表， 此功能將可應用在日常活動或覆診預約上，我們已將你現有的覆診紀錄預先載入日曆裡，你可以根據下列語音指令獲取更新訊息。

請在這周內 每天使用 10 次或以上下列的語音指令，並在每晚於進度記錄表中記錄你今天說出「喂 Siri... 」的次數。

如何查看全部預約行程

語音方程式: 🔊 喂 Siri， 我【日期】 有咩做

例子

1. 🔊 「喂 Siri，我 le 幾日有咩做？」
2. 🔊 「喂 Siri，我下星期三有咩做？」

如何查看特定預約行程

語音方程式: 🔊 喂 Siri， 睇下日曆 【活動名稱】

例子: 🔊 「喂 Siri，睇下日曆幾時覆診」。

siri 會將所有帶有’覆診’字眼的預約整理好並說出來或傳送至手機上

行程安排流程圖

1. 先透過聲控虛擬助理**搜尋目的地或有趣景點**
   a. 🔊「喂 Siri，最近的__係邊 / 幾點開」
      i. 例子：喂 Siri，最近的醫院係邊
   b. 🔊「喂 Siri，我肚餓」(他會列出附近的食肆)
   c. 🔊「喂 Siri，附近餐廳嘅電話」(他會列出電話)
   d. 🔊「喂 Siri，我想食【菜式】」例子：我想食日本嘢
   e. 🔊「喂 Siri，去【目的地】要幾耐」
      i. 例子：喂 Siri，去最近的醫院要幾耐
   f. 📱「喂 Siri，香港熱門旅遊景點」或 香港一日遊推介
   g. 📱「喂 Siri，附近有咩活動 / 音樂會」

2. **天氣預測**
   a. 🔊「喂 Siri，今日天氣點 / 洗唔洗擔遮」

3. **如何按排行程或建立預約**

* 請緊記說出**「安排」**來制定行程，若使用其他字眼聲控虛擬助理未必能夠理解你的意思。

   a. 語音方程式：🔊喂 siri，**安排**【日期】【活動名稱】
   b. 例子：「喂 siri，**安排**聽日下晝 3 點食飯」

4. **更改行程**

語音方程式：🔊喂 siri，將【原本活動日期】嘅【活動名稱】改成【新活動日期】

例子：🔊「喂 Siri，將聽日嘅食飯改做後日」

導航

5. 預先查詢路線

a. 「喂 Siri，點樣去__」

b. 「喂 Siri，去__要幾耐」

6. 導航功能

語音方程式：喂 siri，我想去 （目的地名稱）

例子

「喂 Siri，我想去香港理工大學」

終點：香港理工大學

起點 香港國際機場 現在出發

52分鐘

地鐵將於1、11分鐘後開出 延遲

3分鐘 215X

2分鐘

開始

香港理工大學

開始

香港國際機場 中国香港特別行政區新界赤鱲角翔天路1号

乘搭機場快綫地鐵

往香港方向

即將開出，10分鐘 延遲 更多

在九龍落車

青衣之後

機場

搭乘2個站，29分鐘

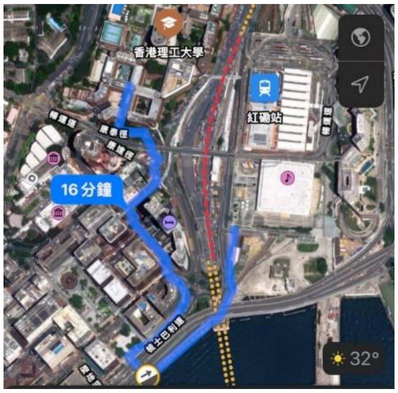
九龍

離開火車站

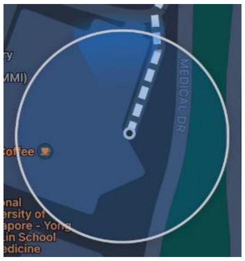
步行至九龍鐵路站

90米，步行約3分鐘

7. 點選中間的鐵路標示即可獲取公共交通資訊
8. 按下開始獲得詳細交通資料。例如列車班次及轉車資料等
9. 按下右上角的圖示來選衛星圖功能來獲取外景圖，方便導航



10. 根據手機上的 gps 定位功能尋找方向



圈中為你的大概位置，藍色指向為電話指向的方向

11. 若你選擇步行至目的地,在按下開始後聲控虛擬助理會說出路線圖

路線

我的位置

紅磡站

步行

避開

16 分鐘

1.1公里・平緩山坡

開始

80 米

轉右進入小路

康達徑

12. 同時你亦可以按下箭咀

終點：紅磡站

16 分鐘

13. 便可以分享預計到達時間給不同的聯絡人

14:22 抵達

15 分鐘

1.1 公里

分享預計抵達時間

第五週 - 娛樂及其他輔助功能

娛樂

日期:

你可以透過聲控虛擬助理於互聯網或 youtube 搜尋娛樂訊息。請在這周內 每天使用 10 次或以上下列的語音指令，並在每晚於進度記錄表中記錄你今天說出「喂 Siri... 」的次數。

<u>尋找 youtube 影片</u>

語音方程式：📱喂 Siri，係 youtube 搵 【影片內容】

1. 📱「喂 Siri，係 youtube 搵 K 啦 ok」
2. 📱「喂 Siri，係 youtube 搵輕鬆音樂」
3. 📱「喂 Siri，係 youtube 搵風景片」
4. 📱「喂 Siri，係 youtube 搵 【地方名稱】旅行」
5. 📱「喂 Siri，係 youtube 搵 【藝人名稱】」

<u>播放電台 / 廣播劇</u>

1. 🔊「喂 Siri，**播** 香港電台 / 香港電台第三台 / 香港電台第四台 / 新城財經台」
2. 📱/🔊「喂 Siri，喺 podcast 播晨早新聞天地」
3. 📱/🔊「喂 Siri，喺 podcast 播報章摘要」
4. 📱/🔊「喂 Siri，喺 podcast 播講東講西」
5. 📱/🔊「喂 Siri，喺 podcast 播健康大道」

你亦可說出📱「喂 Siri，打開 podcast」/ Podcast 來瀏覽節目

<u>音樂播放</u>

聲控虛擬助理亦可在你的音樂庫搜尋歌曲

🔊「喂 Siri，**播** 【歌手/歌名】」

🔊「喂 Siri，喺【音樂軟件】**播** 【歌手/歌名】」
(音樂軟件例子包括: Spotify, Apple music 或 KK box)

🔊「喂 Siri，播輕鬆音樂」

如何控制音樂播放

1. 🔊「喂 Siri，下一首」
2. 🔊「喂 Siri，上一首」
3. 🔊「喂 Siri， le 首歌邊個唱 」
4. 🔊「喂 Siri，停」
5. 🔊「喂 Siri，播 30 分鐘後停止」

注：如無需要，當聲控虛擬助理問你會否訂閱 apple music 時，回答不需要便可。

提醒事項

建立列表

語音方程式：🔊喂 Siri，幫我係【列表名稱】加入 【需要項目】

例子

1. 🔊「喂 Siri，幫我係購物列表加入買廁紙」
2. 🔊「喂 Siri，幫我係家務列表加入清潔」

查看提醒事項

🔊「喂 Siri，我有咩提醒事項」

讀出列表時

語音方程式：🔊喂 Siri，讀出 【列表名稱】

例子：🔊「喂 Siri，讀出購物列表」

同時你亦可透過手機中的提醒事項 app 提醒事項 來查看資料

<u>完成提醒事項後</u>

語音方程式：🔊 喂 Siri，我完成咗【列表名稱】嘅【提醒事項名稱】
例子：喂 Siri，我完成咗購物列表嘅買廁紙

<u>如何設置計時器</u>

語音方程式：🔊 喂 Siri，幫我計時 【時間】
例子：

當你在煮食時，可以說 🔊「喂 Siri，幫我計時 15 分鐘」

並透過 🔊「喂 Siri，計時仲有幾耐」來獲得更新

<u>當計時器響起來後的處理方法</u>

你可以說 🔊「喂 Siri，停」來關掉計時器 。

第六至八周 - 自由使用

恭喜你已在過去 5 周完成了聲控虛擬助理的基本訓練。請在餘下的 3 周內按照自行需要繼續使用聲控虛擬助理，並記錄使用次數。

資料來源

Apple (2020). *使用 Siri 實現更多操作- Apple 支援（香港）*. https://support.apple.com/zh-hk/HT208336

Shane Whatley (2019, December 15). *Conversational Siri Shortcuts for the Smart Home! | HomeKit Siri Shortcuts for the Apple HomePod*【Video】. Youtube. https://www.youtube.com/watch?v=qJY3eP7Kb-c